



Monitoring of **Mediterranean** **Coastal Areas**

PROBLEMS AND MEASUREMENT TECHNIQUES

EIGHTH INTERNATIONAL SYMPOSIUM
Livorno (Italy) June 2020



edited by

Laura Bonora, Donatella Carboni,
Matteo De Vincenzi



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ANALYSIS OF THE THEORETICAL SETTLEMENT SCENARIO IMPLEMENTED BY THE MUNICIPAL PLANS. THE CASE STUDY OF THE ROMAGNA COAST MUNICIPALITIES

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Abstract - In Italy, the transformative predictions of the municipal urban planning instruments are very often far away from the socio-economic dynamics related to characteristics of the territories in which they operate. In fact, the political component considers the oversizing of urban transformative projections as a solution to improve the situation of the territories in crisis for several aspects. This happens regardless of the geographical location of the municipality and even the recent regional laws on the stop/containment of land consumption are able to reverse this course, also because they often add the sentence "without prejudice to the provisions in force" or similar. In many cases it must be considered the date of approval of the urban planning instrument which over time leads to the implementation of different varying, which are necessary both to amend the urban projections and to update their contents according to the changed social, economic and environmental conditions. In particular, this work analyses the projections of the urban planning instruments in force in the coastal municipalities of Emilia-Romagna. Through this analysis, the work aims to highlight how the settlement forecasts contained in the municipal planning instruments can change the future settlement structure in the case study area. The coastal strip investigated is already highly urbanized but also home to an extremely fragile environment such as the coastal one, which is one of the most urbanized of the Mediterranean. It extends for about 150 km, equal to the 10 % of the entire Adriatic coastal sector, and it has been characterized, over time, by intense urbanization processes, particularly in the 500 m strip from the (coastline). Currently, the sections that remain free from constructions are little less than 50 km (about one third of the total extension) and they are more concentrated in areas where the environmental conditions (swampy areas, river mouths) are less suitable for urbanization. They have a population of about 525 000 units (11 % of the regional population), a value higher than the population of regions such as Molise or Valle d'Aosta, although it covers an area of about 1500 km². Moreover, they are characterized by a population density of 350 inhabitants/km², which is higher than both the regional value and the national value. Currently, the urbanized areas are around 290 km² but the theoretical scenario of the plans implemented would see the urban areas rise to 340 km² (50 % of these transformations involving the municipalities of Rimini and Ravenna). The situation is certainly more critical for the coastal strip where the current urbanization rate is about 50 % and the municipal planning instruments provide for an additional 7,5 km² of areas that can be transformed along this area which should not be neglected from an environmental point of view. Most of these areas of urban expansion affect the residual coastal spaces, but the construction of a new tourist settlement is also planned, which would eliminate another 2 km of coastline in the municipality of Ravenna, in an area affected by 2 Special Areas of Conservation (SAC).

Introduction

The presented research paper focuses on the urban planning tools used in the municipalities along the Romagna coast, an area highly representative of the Adriatic seaside tourism sector as a whole. By analysing the changing trends expressed through municipal urban planning tools, the paper aims to highlight ways in which urban planning projections can alter the future layout of an already densely urbanised area, but which is still home to an extremely fragile environment like that of the coast [6], [15], [25], [1]. Indeed, we are referring to a vibrant ecosystem where natural processes and anthropogenic transformations interact modifying the physical, geological and morphological features of the sandy coastlines. Also, the persistent pressure exerted upon these areas stems from the high population density recorded there: in 2012, more than 30 % of the population of the European Mediterranean countries lived near the coast [13] with estimates of over 170 million in 2025 [29]. Today in Italy, over 17 million people live in coastal municipalities with a population density equivalent to 400 inhabitants per square kilometre, which is double the national figure. From an economic point of view they are very important locations [22] and, at the same time, environmentally fragile. Historically, urban planning tools have often supported approaches which gave greater priority to socio-economic aspects whilst, in practice, proving to be less attentive to environmental issues. This is partly attributable to the fact that environmental legislation has only become more significant and established over the last thirty years. Furthermore, transformative projections of municipal urban planning tools are often detached from the socio-economic dynamics of the applicable territory [26], [8]. The excessive scale proposed by urban planning projections is seen by politicians as providing a solution to the challenges facing territories which are experiencing several crises. This happens irrespective of the geographical location of the municipality and not even the recent regional laws on the cessation/containment of land consumption succeed in reversing the trend to a certain extent not least because of the inclusion of the phrase "subject to the provisions in force". In many cases, it is necessary to add to that the age of the tool which over time leads to the implementation of different variants both to scale down the projections and to update their contents according to the changed social, economic and environmental conditions. This research shows the possible settlement scenarios of the Romagna riviera's municipalities and then analyses a 1 km coastal strip from the shoreline, which is where the transformative pressures are most concentrated. Primarily linked to tourist activities associated with the marine environment's economy. After analysing the trends in progress, the paper concludes by proposing a decision-making support tool to be used when evaluating the plans.

