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Prochaotic tourism development pressure on coastal habitats – adequate evaluation case study in Sulina, România

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Abstract. On the coastal areas, the pressure of touristic development upon natural areas is increasing and interfering with main purposes of Natura 2000 sites designation. Therefore the habitats tendency, adequate for species development, is in regression as far as areas size and homogeneity are concerned. In this respect, a case study is presented for the Black Sea's north-western littoral, in Sulina locality, Romania. The present paper was elaborated in conformity with Ministry Order 19/2010 for the Methodological Guide with regard to the adequate evaluation (A.E.) of the effect of potential plans or projects on protected natural areas of community importance. The case study is an investment project called "*Sulina beach arrangement*". Its objective was to develop a plot for the beach area's tourist infrastructure in order to provide services to the public. The cumulative impact of the existing project may affect the coastal habitats (1210, 1310, 1410, 2110 and 2160) and Natura 2000 site integrity (ROSCI0065 Danube Delta). Regarding these habitats types, conservation value, criterion of representativeness and functions in concern with possibilities for restoration are analyzed. At present, the studied emplacement is mainly affected by the anthropic interventions, having the aspect of a degraded natural area. In addition, conservation measures are described, which were elaborated in accordance with both the national legislation and by consulting the management plans of certain protected natural areas from abroad, which contain habitats characteristic to the marine coast and sandpits within their perimeter.

Key words: adequate evaluation, coastal habitats, tourism development, biodiversity

INTRODUCTION

Most of the countries have estimated losses of coastal wetlands exceeding 50% of the original area with peaks above 80% for many regions [1; 16]. Coastal habitats are important biodiversity hotspots supporting rich species assemblages. This renders them important habitats for biodiversity conservation as they frequently harbor endangered species [11]. The Romanian coastal habitats, in the north western part, include forest plantations (4.51%), salt marsh vegetation (8.5%), aquatic vegetation/lakes and channels (1.39%) and vegetation on sand dunes (85.6%). From tourist development perspective, in Sulina area, in the last years, the investment was done within the beach area with negative impact, at least upon the landscape, is strongly degraded from the perspective of species and habitats. Anthropogenic pressures, such as grazing, is one of the activities frequently observed on the entire littoral [18]. At present, this activity, uncontrolled administrated, intensifies the process of habitat degradation through the ruderal and invasive plants' expansion [2]. Another activity which develops in the littoral area is tourism. Coastal habitats are strongly affected by this activity which is not established under the Order 1204/2010, furthermore, in the sector of Sulina - Sf. Gheorghe, habitats 1210 and 2110 are strongly affected by the erosion process [12]. The study area is considered the existing investment project "Sulina beach arrangement" and it was aimed at creating specific recreation facilities (sport fields, pedestrian access alleys to the seashore, green spaces, kiosks/stalls, pontoons for walks along the seashore), the attainment of the sewerage system, and the rehabilitation and expansion of drinkable water distribution system. The land displays as a strip between the beach and the leasehold land, is about 450 m long and with varying width between 65-75 m. The surface occupied with constructions and endowments represents 3.35% of the entire surface, the occupying coefficient is 31%, and the vegetation occupies approximately 45%, while the rest of 22% is not enhanced. The necessity to enclose the aforementioned object is justified by the need for limiting unauthorized persons and domestic animal access. The planned objective is the enclosure of the constructed premises with stall moduli. This investment project will be approximately 1100 m long and 1.3 m high. The construction works with regard to the project implementation will be carried out manually. The material that it will be built of on the west, north and east sides will be bordered-net panels fixed/shielded on wooden poles directly planted in the ground, without concrete cribs. On the southern side, the enclosing fence will be manufactured out of willow, reed or scrubs characteristic to the area. Its purpose is to ensure the enclosure of the "Sulina beach arrangement" premises built with stall type moduli.

MATERIAL AND METHODS

The investment project is located in Romania, Tulcea County, within the incorporated area of Sulina town, eastward of the locality and at a distance greater than 150 m from The Black Sea coast (Fig. 1). The land is situated within the area of Sulina locality, in UTR-“A”, the total area quantum being 3.5 ha. The emplacement of the proposed project lies within the limits of ROSPA0031 Danube Delta – Razim Lagoon and ROSCI0065 Danube Delta, which identified, mostly, as Danube Delta Biosphere Reserve (D.D.B.R.) territory. The limits of the investigated area, for A.E., confine the surface scheduled in the project (the area marked with blue in Fig. 2) as well as its vicinities and were marked following the reference points mentioned in the task book: on Sulina Arm, N and N-E, the national-interest public domain land and stone dam belonging to Galați Fluvial Agency of Lower Danube (A.F.D.J.), E and S-E The Black Sea, S and S-V, link the canal between the belt canal (Canal Centura) and The Black Sea, N and N-V littoral cordon (Canal Cordon litoral). The total investigated area measures approximately 150 ha.

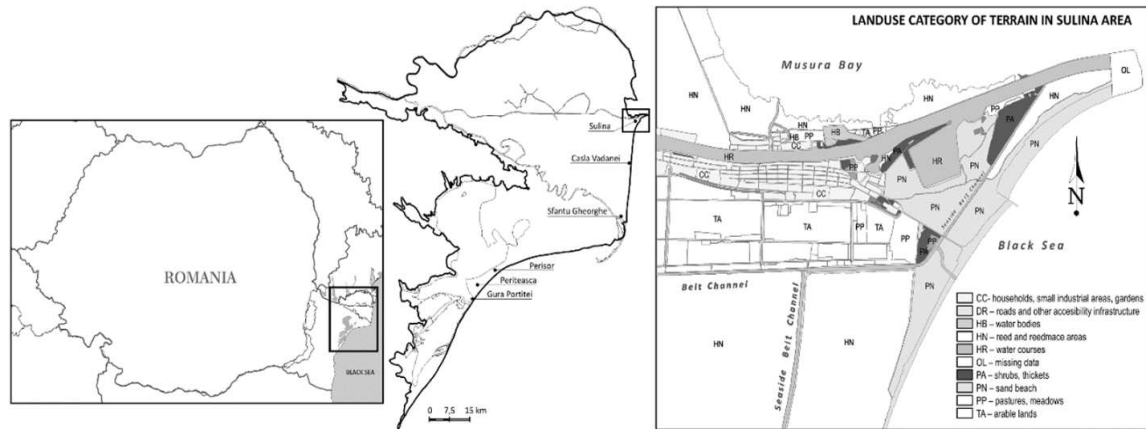


Fig. 1 Location of the study area (source: D.D.N.I.)

