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Indicator-Based Sustainability Assessment Tool to Support Coastal and Marine Management

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Abstract: The applied Indicator-based Sustainability Assessment Tool (InSAT) serves as a user-friendly computer-aided tool to support coastal and marine management. Focus is on sustainable coastal development, including environmental, social, and economic aspects. We apply the InSAT to assess the changes in sustainability before, during, and after the implementation of management measures. The assessments address three case studies in Lithuania: the construction of a liquefied natural gas terminal in Klaipeda, the renewal of the port of Sventoji, and the opening of a beach in Nida. The application of core and optional indicators highlights the strengths and weaknesses of the management measures. We analyze to what extent, how, and when the InSAT can be applied within a stepwise Systems Approach Framework (SAF) to support sustainable coastal and marine management. Further, we assess how the tool can be applied within other integrated approaches. The application of tailor-made indicators helps to identify potential conflicts and raise discussions about sustainable development between stakeholders and decision-makers and therefore supports the decision-making process. The tool indicates the management measures' weaknesses, but the assessment results do not indicate what kind of solutions should be undertaken. However, it can still serve to support, guide, and supplement the participation and discussion processes.

Keywords: integrated coastal zone management; systems approach framework; sustainable development; decision support tool; public participation; stakeholder

1. Introduction

As early as 1987, the Brundtland Report briefly defined the basic idea of sustainable development, namely "to ensure that it meets the needs of the present without compromising the ability of future generations to meet their own needs" [1]. A growing population and intensified human activities cause increasing pressure on the environment. This is true for seas and especially coastal systems all around the world as well. It was clearly stated during the United Nations Conference on Environment and Development in Chapter 17 of the Agenda 21 that oceans, coasts, and marine resources need to be properly managed for the future [2]. Nowadays, sustainable development is a high political priority, and as a result, in 2015, the General Assembly of the United Nations (UN) adopted 17 sustainable development goals (SDGs). The aim of these goals is to set attainable targets that can be achieved as a 2030 agenda for sustainable development [3]. SDG 14 aims at a conservation and sustainable use of the oceans, seas, and marine resources, explicitly considering coastal areas in two of its targets (14.2 and 14.5) [3,4]. The SDGs seek for universal application and are thus global in nature. On the other hand, it is expected to be adapted at national and local levels, taking into account numerous factors, such as the level of development and existing national and local policies [5]. Still the integration into national policies requires significant capacities at the national level, including functioning governance systems, where their performance is expected to be improved in measurable ways [5,6].

The coastal and marine sector experienced fast growth, and this trend will continue in the future. As a consequence, the pressure on coastal and marine resources will increase and requires improved planning and managing of the coastal and marine environment [7]. In order to attain sustainable development, the EU Recommendations on Integrated Coastal Zone Management (ICZM) were adopted in 2002 [8]. The European Commission defined ICZM as a dynamic, multi-disciplinary, and iterative process to promote sustainable management of coastal zones while covering the full cycle of information collection, planning, decision-making, management, and monitoring of implementation [9]. Unfortunately, in practice, ICZM shows several weaknesses, such as an insufficient application of a broad holistic and long-term approach, a lack of adaptive management [10,11], and a shortage in genuine stakeholder engagement, thus ignoring vital social needs of local communities [11–14]. As a consequence, ICZM vanished from the political agenda in Europe. Its major principles became part of Maritime Spatial Planning (MSP). MSP aims to support the sustainable use of marine resources including the development of a cross-sectoral approach towards addressing environmental, social, and economic goals [15,16]. However, since the problems in the coastal zone are not solved, the need for integrated approaches in planning and management still exists.

An effective sustainable resource management has to be rooted in system thinking [17,18]. The Systems Approach Framework (SAF) for the integrated assessment of coastal systems has been developed as a holistic approach to revitalize ICZM and to overcome its existing weaknesses. The SAF helps to organize the best available scientific knowledge for it to be mobilized in supporting deliberative decision-making processes [17,19]. The SAF has been tested in a wide range of case studies [20–23]. It turned out to be a suitable stepwise, guiding approach to systematically address and solve problems in coastal systems and to improve the implementation of measures [19]. However, to support the SAF process and to enable practitioners to carry it out successfully, supporting tools and methods are still needed. Indicators that allow for the post-evaluation of the success of a management process, as well as a comprehensive assessment of its final result in close cooperation with stakeholders, are important requirements [19].