Study area

The work is focused on the municipalities of the Romagna Riviera, which is one of the most urbanised sectors of the Adriatic coast. It is a linear stretch of about 150 km, equivalent to approximately 10 % of the entire Adriatic coast. It is a low-lying coast comprising of sandy and pebble beaches covering a fairly large surface area with a vast lowland behind [5]. These morphological characteristics have strongly influenced the dynamics of local settlement [13], [8] which has recorded one of the highest rates of soil depletion in the last 50 years. Notably, in the 500 metres strip of shoreline, where urbanisation



Figure 1 - Study area.

has almost halved the kilometres of coastline free from construction at a rate of 1 km every year [24]. The Romagna coast covers 14 of the 328 regional municipalities, including two provincial capitals (Ravenna and Rimini), with a total area of 1500 km², representing about 7 % of the entire regional area (Figure 1). According to the Istat data updated until 2019, about 525 000 inhabitants (12 % of the regional population) live in this area, which is higher than the local populations of regions such as Molise or Valle d'Aosta. The population density is about 350 inhabitants/km², against 200 inhabitants/km² of the regional and national average. Between 2011 and 2019, the population increased by about 19 000 units (more than 2300 new inhabitants every year), representing 16 % of the increase recorded in the same period for the entire region. From an economic standpoint, the taxable income of the surveyed municipalities has increased by 15 % in the last 8 years (2011-2018) and the income per capita for 2018 is close to the national average (20 000 euros) for almost half of those municipalities. The lowest amount is recorded for Goro with just over 12 000 euros.

As for the state of municipal planning, urban plans refer to two distinct regional laws: the L.R. 47/1978 and the ex L.R. 20/2000 subsequently repealed and then replaced by L.R. 24/2017 (art.79). As for the state of municipal planning, urban plans refer to two distinct regional laws: the L.R. 47/1978 and the ex L.R. 20/2000 subsequently repealed and then replaced by L.R. 24/2017 (art.79). The first law, therefore, refers to all the Municipal Urban Plans (PUC) drawn up between 1972 and 2001. The plans in force in the municipalities of the study area were all approved after 2010 except for the municipalities Goro (1997), Misano Adriatico (1999), and Comacchio (2002). As for the state of municipal planning, urban plans refer to two distinct regional laws: the L.R. 47/1978 and the ex L.R. 20/2000 subsequently repealed and then replaced by L.R. 24/2017 (art.79). The first law, therefore, refers to all the Municipal Urban Plans (PUC) drawn up between 1972 and 2001. The plans in force in the municipalities of the study area were all approved after 2010 except for the municipalities Goro (1997), Misano Adriatico (1999), and Comacchio (2002) (Source: <http://wwwservizi.regione.emilia-romagna.it/territorio/pianiurbanisticicomunali/StatoVigenza.aspx>) even though some of these entities have already started the process of drawing up the General Urban Plan (PUG), thereby complying with the provisions of L.R.24/2017 to date only the Cervia Municipality has a PUG drawn up in accordance with the latter. The territorial footprint, albeit widely

anthropised, still holds significant environmental value [19][20][28] testified to by the presence of 21 sites (SAC's and SPA's) of the Natura 2000 network, mostly located in the northern coastal regions of the Ravenna and Comacchio municipalities. These are largely residual environments [13], [11] in which anthropic transformation processes are less intense due to physical conditions (marshy areas, salt pans, river mouths) not suitable for settlement. Some small nature reserves and a Regional Park (Parco Regionale del Delta del Po) are located in these areas, within the boundaries defined by the SPAs and SACs indicated above.