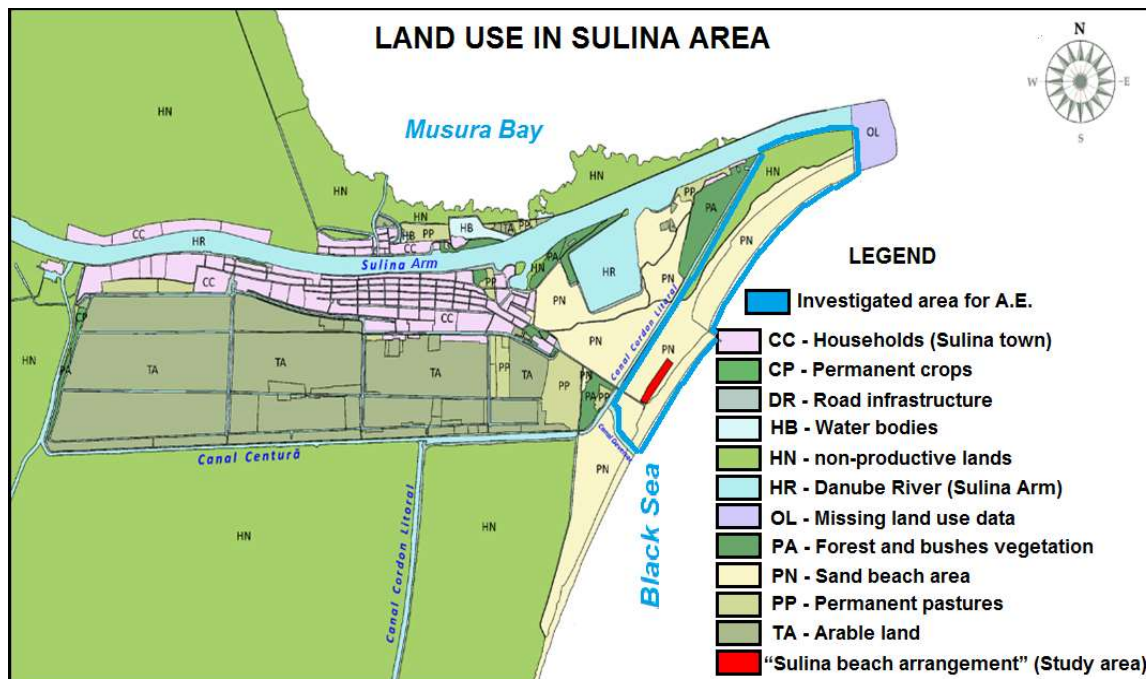


Fig. 2 The emplacement of the area for the investment project “Sulina beach arrangement” and investigated area for A.E. study

The information concerning the study elaboration was accessed from documents applied for to the Tulcea County Council. In these documents, there was no information found regarding the enclosing project’s time period. In order to elaborate the A.E. study, the following documents were employed: D.D.B.R. management plan; standard

forms Natura 2000 SCI and SPA; relevant information supplied by peers from Bucharest University and "Alexandru Ioan Cuza" University in Iasi; plans, maps, materials dealing with the area's geology, hydrology and ecology from Danube Delta National Institute (D.D.N.I.) archives; the report regarding the environmental state within D.D.B.R., as well as the plans concerning land use. It must be mentioned that numerous studies for the biodiversity component were carried out in the studied area over the last 5 years. Updating and checking of the information from the above-mentioned sources was carried out through field studies.

RESULTS AND DISCUSSIONS

1. Description of Case study area

Physical modifications that will result from the investment project and will take place during the various implementation stages. The scheduled objective to be carried out consists of enclosing one side of the existing investment project "Sulina beach arrangement", respective to the objectives built premises, where six stall-type moduli and a first-aid point are located. They will be connected via a wooden bridge. The surface enclosed by the fence, 450 m long and 75 m wide, measures 3.375 ha, respective to the surface of the existing "Sulina beach arrangement" objective. The investment work, by means of carrying out the enclosure of the objective, will limit access to unauthorized persons and domestic animals. Subsequent to the enclosing work, there will be modifications in the natural area where the wooden poles/pylons are planted for supporting the bordered-net panels, respectively the northern, eastern and western sides. In the technical documentation, it is mentioned that *"on the southern side, the enclosing fence will be manufactured of willow, reed or scrubs characteristic to the area"*. However, the height of the bottom edge of the fence in relation to the ground is not specified. Unless certain criteria for the enclosure of an object will be taken into consideration, under the circumstances of a protected area, there will be physical modifications with repercussions on species and habitats on all the enclosing sides. The yards establishment/logistics will be made inside the private company premises that will built the site, and this establishment/logistics does not imply activities that might damage the environment. The materials will be gradually transported to the object as the works are carried out. It will include vegetation-clearing activities with a mechanic impact on soil during the execution stage. Subsequent to the completion of works, the surface occupied by the enclosing fence will measure approximately 0.03 ha. It will cause physical modifications during the working time period by way of using the land, namely the separation of the natural area from the existing project area, "Sulina beach arrangement". The investment is long-term, the accidental pollution may refer only to the waste resulting from construction activity, but it will be temporarily and selectively deposited. The enclosing works for the "Sulina beach arrangement" would employ poles/pylons made of wood, willow, reed and scrubs, characteristic to the area. The natural resources employed for the enclosing works of the object "Sulina beach arrangement" will not be extracted from the D.D.B.R. site.

The investment project will not imply the use, stocking, transportation, and manipulation, production of substances and materials that might affect the species and/or habitats of community importance. The materials will be gradually transported from the yards established within private company premises to the objective, as the works will be carried out. In order to transport the materials, the use of an equipment park is required, which is an air pollution source. The specific polluting substances are nitric oxides (NO_x), non-methanic volatile organic complexes (COV_{nm}), methane (CH₄), carbon oxides (CO, CO₂), ammonia (NH₃), heavy metals particles (Cd, Cu, Cr, Ni, Se, Zn), polycyclic hydrocarbons (HAP) resulting from fuel-burning engines. Other polluting sources may be in-suspension and powders, resulted from car traffic and materials circulation. It is assessed that polluting substances emissions (caused by both the car traffic characteristic to the yards and material handling) which might get into the air are not quantitatively important and do not modify the classification into air quality categories. Additionally, the distance covered to the establishment, moving and maneuver times as well as the frequency during a day have to be considered.

The use of certain high-performance equipment and transportation means, efficiently adequate and with specific reduced consumption of fuel both in the yards and during the loading, downloading and transportation of bales/materials. According to art. 17 (1) of Ministry Order 462/1993, the preventive limitation of polluting emissions from road vehicles is carried out by the technical conditions provided by periodic inspections/checking, and (2) maximum emission limits allowed are set by the Ministry of Transport and The Ministry of Environment in conformity with Economic Commission for Europe - O.N.U.

On the access ways, where the equipment will circulate, aspersion will be cyclically done with the view to reduce, until annulment, areal dust pollution. The materials employed in building the object do not have the potential to pollute air, soil, and underground and surface waters. The measures to reduce impact within the protected habitats are those strictly related to waste management. The waste, which will occur during the enclosing works, is classified as refuse – resulting from the work crew, and technological refuse – resulting from the execution stage. During the working stage, waste will be generated by tourist activity. According to Governmental Decision (G.D.) no. 856/2002 concerning the record of waste management and for the passage of the list with the waste, the non-dangerous ones included, they fall into municipal waste and waste assimilated from commerce, industry, institutions, including fractions collected separately. At present, there is no known data regarding the total number of staff who will carry out the enclosing works. Therefore, it is not possible to estimate the resultant refuse amount. However, if the waste generation index is considered, an amount of 0.6 kg/person/day may be estimated (**Table 1**).

Table 1

The list of potential waste in the emplacement area

Category no.	Waste type code	Waste type	Waste type	
			(*)	(**)
1	20 01 01	paper and cardboard	x	x
2	20 01 02	glass	x	x
3	20 01 08	biodegradable waste from kitchens and cafeterias		x
4	20 01 11	textiles	x	x
5	20 01 34	batteries and accumulators, other than those specified in 20 01 33		x
6	20 01 38	wood other than that specified in 20 01 37	x	x
7	20 01 39	plastic materials		x
8	20 01 40	metals	x	
9	20 01 99	other unspecified fractions	x	x
10	20 02 01	biodegradable waste		x
11	20 02 03	other non-biodegradable waste		x
12	20 03 06	waste resulting from sewerage clearing		x

(*) during the work execution time period; (**) during the working time period

The modality to eliminate/reduce: The solid waste produced during the building work will be deposited, temporarily, until the completion of work, in the space aimed for the yards development. The temporary waste deposit may affect species and/or habitats if the building activity is scheduled within a time period favorable to species' activities. The resulting waste will be selectively collected and delivered to a company of profile in Sulina according to a set timetable, the time period and the intensity of the scheduled activities.