Many sets of indicators have been developed in the last two decades and applied for sustainability assessment worldwide and in Europe [24–29]. Moreover, numerous coastal indicator sets have been developed and used for different purposes [30–33]. Indicators are designed to measure progress, to raise awareness, and to support decision-making, while being easy to communicate and to understand [31]. Indicators are often used because they provide a simplified view of complex phenomena, quantify information, and make it comparable. Still, there is a lack of indicator systems applied in practice, and the acceptance of existing indicator sets at this level is poor, due to, for example, limited political support, expertise, data, and time and to uncertainty regarding potential benefits [24,31]. Many indicator systems are kept general and do not meet the practical demand or the concrete objectives of an application. The measurement of the effectiveness of a management system requires performance measures that have easily comparable goals [30,34].

There is also lack of a guided stepwise process and supporting tools that enable an easy and relatively fast application process. Therefore, the SAF can serve as a structure to embed an indicator application, and the indicator application can support the SAF process. The use of tailor-made indicators as a decision support tool to assess management planning with an SAF will help decision-makers to identify potential conflicts as well as initiate trade-off discussions between stakeholders, policy makers and society. There needs to be a clear definition laying out success criteria and sustainability indicators that allow a comprehensive assessment of the situation before and after the measure [11,19]. Good and reliable indicators will generally embody a number of characteristics; they will be readily measurable, cost-effective, concrete, sensitive, responsive, specific, interpretable, and grounded in specific theory [24,35]. Indicator-based pre- and post-assessments allow for a systematic compilation of lessons learned for future studies and avoid double work and the repetition of mistakes. However, it requires the provision of tools that allow fast assessment, even in the absence of detailed expert knowledge [11].

The objectives of this study are therefore to (1) develop a method for choosing indicators that can be applied in the SAF and (2) demonstrate the role and value of indicators in the SAF application for coastal and marine management.

2. Methodology and Study Sites

2.1. Setting Indicators and Indicator-Based Sustainability Assessment Tool (InSAT)

The Indicator-based Sustainability Assessment Tool (InSAT) adapts the approach of the SUSTAIN partnership [36] and builds upon lessons learnt from previous applications [30–32]. An identified weakness was that some of the indicators were incomprehensible to the extent that they were complicating the application process. The proposed InSAT framework has been substantially improved and consequently serves as a user-friendly tool to support coastal and marine management, with particular focus on sustainability and incorporation of environmental, social, and economic aspects. The indicator sets can now be tailored to the strategic goal and requirements of ICZM initiatives. Additionally, indicators are divided into *core* and *optional*, thus making their use more flexible. The framework of the InSAT involves 6 application steps, as shown in Figure 1. Our proposed tailor-made indicator system is designed to (a) assess changes in the state of sustainability before and after coastal/marine management initiative implementation, considering the categories of sustainability (environmental quality, economics, and social well-being), and (b) measure the quality of management process from initiation to implementation. Moreover, the InSAT is inserted and tested in the revised SAF as a decision support tool [19].

Figure 1. The proposed indicator-based sustainability assessment framework using the Indicator-based Sustainability Assessment Tool (InSAT).

The first methodological step of the sustainability assessment is the definition of the concrete objective of the coastal or marine management measure, which is planned to be practiced, improved, or revised. The objective of the management initiative lays out the potential and the aimed direction of the same focused initiative with respect to achieving sustainability. Once the strategic management initiative objective is determined, the main targets of the different Management Options (MOs) can be subsequently established (Figure 1, Step 2). The principal goal of this step is to understand the nature of what is to be achieved and within which limits of the focused sector, area, or region it is to be achieved. If this is clearly identified at an early stage, more suitable tailor-made indicators can be selected, with more satisfactory outcomes expected from the assessment.

The third step of the sustainability assessment framework is the selection of the most relevant indicators. However, due to significant differences between sustainability concepts and aims in different coastal and marine management solutions, the proposed framework under this study encourages a careful analysis of the outcomes and needs of a specific management measure. To this effect, we suggest selecting specific, more flexible tailor-made *core* and *optional* indicators (Figure 1, Step 3). The indicator list proposed is based on sustainability criteria covering both the technical and thematic spheres [30]. Without the determination of sustainability criteria, indicator selection, and consideration of different management options, it will not be possible to obtain reasonable results of sustainability. The selected optional indicators must be technically capable of assessing the determined management options in terms of the sustainability criteria.