Materials and methods

The data used in this survey originates from several sources. In particular, data from the mokaGIS portal (http://www.mokagis.it/html/applicazioni_mappe.asp) was extracted from the CSPs (Municipal Structural Plans) from 5 of the 14 coastal municipalities. These tools divide the territory into urban, brownfield and rural, and planning is divided into areas. The most significant infrastructures and facilities are also reported as indicated by L.R. 20/2000. The urban planning projections for the remaining municipalities have been extracted from the minERva portal (<https://datacatalog.regione.emilia-romagna.it/catalogCTA>) except for the Cervia municipality where the vector data of the recent PUG (approved in 2018) is not available. From the PSCs, territories defined as suitable for urbanisation have been selected, while for the other municipalities' systems, all the transformative categories with an urban destination have been extrapolated. The following zoning uses have been taken into account for this last point: residential completion, residential expansion, productive-touristic areas, technological infrastructure and public service areas. As a result, a single source of information was obtained containing all the settlement expansion projections for each municipality on the Romagna coast. To gauge the extent to which the projected plans have been realised, the level of soil waterproofing and the latest transformative dynamics along the coastal system including several map databases have been used. The recent soil waterproofing trends (2012, 2016, 2018) have been analysed through the database of the Istituto Superiore per la Protezione e la Ricerca Ambientale (ISPRA) (<http://geoviewer.isprambiente.it/index.html?config=config.xml>) which provides an information layer showing the geographical distribution of the waterproofing areas in the country's soil at a resolution of 10m/pixel. Land use maps (minimum cartographic unit of 0,16 hectares, minimum size of 7 metres for linear development elements) updated until 2017, allowed the analysis of aspects related to the dimensions of existing urban planning tools in relation to the urban areas currently present in the territories of the municipalities surveyed. It is worth pointing out that urbanisation is not synonymous with waterproofing. Waterproofed surfaces are those covered by layers of water-resistant material that prevent the absorption of surface water. This includes either built-up soil or land intended for other purposes requiring paving such as streets, public squares and car parks and all those instances where the layers of natural soil are completely removed and replaced with other materials that improve the stability and non-deformability of the surfaces. Urbanised surfaces, on the other hand, are those intended for urban use, with replacement or maintenance of the natural soil. This type of surface includes parts of built-up soil and those intended for incidental functions of the settlement, such as public and private gardens, sports facilities, dirt roads and other service areas. Extra-urban roads are excluded from the calculation. These areas are

the same as those surveyed under heading 1 in the CORINE Land Cover classification, which was also adopted by the Emilia Romagna Region for the preparation of the various land use maps. The current settlement conditions and those resulting from the possible implementation of the projections of the plans have been analysed with the help of appropriate urban planning indicators used for some time in studies in this sector. The indicators used are the following:

Impermeabilization/urbanization density (a): $DI - DU = \frac{\sum A_i}{A_u}$ (%)

Planned Urban Surfaces Index (b): $IEUP = \frac{A_p}{A_{urb}}$ (%)

where:

A_i = Impermeable/urbanised areas

A_{urb} = Urbanised areas

A_p = Urbanised area foreseen in the urban planning tools currently in force: sum of areas destined for residential use (expansions, developments, land parceling), areas destined for services (social, cultural, technological) and areas destined for productive activities (craft and industrial)

A_u = Statistical unit considered (Municipality or municipal coastal belt)

Both indicators were drawn up on a municipal basis. Index (a) indicates the percentage of municipal territory affected by actual waterproofed/urbanised areas. Hence, providing indicators of the level of degradation of the natural matrix. Index (b), on the other hand, represents a typical settlement behaviour index as it shows the number of times that the transformation projections of the current urban planning tool multiply what has been achieved within the surveyed municipality. A detailed analysis has also been carried out in the 1 km coastal strip, which is substantially affected by the settlement transformations linked to the marine economies.

Results

The urban areas currently located in these territories amount to about 290 km², equivalent to 12 % of the regional total with an urbanisation density that reaches 18 %, a value that is higher than both the regional (11 %) and the national figure (10 %). These urbanised areas are not uniformly distributed across the various municipalities: more than 50 % of them are located in the capital cities of Rimini and Ravenna. The analysis of the values of the DU index, together with those found for the DI, in the surveyed municipalities are shown in Figure 2. It is interesting to note that only 3 of the 14 municipalities have a DU value below 10 %. These are the municipalities located north of the regional coastal system in which the territory is marked by the presence of vast wetlands and swampy areas that have been less affected by the transformative trends that have affected the entire Italian coastal system, especially from the Second World War until the early 2000s (Romano et alii, 2017). On the contrary, the municipalities with extremely high index values reaching peaks of over 70 % in the municipalities of Riccione and Cattolica, both famous tourist destinations in the area studied