The land regulation regime: The emplacement to be enclosed measures approximately 3.5 ha and is located within the incorporated area of Sulina town. The property type constitutes public town domain. The land is regulated in accordance with the Zonal Urban Plan (P.U.Z.) as being a beach clearing with a touristic purpose (Table 2).

Table 2

The territorial balance of the emplacement

Functional area	The territorial balance of the emplacement					
	Initial (before 2008)		Actual		Proposed (extension potential)*	
	ha	%	ha	%	ha	%
Anthropogenic area	7.09	3.96	10.72	5.91	0.0006	0.0003352
Tourist investment	0	0	3.5	1.95	0.0006	0.0003352
Buildings	0.12	0.06	0.35	0.19	0	0
Roads, pathways	2.9	1.6	3.8	2.12	0	0
Tourist beach	3.07	1.71	3.07	1.71	0	0
Natural area	168	93.85	164.5	91.89	0	0
Vegetation	161.3	90.11	157.8	88.15	0	0
Water bodies	6.7	3.74	6.7	3.74	0	0
Other areas:	3.7	2.06	3.9	2.17	0	0
Garbage site	3.7	2.06	3.9	2.17	0	0
Total surface	≈179	≈100	≈179	≈100	0.0006	≈100

Requirements related to the land use necessary for project execution: The yards establishment will be situated in the minimal possible areas/surfaces, so that it should benefit from certain facilities in order to reduce perambulation and organization expenses, on one hand, and to avoid natural habitats extinction, on the other hand. In order to carry out the enclosing works for the "Sulina beach arrangement", materials transport will be done with specific equipment. Their access is exclusively ensured in the area aimed to be an entrance for automobiles from the western side of the premises that are being enclosed. The placement will be decided according to the access ways to the work site, bridges and areas where the specific conservative-interest habitats and species to the littoral cordon are not present.

The proposal for development: The proposal for development is the enclosure of the investment object "Sulina beach arrangement". The enclosing project aim, together with the existing investment project, is to develop a tourist area in order to practice seasonal tourism, in approximate three months (June to August).

The General Urban Plan (P.U.G.) destination of the emplacement is situated in Reference Territorial Units (R.T.U.) "A" which confines dwelling areas (productive activities and services compatible with dwelling) with low height regime, some of which included in the list of architecture objectives under the protection of the National Commission of Historic Monuments, Ensembles and Sites (N.C.H.M.E.S.), public institutions and services, some of which included in the list of architecture objectives under the protection of NCHMES (I.S.), industry and storage (I.D.), technical-urban (T.U.), public/communal management, including the graveyard within the list of objectives under the protection of N.C.H.M.E.S. (P.M.), special areas (S.). With regard to the protection of human settlements and

other objectives of public interest such as areas of traditional interest, architecture and historic monuments, they are located in Sulina, 2 km distance from the investment project.

2. Impact identification and evaluation

According to the classification stage Order no. 162 from 06.08.2013, the main reasons for which the A.E. study elaboration has been recommended are displayed in five articles. For each aspect, a brief answer will also be provided, which will then be elaborated further in this paper.

1. The arrangement is situated within The Danube Delta Biosphere Reserve area, included in the Natura 2000 sites of community importance ROSCI0065 Danube Delta, respectively the avifauna protection site ROSPA0031 Danube Delta and Razim lagoon;

Answers: The arrangement "Sulina beach arrangement" which is to be enclosed is entirely situated within Natura 2000 sites area ROSCI0065 and ROSPA0031, respectively in the Black Sea bioregion.

2. The distribution of species and/or habitats of community importance characteristic to the littoral is affected by the project implementation;

Answers: The distribution of the species and/or habitats is not affected by the project implementation. Within the arrangement area, there were not identified community importance vascular plant species, reptiles, amphibians, birds and mammals, under the protection of Governmental Emergency Order (G.E.O.) 57/2007, respectively "Habitats" and "Birds" directives. Within the arrangement area, there were identified two insect species of community importance, *Coenagrion ornatum* Selys, 1850 and *Lycaena dispar* Haworth, 1802.

3. Within the arrangement area, there are habitats of community importance characteristic to the littoral: 1530* Pannonic salt-steppes and salt-marshes; 2130* Fixed dunes with perennial herbaceous vegetation; 1310 *Salicornia* and other annuals colonizing mud and sand; 1410 Mediterranean salt meadows (*Juncetalia maritimi*); 2110 Embryonic shifting dunes; 2160 Dunes with *Hippophaë rhamnoides*; 1210 Annual vegetation of drift-lines.

Answer: Within the "Sulina beach arrangement", there were two habitats of community importance characteristic to the littoral identified, namely: 1310 and 1410. Habitats 1530*, 2130*, 2110, 2160 and 1210 were identified in the proximity of the arrangement, within the beach area contained between The Black Sea shore and the arrangement.

4. The project directly influences the community importance protected natural area by the building actions;

Answer: The project for development of the "Sulina beach arrangement" enclosure does not directly influence the community importance protected natural area by the building actions;

5. Within the project area, there are three zones with populations of *Convolvulus persicus* species.

Answer: Within the arrangement area, there were no identified *Convolvulus persicus* (vascular plant) population. In the vicinity of the site, about 100 meters to its limits (45° 08'46.92" N, 29° 41'10.28" E), the beach area between the two pontoon bridges type, there is an estimated population of *Convolvulus persicus* 300-400 individuals. Compared to previous years, the number of individuals is increasing. Under current conditions, there is an extension of the land area occupied by the species. Note that the species is not present in standard sheet of ROSCI0065 in G.E.O. 57/2007, namely Directive "Habitats".

Subsequent to the elaboration of the control list for the classification stage, according to Ministry Order 19/2010 for the passage of The Methodological Guide with concern to the A.E. of potential effects of plans or projects on community importance protected natural areas, it was found that the investment project has impact on environment and biodiversity, by itself or corroborated with other projects.

The objective of the impact identification, in the case of the Natura 2000 ROSCI0065 site, is to evaluate the investment works adequacy to the conservation objectives according to "Habitats" Directive whose aim is to maintain and develop a favorable state to habitat conservation. As far as the evaluation of effects signification on ROSPA0031 is concerned, it must be considered that art. 3 in the "Birds" Directive charges the member states to take measures in order to preserve, maintain or restore a sufficient habitat diversity and surface for all the bird species [24].

For the present case, the evaluation of impact of the project for the elaboration of the objective "Sulina beach arrangement" enclosure on the two sites (ROSPA0031 and ROSCI0065) will be developed in three ways, as follows:

- The estimation method of global pollution impact (G.P.I.) described by Rojanschi and collaborators [15].
- The rapid evaluation method of the impact on environment (R.I.A.M.) [13];
- G.I.S. analysis of the surfaces.

The main analyzed indices were selected in conformity with the criteria of Environment European Agency report "Streamlining European biodiversity indicators 2020"¹ concerning habitat quality. In the selection of indices for impact evaluation of enclosing works for the objective "Sulina beach arrangement", it has also been considered the information on technical documentation, respectively the presentation memoir of the investment works during the classification stage.