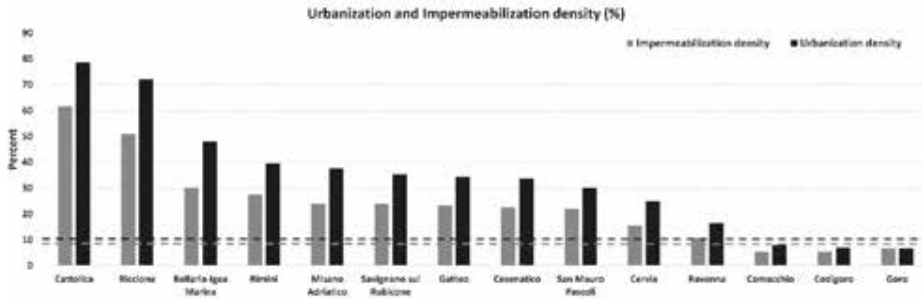


Figure 2 - DU indicator trend (in black) and DI (in grey) for the Romagna coast municipalities. The dotted lines represent the comparable values measured on a national scale.

since the beginning of the last century. An analysis of the density of waterproofing of the municipal soils shows a similar trend with values slightly lower than those previously reported, but which once again underline the high settlement pressure that distinguishes these territories. The values range from 5 % in the municipalities of Goro, Codigoro and Comacchio to 50 % in Riccione and 60 % in the municipality of Cattolica. The study of the relationship between the urbanised and the waterproofed surface is also noteworthy. This indicator provides information on the level of soil waterproofing in urban areas and hence is essential in the study of urban heat island phenomena or the influence of these surfaces on the level of water runoff (Arnone, 2018; McCarthy, 2010). In fact, in cities where the soil is highly waterproofed, the high water runoff strongly influences the capacity of the sewage system. The more soil is waterproofed, the greater the volume of water that flows superficially at the catchment level, reducing the time needed for flood formation and potentially causing more harmful flooding. Of the 290 km² of the surface area assigned for urban use, 193 km² are physically waterproofed (67 %) although the situation differs between municipalities.

The highest levels are found in the municipalities of Goro (83 %) and Codigoro (77 %), whose environmental conditions have led to a high level of soil waterproofing. Levels slightly lower than average for the area affect the municipalities on the southern coast of the region except for the municipality of Cattolica with approximately 80 % of urban areas covered by waterproofing materials. Shifting the focus along the coastal strip (1 km from the shoreline) it can be seen that 25 % of the total urbanised areas are concentrated along this area which is covered by urban surfaces for over half of its size (55 %). It is, however, important to point out that the value range is wide: Goro has a value equal to 1 % while 10 of the 14 municipalities surveyed reach values above 70 %, half of which have a value above 90 %. The above factors largely express the strong anthropic pressure along the coastal system. The ratio between the two different types of transformed surfaces considered in this paper is 65 % in this area with the highest in the municipality of Cattolica (75 %) which has almost entirely transformed the coastal sector administered. The analysis of the transformative projections of the municipal urban planning tools allows us to know the different settlement strategies in the various municipalities not only in quantitative terms but also by zonal typology as, for some municipalities in the area of interest, the information on the zonal subdivision of the plan is also reported. The plans provide for a further 48 km² (Cervia was excluded from the

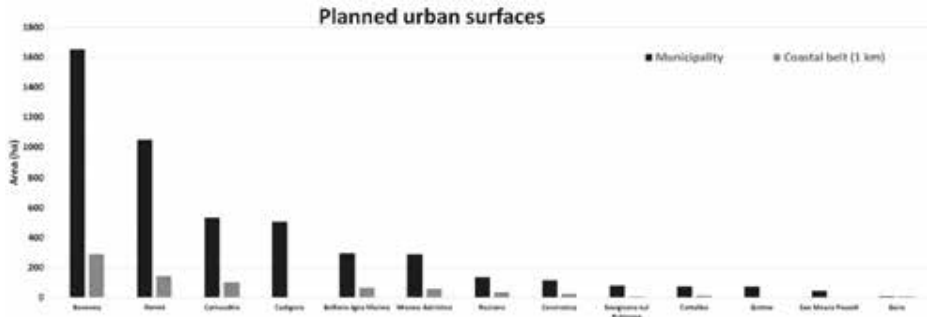


Figure 3 - New urban expansions foreseen by municipal plans. In black for the entire municipality, in grey only for the coast (1 km from the shoreline).

analysis) of surface area to be converted to urban use, one-sixth of which is located in the fragile coastal strip. The histogram in Figure 3 illustrates the situation for each municipality surveyed. Only 3 municipalities do not foresee further transformations along this area: Gatteo, San Mauro Pascoli and Codigoro. For the first two, the reasons are linked to the almost complete urbanisation of this territory while for the third the motives are morphological. Higher values can be found in the areas of the municipalities of Riccione, Cesenatico and Bellaria-Igea Marina where these settlement expansions are well over 20 % of what is foreseeable by the respective plans. The complete implementation of these forecasts would increase the rate of urbanisation to 63 %.

Also interesting is the analysis carried out using the information about the different types of transformation foreseen. It should be pointed out that these zonal categories have been traced back to those of Ministerial Decree 1444/68 through a careful reading of the synoptic description contained in the geographical file database. The results are shown in the diagram in Figure 4. The "Urbanisable Territory" category extracted from the PSC has not been included because it is not possible to attribute this typology to a single synoptic description sensu D.M. 1444/68. However, it should be pointed out that of the 113 ha of the territory referred to this category, 42 ha have yet to be implemented, representing approximately 37 % of the total. On the whole, as shown in Figure 4, more than 60 % of the projections in these territories are related to residential development areas and tourist production areas. The high concentration of the latter type category along the coastal strip can also be analysed by comparing the total number of tourist accommodation areas in the municipalities with those allocated in this area: 60 % is located along this system but for some municipalities (Cesenatico and Rimini) this value exceeds 90 %. Almost all of the B zones have been set up, while a fifth of the D zones is yet to be implemented. Some of these new projected areas (figure 4 on the left) are located right next to the Natura 2000 Network sites, where the residual beauty of the natural environment in a highly anthropised environment certainly attracts new possible accommodation facilities with direct and indirect effects on the very functionality of the network. As far as this last aspect is concerned, it should be noted that the anthropic pressure on this system is already very high: the urbanisation rate of the soils in an area around 1 km from the present sites in the municipalities of the area surveyed is currently equal to 26 % with the new projected areas that, if implemented, would bring this



Figure 4 - Planned but not yet implemented tourist area close to some Natura 2000 network sites (left). Radar diagram showing the percentage breakdown of the different zonal categories in relation to the total forecast (in blue), while the residual plan (in %) for each of them is shown in orange (right). The data has been processed for the whole coastal strip.

value to 30 %. Figure 4 shows that 6 % of the total projected areas are new residential expansion areas (12 % still to be implemented), while public services and technological infrastructure combined account for about 35 % of the total. With regards to the public services category, it is important to underline that a large part of the approximately 3 km² still to be implemented is related to categories of services that involve low soil waterproofing (areas for green spaces, parks, playgrounds and sports) thereby safeguarding part of the essential ecosystem services.

The IEUP value is instead equal to 20 % with a range of values varying between 4 % in the municipality of Goro and up to 43 % more than in the municipality of Codigoro. As mentioned above, the information content of this indicator is directly connected with the settlement behaviour of the municipality to which it relates and is even more relevant when compared with the demographic variation (DV) registered in the decade before the approval of the municipal urban planning tool (Figure 5). It is clear from the analysis how the dimensions of the new settlement areas take little or no account of past demographic dynamics, continuing to be linked to hypothetical development models that are often disregarded both on the economic side and on that of the actual feasibility of the planned urban layout. Municipalities with substantially stable demographic dynamics ($0 < DV \leq 5\%$) show IEUP values ranging between 10 % and 30 %. These are well-known seaside resorts that have further invested in new tourist accommodation and production areas. On the contrary, coastal resorts less frequented by mass tourism but with more dynamic demographic trends ($15\% < DV < 30\%$) show IEUP values below 15 %. This probably is also related to a smaller administered coastal sector of surface area. As far as the 1 km strip from the shoreline is concerned, it should be noted that for 8 of the 13 municipalities considering the IEUP value does not exceed 10 % while values higher than 20 % are reached in the areas administered by the municipalities of Ravenna and Misano Adriatico.