The main indices selected from The Environment European Agency reports are:

¹ <http://www.eea.europa.eu/publications/streamlining-european-biodiversity-indicators-2020>

Protected and threatened species – This index highlights the number and the share of the species existent in habitats, evaluated as being threatened at global level or protected by means of European tools (vulnerable, rare, endangered and critically endangered) out of the total of the European species.

Declared natural protected areas – The index highlights the tendencies of the protected areas within ROSCI0065 and ROSPA0031, designated in conformity with national legislation, “Habitats” and “Birds” Directives and the international initiatives and conventions (expressed in hectares according to the standard form Natura 2000). It, in fact, reflects the surface modifications in time at the local level and of the cumulative habitat surface at the ROSCI0065 level. G.I.S. analysis will indicate the fragmentation percentage, the degree of habitat representation at various scales: local and at the level of Natura 2000 ROSCI0065.

Species diversity – The species groups that have been considered are vascular plants (*Cormophyta*), macro-invertebrate (*Bivalvia*, *Insecta*), fish (*Pisces*), reptiles (*Reptilia*), amphibians (*Amphibia*), birds (*Aves*) and mammals (*Mammalia*) within the studied area (area marked in blue). The information regarding species distribution relies on data collected by means of the standard methodology during the previous time period (2009-2013) and during the present evaluation study (2014).

Land use – The identification of habitat surfaces’ modifications within anthropic surfaces (roads, buildings, and so on) are calculated depending on the data extracted from orthophoto plans (Corine Land Cover 2006 and 2012) and expressed in hectares, then converted into percentages out of the total surface of ROSCI0065 and percentages out of the respective habitats at the level of the “Sulina beach arrangement” establishment.

The condition of impact on the integrity of Natura 2000 (ROSPA0031 and ROSCI0065) sites is present provided that the investment project may cause:

- Delays in reaching the objectives for the protected natural area of community importance; for this aspect, the D.D.B.R. management plan will be consulted with the view to identify certain objectives which targets the littoral.
- The blockage in reaching the objectives for the protected natural area of community importance; for this aspect, the D.D.B.R. management plan will be consulted with the view to identify certain objectives which targets the littoral.
- Negative actions on the conditions which determine the maintenance of a favorable state for the conservation of the habitat of community importance; for this aspect, information with regard to the biodiversity in the littoral area will be employed.
- Modifications of relationship dynamics (for example, modifications of relationships between soil and water or flora and fauna) which define the structure and/or the function of the protected natural area of community importance; the species which can be damaged as a result of the modifications caused by the enclosing works will be indicated.
- The reduction of habitat surfaces and the number of species of community importance; maps with habitat distribution in the area susceptible to be affected by the investment works, respectively maps with the distribution of the species identified in the field will be provided.
- The fragmentation of habitats of community importance. An analysis on habitat fragmentation within the investigated area will be presented. A comparison of the fragmentation degree (G.I.S. analysis) will also be elaborated.

The first calculation method is that of global pollution impact (G.P.I.) described by Rojanschi and collaborators [15] for the selected environmental indices (air, soil, species deficit, landscape) without eloquently highlighting the negative effects on habitat integrity. Among the method’s advantages, the following can be mentioned: the possibility to compare various environmental components of an initial state (S_i), (it was selected: the selected area in the northern side of the forest plantation in Sf. Gheorghe) with those of the real state (S_r) within the studied area.

The main drawback of the method is its high degree of subjectivity as it involves the assessor’s judgment and the fact that the evaluation is qualitative [14]. The relative shares of the individual environmental aspects are expressed in parameters importance units. The reference of environmental indices quality to the limits admitted by the national standards will be ensured, when the evaluation is quantitative (**Table 3**).

The reference is also carried out by considering the comparative state of an index with regard to the natural normal reference state. The G.P.I. can be obtained by scoring with evaluation marks from 1 to 10, where 10 represents the natural state unaffected by human activity and 1 represents an irreversible situation and particularly serious damage to the analyzed environmental sector (**Fig. 3**). By employing the illustrative method with evaluation marks, a diagram is elaborated in which the initial state is graphically represented by a regular geometric shape, with equal rays, having given the value of 10 evaluation units.

Table 3
Analyzed criteria for Si and Sr

Criteria considered for the environmental components	Sf. Gheorghe Initial state (Si)**		"Sulina beach arrangement" Real state (Sr)**	
	1310 <i>Salicornia</i> and other annuals colonizing mud and sand	1410 Mediterranean salt meadows (<i>Juncetalia maritimi</i>)	1310 <i>Salicornia</i> and other annuals colonizing mud and sand	1410 Mediterranean salt meadows (<i>Juncetalia maritimi</i>)
Diversity of species	10 species	22 species	6 species	15 species
Coverage with ligneous species	0%	0%	2%	10%
Ratio distribution in habitat/aggregation of characteristic species*	4 species/ m ²	6 species/m ²	2 species/m ²	2 species/m ²
Built-up surface	0%	0%	4%	8%
Invasive/alien species	0	2	1	4
Red-list species	2	3	1	1
Vegetation profile	Up to 30 cm	6 species/m ²	Up to 2.3 m	6 species/m ²
Invasive/alien species	0	2	2	6
Access ways/sub-layer settlement	1%	1%	5%	3%
Air pollution sources (exhaust gases, dust powder)	Reduced car traffic during all the year in the western side of littoral belt canal's dam	Reduced car traffic during all the year in the western side of littoral belt canal's dam	Car traffic more intense during the tourist season	Car traffic more intense during the tourist season
Potential anthropic activities	Reduced grazing	Moderate grazing	Intense grazing Tourism and recreation Person transportation Other commercial services	Intense grazing Tourism and recreation Person transportation Other commercial services

*acc. Eddy van der Maarel, Janet Franklin (2012); **the compared surfaces have the same surface, 3.5 ha.

Along these rays, the real value of evaluation factors marks analyzed in the field and the geometric shape of the real state is obtained. G.P.I. represents the ratio between the ideal area S_i and the area which represents the real state S (Fig.3). Subsequent to objectively having set the evaluation marks of the analyzed factors, the almost initial area (which indicates a natural environment without obvious anthropic influences) is calculated according to the geometric shape resulted from the composition of these factors and the surface of the geometric shape resulted from the composition of the segments resulted from the real evaluation marks in the field.

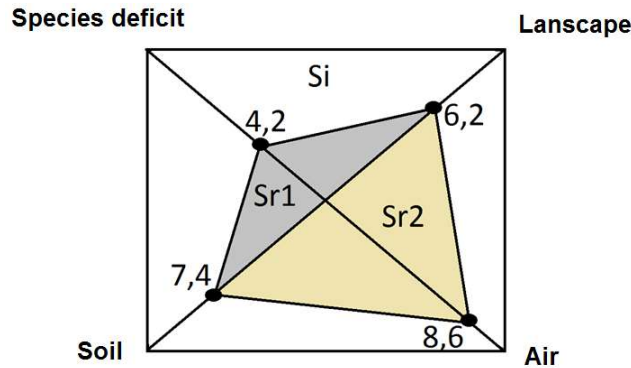


Fig. 3 Graphic representation of G.P.I. for the studied area

The results are related to a reference scale with regard to the quality of the analyzed environment. The values of the evaluation marks identified in the field for the four indices are the following: $NB_{landscape} = 6.2$; $NB_{soil} = 7.4$; $NB_{species\ deficit} = 4.2$; $NB_{air} = 8.6$.

The global pollution index is calculated according to the formula $G.P.I. = Si/Sr$

The irregular polygon real area resulted from the real evaluation values in the field is the sum of the two resulted triangles and it was calculated according to the formula:

$$Sr_1 = (6.2+7.4) \times 4.2/2 = 28.56$$

$$Sr_2 = (6.2+7.4) \times 8.6/2 = 58.48$$

$Sr = 87.04$ from where:

$$G.P.I. = Si / Sr = 200/87.04 = 2.29$$

The presented analysis result indicates that the impact is negative on the species and habitats in the littoral area. The obtained value comes under the reference scale concerning the environment quality within the limits of the class "environment subdued to human activity effect, causing discomfort to life forms" with medium risks at an acceptable level which requires monitoring after building completion. Thus, the result is that the works for the enclosure of the "Sulina beach arrangement" object have a significant negative impact on both habitat areas and species within the habitat at the local level (Table 4).

Table 4
Classification for the global pollution impact

G.P.I.	Evaluation mark	Description of environmental impact
GPI=0	10	Natural environment unaffected by human activity
1 < 2	9,999-7,072	Environment under human activity effect in admissible limits
2 < 3	7,071 – 5,774	Environment under human activity effect, causing discomfort to life forms
3 < 4	5,773 – 5,001	Environment under human activity effect, causing disturbance to life forms
4 < 6	5 – 4,083	Environment seriously affected by human activity. Dangerous to life forms
Over 6	≤ 4,083	Degraded environment, inappropriate to life forms

The second method is the rapid impact evaluation matrix (R.I.A.M.). The matrix impact method involves the elaboration of a matrix in which, the evaluated activities are specified on one axis, while on the other axis, the potential affected ecologic factors are presented. At the intersection of the activities with ecologic factors, impact intensity and importance are quantified. The employment of this method allows the analysis of all possible relations, which leads to a more objective total evaluation. It must be emphasized that the method provides the direct and indirect impact as well.

Usually, in the impact evaluation matrices, evaluation scales and grids for differentiating the roles of various activity and ecologic factors types are employed, which grants a complex nature to the method. Among the method's advantages, there can be considered: the opportunity to compare various impact types on the basis of common views. The main disadvantages of the method are: its subjectivity, as it involves either the assessor or an assessment team's judgment and the fact that the evaluation is qualitative, although quantitative marks are scored [14].

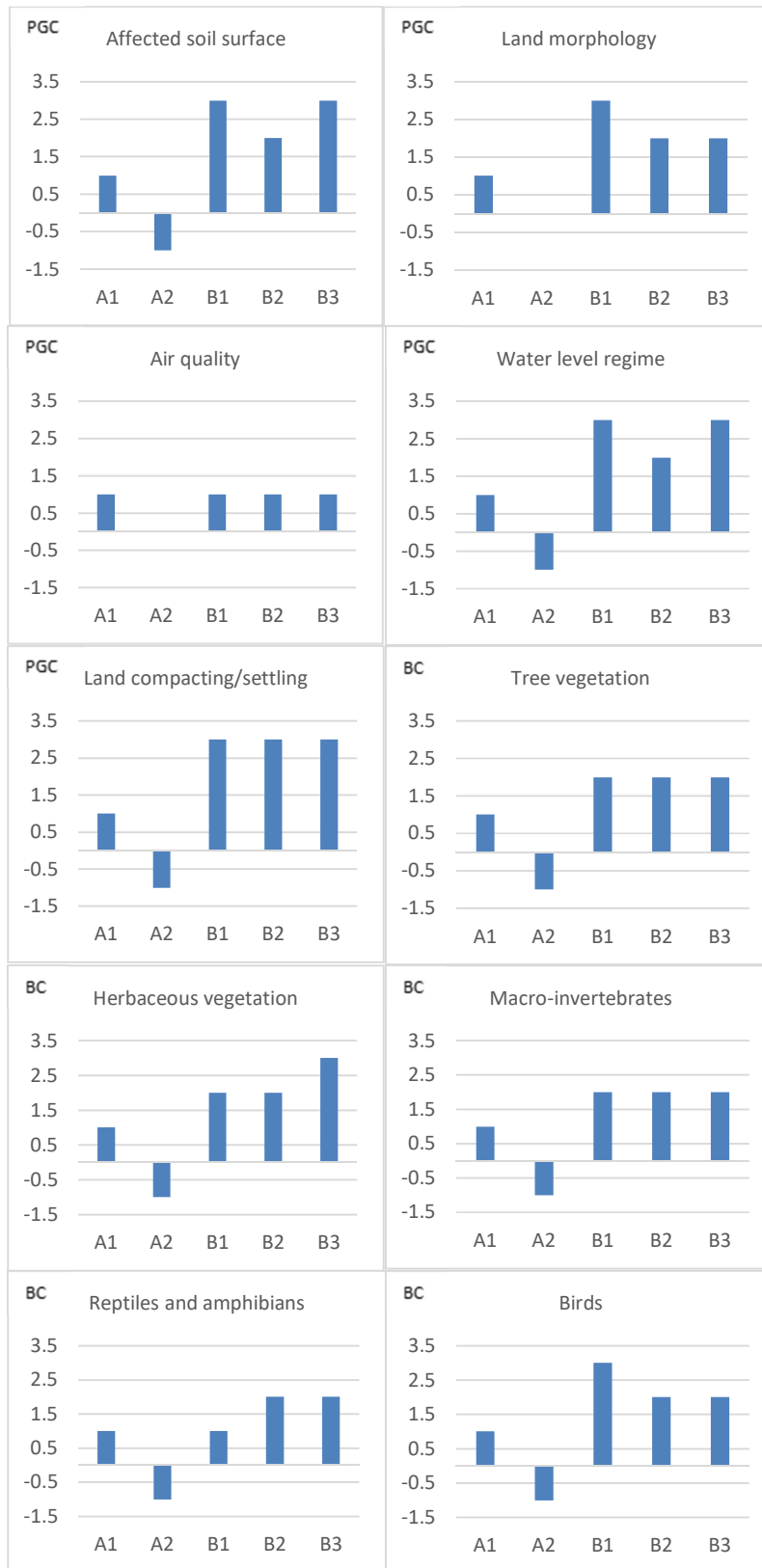
The R.I.A.M. method relies on a standard definition of the important evaluation criteria and of the means by which quantitative values for each criterion (represented through a concrete independent mark) are inferred (Table 5). The impact of the activities that will be carried out is evaluated toward environmental aspects and for each environmental aspect is decided a mark according to the defined criteria, thus the measurement of the potential impact for each considered environmental aspect is ensured [7] (Table 6).

Table 5
Criteria and evaluation stages through R.I.A.M. method [13]

Criterion	Score	Description	
A ₁ – The importance of environment modification (effect)	4	Important for national/international interests	
	3	Important for regional/national interests	
	2	Also important for the areas in the immediate proximity of the area	
	1	Important only for local conditions	
	0	No importance	
A ₂ – The magnitude of environmental modifications	+ 3	Major important benefit	
	+ 2	Significant improvement of the present state	
	+ 1	Improvement of the present state	
	0	No changes of the actual state	
	- 1	Negative change of the present state	
	- 2	Significant negative disadvantages or changes	
B ₁ - Permanent	1	No changes	
	2	Temporary	
	3	Permanent	
B ₂ - Reversibility	1	No changes	
	2	Reversible	
	3	Irreversible	
B ₃ - degree	Cumulative	1	No changes
		2	Non-cumulative / unique
		3	Cumulative / synergistic

Steps in R.I.A.M. implementation:

1. Specification of criteria and evaluation stages;
2. Definition of considered environmental aspects and their classification;
3. Calculation of environmental scores for each environmental aspect;
4. Conversion of individual environmental scores into impact categories;
5. Specification of the impact category for each environmental aspect class;
6. Representation in the numerical form of environmental score decided for environmental aspect classes and environmental categories (**Fig.4**).