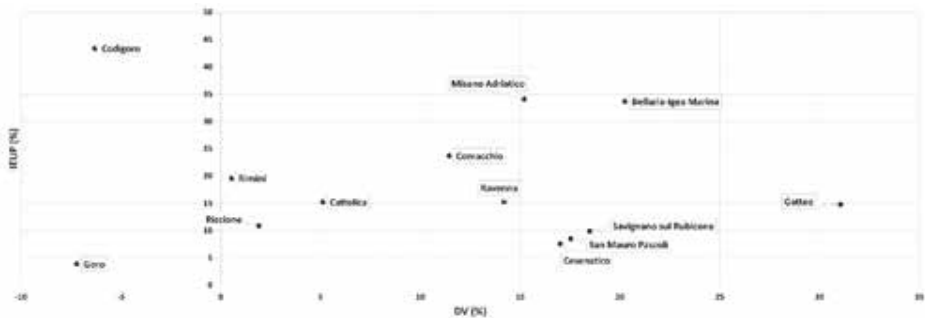


Figure 5 - Dispersion graph showing the IEUP values compared with the demographic trends of the respective municipality.

Conclusions

The coastal environment itself is an extremely diverse habitat consisting of a wide variety of ecosystems which are of primary importance for long-term conservation. Tourist exploitation and industrialisation have strongly accentuated the anthropic impact on these systems since the early years of the last century and, as demonstrated in this paper, do not seem to have stopped. The incidence of high urban development and mass seaside tourism on the coastal sedimentation trends is such that it now requires various and widespread conservation measures along the Italian peninsular coast [4], [11], [17]. To this must be added the increase in the frequency with which sea storms and floods occur [2], [16], [7] which have created and cause considerable environmental damage in addition to economic losses. The Romagna coast has suffered a number of these events which have intensified since 2000 [21]. The region has already financed several important beach rehabilitation projects (2002, 2007, 2016) which highlight how the issue of coastal conservation plays a major role in regional policies. Also, more than 30 million Euros have been allocated by the Regional Council for 10 regeneration and redevelopment projects along some stretches of the waterfront (<https://www.regione.emilia-romagna.it/notizie/2019/ottobre/turismo-riqualificazione-della-costa>) together with another 25 million Euros for the regeneration of hotels and accommodation facilities. As pointed out in this paper, the urban conversion of soils represents an important threat to the integrity and functioning of the coastal environment [26], with urban planning tools that continue to support old models of tourism by designing new areas to be transformed among the remaining natural environments, thus intensifying the anthropic pressure in the already highly urbanised coastal territorial mosaic. The recent urban dynamics (2012-2018) examined along the coastal strip show a decreased transformative impact (23 ha waterproofed) with more localised interventions in the sectors of the municipalities of Ravenna and Rimini. It should also be pointed out that in 2017 the region adopted a law (n.24) regulating the use and protection of the territory, which contains measures that favour urban regeneration and the containment of soil wear (art.5). This law provides for a phase of updating and adaptation to the new rules of existing territorial governance measures through the drafting of the WFP aimed at promoting these important measures in the regional context. Entered into force on 1 January 2018, the new law requires municipalities to start the approval procedure for the new WIP within three years,

which must then be completed within the next two years. Until then, it is possible to continue to transform the territory in accordance with the current legislation (Article 4), through a series of appropriate measures. As mentioned above, there are still 7,5 km² of land intended for urban use but not yet implemented along the coastal strip. It could, therefore, prove useful to build a geographically applied database for the whole coastal system to be built with urban/environmental information aimed not only at real-time monitoring of land-use transitions but also as a tool for public awareness of what is happening in these areas of fragile environmental balance. Such a technological platform would fully integrate into the environmental assessment procedures of the plans (SEA), thus optimising the possible location of the newly settled areas. This would result in an improvement in the efficiency of the geographical location of these sites from the perspective of a touristic economy that responds to logical reasons of regional significance and less easily influenced by simple localisations that consider little or nothing of the delicate equilibrium of the ecosystems along the shores. It would, therefore, be a tool with a strategically driven vision capable of directing territorial policies, favouring actions of environmental regeneration where conditions permit, but at the same time it would also be effective in promoting actions of relocation/removal of areas that could potentially have effects on diverse and essential ecosystem services, ensuring in fact more sustainable transformations in the long run.

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