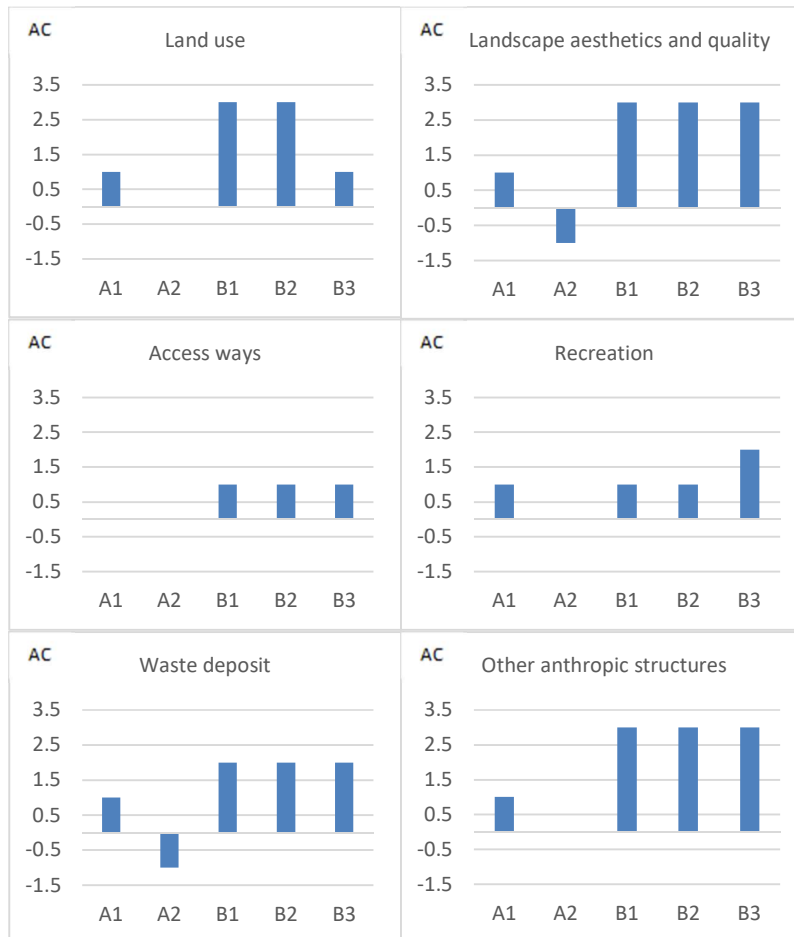


Fig. 4 Criterion analysis for environmental components - physical and geographic (PGC); biologic (BC) and anthropic (AC)

The calculation procedure for R.I.A.M. requires the following equations:

$$A1 \times A2 = At; \quad (1)$$

$$B1 + B2 + B3 = Bt; \quad (2)$$

$$At \times Bt = SM; \quad (3)$$

Where:

A1, A2, B1, B2, B3 – evaluation impact by means of R.I.A.M.

At, Bt – marks decided by multiplying, respectively adding up of the values assigned to the evaluation criteria

S.M. – environmental score for the analyzed factor

The established standard evaluation criteria fall into two main types:

A - Criteria that may change individually the obtained environmental score

B - Criteria that may not individually change the environmental score.

Subsequent to having obtained the environmental scores, they are converted into impact categories (I.C.) on the basis of the aforementioned conversion scale (Fig.4). The environmental score and the impact category were calculated both for each category of component and for the entire study area.

The 16 evaluated environmental components were selected from Leopold's matrix and adapted to the evaluation methodology and the analyzed study area. The evaluated components were divided into three categories: abiotic components (physical and geographic); biological and anthropic components. The matrix results of the cumulated impact evaluation for each evaluated component as follows: Physical and geographic components (PGC) S.M. (-16), I.C. (-A) (Slightly negative impact); Biologic components (BC) S.M. (-31), I.C. (-B), (Negative impact); Anthropic components (AC) S.M. (-15); I.C. (-A), (Slightly negative impact).

The method was employed by considering the environmental particularities within the study area and field data analysis presented in the previous chapters. The matrix was completed by granting a value from the evaluation mark scale, according to the impact of the works for enclosing the "Sulina beach arrangement". The results obtained after the matrix completion clearly point out the fact that the enclosing works will have a slightly negative impact locally on certain physical-geographic components, negative impact at the level of biotic components and a slightly negative impact with regard to the anthropic components.

Table 6

The classification and description of anthropic impact categories on the basis of environmental scores

Environmental score	Impact category	Category description
Over +101	+E	Major positive impact
+76 to +100	+D	Significant positive impact
+51 to +75	+C	Medium positive impact
+26 to +50	+B	Positive impact
+1 to +25	+A	Slightly positive impact
0	N	No change observed - It does not apply
-1 to -25	-A	Slightly negative impact
-26 to -50	-B	Negative impact
-51 to -75	-C	Medium negative impact
-76 to -100	-D	Significantly negative impact
Below -101	-E	Major negative impact

The surfaces analysis is carried out by means of geographic informational systems (G.I.S.) which offer the possibility to manage and present the environmental data generated by the environment mapping activities [5]. G.I.S. techniques are more and more frequently employed in both qualitative and quantitative evaluation, providing not only environmental elements' dynamics, but mostly their spatial distribution [17; 8]. The employment of G.I.S. techniques is conditioned by the existence of particular plans, maps, satellite pictures, orthophoto plans, which may be non-preferential, the spatial dimensions of the final product on their basis. G.I.S. techniques are mostly employed for the vicinities analysis [4] and for the thematic layer overlap [3].

During the building stage, for material transportation, there is a slightly negative impact on the environmental component of air, in the short term, caused by dust powder/dust in suspension, without endangering human health, habitat and species existing within the arrangement area. The daily limit value for human protection with regard to powders in suspension² in the air needs to be mentioned; according to the reference values for air quality indices [20], for a mediation time period of 24h, they must not exceed (70% of the limit value) 35 µg/m³. PM10 – the superior evaluation limit; it must not be exceeded more than 35 times within a calendar year. Every hour, the alert threshold is 240 µg/m³. In the investment works presentation memoir, it is mentioned that there will not be noises and vibrations produced during the works. The excavation will be carried out manually and locally, thus the caused impact will be located. During the building stage, in order to fix the wooden pillars, there is an insignificant on the environment component soil/sub-layer, caused by digging holes, settling and compacting the land on a cumulative surface of approximately 50 m². Within the objective "Sulina beach arrangement" area, respectively the perimeter to be enclosed, two types of habitat were identified, namely: 1310 *Salicornia* and other annuals colonizing mud and sand and 1410 Mediterranean salt meadows (*Juncetalia maritimi*).

Direct impact is represented by the change of land use. In time, it is locally estimated the irreversible habitat loss within the areas to be occupied with the enclosing works. The estimation relies on the direct monitoring of the habitats that will be affected during the stage of enclosing works for the objective "Sulina beach arrangement" and on the observations carried out within other areas for the same habitat types under anthropic pressure as well. During the building stage, the works will have direct negative impact on habitats 1310 and 1410. The works will also have a direct negative impact on habitat 2160 Dunes with *Hippophaë rhamnoides*, caused by local afforestation on 50 m², representing approximately 0.00011% of the ROSCI0065 total area in Danube Delta. Indirect impact represents a consequence of the direct effect and an adapting response of fauna to the new environmental conditions. Two community importance insect species have been identified, *Coenagrion ornatum* Selys, 1850 and *Lycaena dispar* Haworth, 1802. Nevertheless, they are neither influenced during the building stage,

² PM10 - 50 de micrograms/m³/day, not more than de 35 days/year, or 40 micrograms/m³/year according to 2008/50/CE Directive

nor during the functioning one, provided that the conditions for a tourist activity with no negative impact on environment should be followed.

The development of the works established in the project for the enclosure of the objective “Sulina beach arrangement” affects, during the building stage, habitats 1310 and 1410. The impact is direct and negative.

It is estimated that the land which partially will be uncovered of vegetation is 565 m² (1, 61 %) out of 3, 5 ha. Exterior to the enclosed perimeter, specific vegetation for habitats 1310 and 1410 will be able to recover by means of sub-layer seeds within 5 years, unless additional anthropic interference will take place within the habitat.

As was mentioned above, in the description of the habitat conservation state, it must be pointed out that the habitats identified within the studied area are in an unfavorable conservation state. A high number of alohtoneous invasive species has been evidenced as a result of overgrazing by a high number of domestic animals. The fragmentation degree, according to the G.I.S. analysis, is highest within the Sulina beach area (Fig. 4). For habitat 2110 Embryonic shifting dunes, a direct negative impact is locally estimated within the area limited by The Black Sea shore.

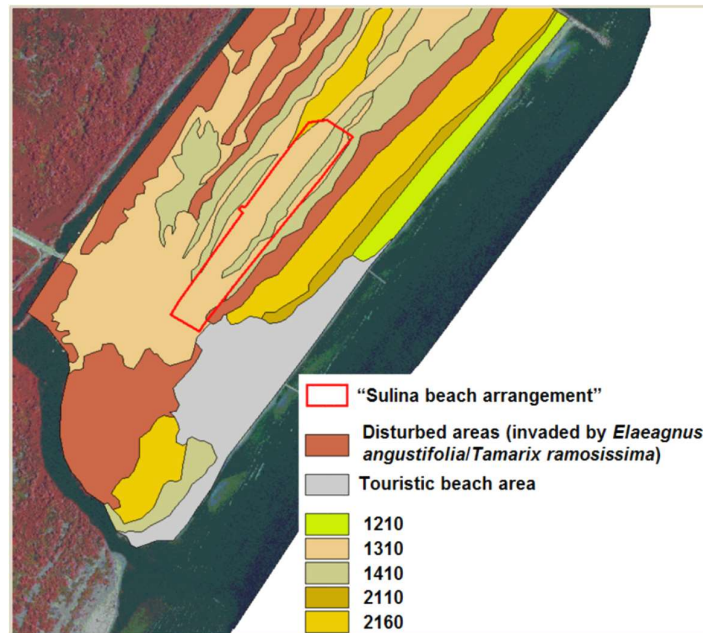


Fig. 5 Habitat distribution in Sulina beach area

The main pressure is represented by tourist activities within the area. Habitat recovery is recommended by eliminating the invasive species and/or their control within reduced limits during a three-year time period with grazing elimination and habitat signalization, with the view to avoid degradation or extinction. The surface which may be affected by uncontrolled intensification of tourist activities is estimated at approximately 1.2 ha, namely 0.026% of the total habitat surface within ROSCI0065 (Table 7).

The 3.5 ha area of the objective “Sulina beach arrangement” covers 1.11 hectares of habitat 1310 and 2.36 hectares of habitat 1410.

For habitat 2160 Dunes with *Hippophaë rhamnoides*, an indirect slightly negative impact is locally estimated. Although it is difficult to access it, fruit collecting by tourists and locals as well was noted during September. There are also collecting demands from private companies with the purpose to commercialize them. An additional pressure may be caused by waste production as a result of uncontrolled tourist activity.

The increasing number of tourists and uncontrolled tourism development may generate an indirect slightly negative impact for long term.

For habitat 1210 Annual vegetation of drift-lines, the surface which may be affected by intensification of tourist activity is approximately 1.8 ha, namely 0.039% of the ROSCI0065 site's total area.

Table 7
Lost habitat areas subsequent to the enclosing works

Habitat type	Objective's area (ha)	Habitat area occupied by the objective (ha)	Percentage of the habitat area which will be lost	
			Locally	ROSCI0065
1310 <i>Salicornia</i> and other annuals colonizing mud and sand	3,5	1,1	9,07	2,,42
1410 Mediterranean salt meadows (<i>Juncetalia maritimi</i>)		2,36	36,08	5,19

For habitat 1310 *Salicornia* and other annuals colonizing mud and sand, the loss of this habitat is estimated, as a result of area anthropogenic influence (sub-layer settling, presence of anthropogenic plants, and waste, animal excrement). An example to illustrate this estimation is the area in the immediate proximity of Sulina town, opposite the graveyard.

For habitat 1410 Mediterranean salt meadows (*Juncetalia maritimi*), an increase of the invasive species number is estimated. At present, this habitat type has an unfavorable conservation state. The ratio between the invasive species and the optimal number of characteristic species is 1:5. The development of invasive and colonizing ligneous species (*Elaeagnus angustifolia*, *Tamarix ramosissima*) is a phenomenon observed within this habitat type. In its initial state, within this habitat type, there are no more than 1% ligneous species within the littoral area. Within the Sulina beach area, there are many construction works dated prior to the object to be enclosed, the "Sulina beach arrangement". The cumulative effect on habitats lies in the cumulated impact of uncontrolled anthropic activities that are developed within the perimeter of these construction works (Table 8). Waste generation, unauthorized tourist access within the habitats area, and the increasing number of tourists may lead to indirect long-term impact on the habitats in the area proximity and direct impact on habitats 1210, 2110 and 2160. Grazing effect within the study area may also be intensified by these activities. An argument to illustrate it is the high number of invasive fallow species and their individuals' density. On the tourist beach within the Sulina area, flora and fauna are strongly influenced by anthropic activities. Thus, at the summer's beginning, the beach's geomorphologic profile is modified by the activity of sand levelling which, this way, destroys and eliminates both plants and animals outside of this perimeter. Rehabilitation actions, clearing, in general, those actions for the tourist beach's maintenance, and summer tourism as well do not allow fauna and flora to develop. The surface which may be affected by intensification of uncontrolled tourist activities is estimated at approximately 2 ha, that is 0.04% of the total area of ROSCI0065 site.

Table 8
Estimation matrix for the cumulated impact

IDENTIFIED IMPACT FACTORS	ECOLOGICAL EFFECTS							Interpretation of impact factor intensity
	Anthropogenic influence/invasive species	Degraded landscape	Species deficit	Biological activity decrease	Suspension dust	Sublayer destruction	Habitat fragmentation	
Anthropic factors								
Intensive grazing	xx - 3	xx - 3	xx - 3	x - 2	x = 2	xx - 3	xx - 3	xx - 3
Arrangement works	x = 1	xxx - 3	xx - 2	x - 2	x - 2	xxx - 3	xxx - 3	xxx - 3
Uncontrolled recreational activities	x - 3	x - 2	x = 2	x = 1	x = 2	x = 1	xx - 2	x - 2
Transportation	x - 2	x - 2	x - 2	x = 1	xx - 3	xx - 2	xx - 2	x - 2
Waste generation	x - 3	x - 3	x = 2	x - 2	x = 2	x - 2	xx - 2	x - 2
Interpretation of ecologic effects	x - 3	x - 3	x - 2	x - 2	x = 2	xx - 2	xx - 2	x - 2

"x"- minor (extinction of 0 – 10% of species or local population reduction with the same percentage). The minor impact involves an insignificant alteration of natural components, including local species and populations, in the short term, with a strong reversible character, so that the recovery of the initial state occurs naturally, in a short time with no additional efforts.

"xx"- medium (extinction of 11 – 25% of species or local populations reduction with the same percentage). Medium impact involves a significant influence of local species and their populations, whose irreversible character is low, the environment initial state recovery being possible, albeit during a long time period.

“xxx”- major (extinction of 26 – 50% of species or local populations reduction with the same percentage). A major impact is characterized by significant influence on local species and populations, with minimum chances of recovering the natural balance, even if a long term is allowed, therefore having a strong irreversible character. Impact quality: “=”- indifferent; “-”- negative; “+”- positive; Impact certainty: “1”- improbable; “2”- probable; “3”- certain.

The analysis of the cumulative impact is being carried out according to each identified ecologic effect's consequences and probability, taking also into account the irreversible degree of the impact factors. The interpretation of the two characteristics (ecologic effect and impact factor) is defined as the level of cumulative impact. From this analysis, it can be inferred that, singularly, the activities that may have, in the short term, an undeniable major impact, a negative one, on the environment are the arrangement works. In the case of a cumulative impact, the activity that may have, in the long term, a probable medium impact - negative - is intensive grazing over the tolerance limit of the grasslands within the littoral area. According to the latest studies [6; 9], the grasslands within the littoral area are scored as weak grasslands (1.4 cattle unit/ha).

The development of the enclosing works for the “Sulina beach arrangement” object involves a direct impact, during the building time period, on species and habitats situated within the constructed area and its immediate vicinity through modifications in vegetation structure, modifications which will also include soil digging for fixing the wooden pillars. This means that the impact will affect fauna and flora, destroying habitats with an important role in species nutrition. In the long term, the residual impact will be insignificant. The habitats disturbed by the enclosing works will recover almost entirely. The exception will be the cumulated surface covered by the wooden pillars, estimated at 50 m².

In the project area, the two types of community importance habitats identified (1310 and 1410) are in inadequate unfavorable conservation status. Improvement of the habitats conservation status in the existing areas other than those included in the site, by reducing grazing and removing invasive plant species *Elaeagnus angustifolia*, *Xanthium strumarium* sl and *Tamarix ramossissima*.

In the vicinity of the site, about 180 meters to its limits (45°08'55.53" N; 29°40'57.50" E) have been observed the species *Centaurea pontica* (endemic species) only in one place, but this species will not be affected by fencing work. The placement boards for tourist information on *Convolvulus persicus* and *Centaurea pontica* status. This is an awareness of tourists on protected species. For the same goal, we also suggest the printing of promotional materials designed to raise awareness of the local community. Carrying out regular checks, especially during summer, to verify compliance with the warnings given in the notice boards and penalties required by law, is recommended.

The investment which includes the placement of poles for fencing objective "Sulina beach Arrangement " has a slightly negative impact on habitats 1310 and 1410 (under the project site). Restoring natural habitats 1310 and 1410 affected by uncovering possible during construction of the fence is possible in a period of 4-5 years from seed reserves in the soil. Slightly negative impact assessed for the period of construction, can be reduced if the fence panels are installed on existing wood poles. Thus, there will be no interference with the substrate and herbaceous vegetation. Materials used for fencing (mentioned in technical description) does not fully integrate the formulas established in traditional architecture or later in the Danube Delta. In accordance with art. 21, paragraph 2, point “C” of H.G. 1516/2008, mesh fence must be doubled vegetation - hedge, creepers, vines. This leads, on the one hand, an expensive investment, and on the other hand, the introduction of invasive alien plant species.

We recommend installing a fence of traditional materials, reeds or straw, mesh panels instead of flanged as less expensive solution, since we need another investment hedge. This will not violated the provisions of G.O 1516 (art. 21). On the other hand, the same G.O recommended reed fencing or other traditional materials. We have conducted measurements at the site studied and found that the surface of the fenced area is 33957 square meters.

The measurement result is shown in the attached location plan. The property is fenced mesh on wooden pillars on the east side, with small kindling wood fence on the north side and the street there is no fence, just a wooden barrier between the west and south sides and partially hedge. It is necessary to conduct a post-investment monitoring program for habitats and species of conservation interest in the area of "Sulina beach arrangement" and the study area in Sulina. It is recommended, the preparation of cadastral documentation for integration into the cadaster and land registration system enclosed lens "Sulina beach arrangement". It is estimated that during operation, habitats 1210 and 2110 are the two pontoon bridges type of neighborhood objective it will be exposed pressure from human activities leisure during summer. Movement of tourists outside the perimeter of the beach between the two pontoon bridges type is not restricted. There are necessary measures to implement local awareness actions by describing, signaling and marking of the protected habitats. In describing habitats is important to present in a concise way, the biological diversity value and the pressure that represents tourism activities that violate the rules of conduct in nature.

CONCLUSIONS

Impact of investment „*Sulina beach arrangement*”, in terms of the surface occupied, is slightly negative, habitats surface of community importance in 1310 and 1410, affected by the project, relative to the total area of the same habitat in the protected area ROSCI0065 being small. According G.E.O. 57/2007 none of them is a priority habitat. All five habitats specific for the coastal belt, is currently inadequate in unfavorable conservation status because of the phenomena of invasion / colonization of plant species *Elaeagnus angustifolia*, *Xanthium strumarium* sl, *Erigeron canadensis*, *Cynodon dactylon*, *Amorpha fruticosa* and *Tamarix ramossissima* as a result of overgrazing activity. To bring favorable conservation status of habitats, it is necessary to eliminate or control the invasive species in critical areas identified during the study period. These critical areas are located on the beach Sulina rock dam to the A.F.D.J. Galati. In terms of grazing, it is recommended a study on the assessment / mapping coastal grasslands from the littoral area, and establish the carrying grazing capacity / ha.

There were identified, in the investigated area (marked in blue), 5 Natura 2000 habitat types (1210, 1310, 1410, 2110 and 2160) as inclusive for Black Sea bioregion. The habitats of conservation value identified in the studied sector were evaluated in terms of conservation value, the representativeness in the D.D.B.R. and on the conservation status of endangered reported factor, as follows:

After conservative value criterion, there is 1 habitat type (2110) with very high conservation value, 3 habitat types (1210, 1410 and 2160) with high conservation value and 1 habitat type (1310) with moderate conservation value; after the criterion of representativeness, 3 types of habitats have a good presence (1310; 1410 and 2160) and 2 in low presence (1210 and 2110);

After criterion conservation status, the habitats were divided by the degree of conservation and functions in concern with possibilities for restoration / ecological reconstruction. Depending on the degree of conservation of structure, at D.D.B.R. level, 3 are partially degraded habitats (1210, 2110 and 2160) with moderate or unfavorable prospects in the future and 2 habitats are well preserved (1310 and 1410) with good prospects in the future. Depending on the possibilities of recovery / reconstruction, 3 habitats falls to recovery possible with average effort (1310, 1410 and 2160) and 2 habitats fall to recovery difficult or impossible (1210 and 2110).

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