The following criteria are used for selecting indicators: (a) scope (selecting indicators that fit into the main aim and targets of the studied management initiative, with particular focus on sustainability issues) [25,26]; (b) relevance (selecting the most suitable indicators for a specific coastal or marine study subject) [25–27]; (c) data availability (taking into account the accessibility of data); and (d) quantification (considering the quantification capacity of an indicator as a selection parameter or reference value for making comparisons) [25]. Moreover, the selection of the indicators was carried out according to the following criteria: (a) theoretically well founded; (b) relatively stable and independent; (c) clear in content; (d) measurable and comparable, easy to quantify; (e) regionally specific; (f) based on data that is acquirable [30]. Additionally, selected indicators are used to guide decisions in managing human activities in coastal and marine areas. Therefore, they ought to be specifically orientated towards guiding the decision-making process.

Our proposed core and optional indicators (see Appendix A) are selected based on previous research shortcomings [30]. The list was improved through the inclusion of specific, tested, and tailor-made indicators, considered to cover essential aspects of coastal and marine sustainability. The procedure for indicator selection was conducted systematically to minimize the number of irrelevant indicators and potential management difficulties. Therefore, the total number of selected indicators is an important factor to consider to avoid time-consuming and ineffective assessment processes. In this regard, it is suggested that using 65 indicators in an assessment is reasonable. This strikes a healthy balance between allowing for a manageable number of indicators and avoiding a scenario of having too few, which would otherwise result in the exclusion of important information. On the other hand, while too many indicators would likely tax resources, there could also be insufficient data available (Figure 2).

The core indicators should be used and applied at all times when relevant data is available for assessment. The optional indicators reflect local and regional specificities, the selection and application of which are adjusted to circumstances.

Our InSAT is provided in a user-friendly Microsoft Excel spreadsheet format. The new indicator set consists of 16 core and 20 optional indicators in the environmental quality (EQ) category, 12 core and 12 optional indicators in the Economic (E) category, and 8 core and 7 optional indicators in the social well-being (SW) category. Finally, the process category consists of 14 separate and distinct indicators that are suitable for evaluating the success of coastal and marine management processes (P) (Figure 2). The indicators are inserted in the InSAT and cover the three aforementioned sustainability categories, which are further divided into sub-categories (Figure 3). Each sub-category has its own indicators with specific objectives to assess the specific coastal and marine management initiatives. The EQ category consists of 9 sub-categories (pollution, water resources management, waste management & recycling, changes at the coast and adaptation, energy & climate mitigation, sustainable mobility, planning & management, tourism & recreation, and biodiversity & nature protection). The SW category is divided into 4 sub-categories: freedom & justice, public health & wellbeing, learning & awareness raising, and local identity & tradition. Furthermore, the E category has 7 sustainability sub-categories (accounting & regulation, labour & welfare, technology & infrastructure, production & resourcing, tourism, consumption & use, and exchange & transfer).

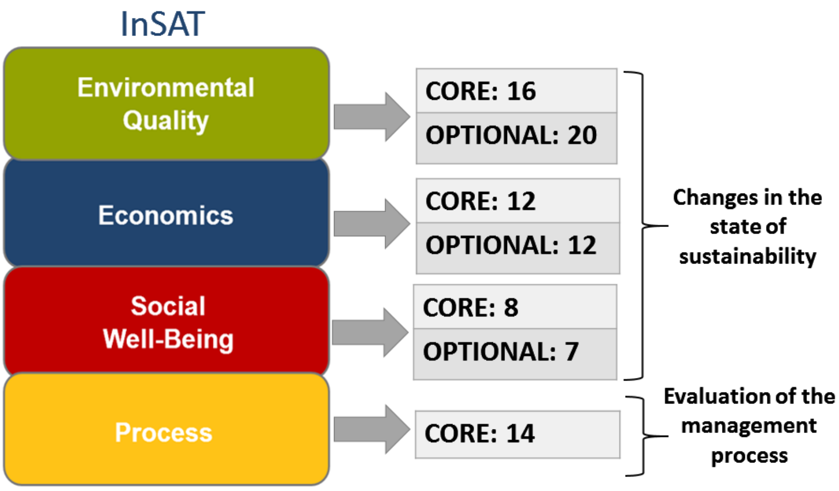

Figure 2. This graphic shows the InSAT sustainability categories (on the left), main objectives (on the right), and the total number of core and optional indicators included in the tool.

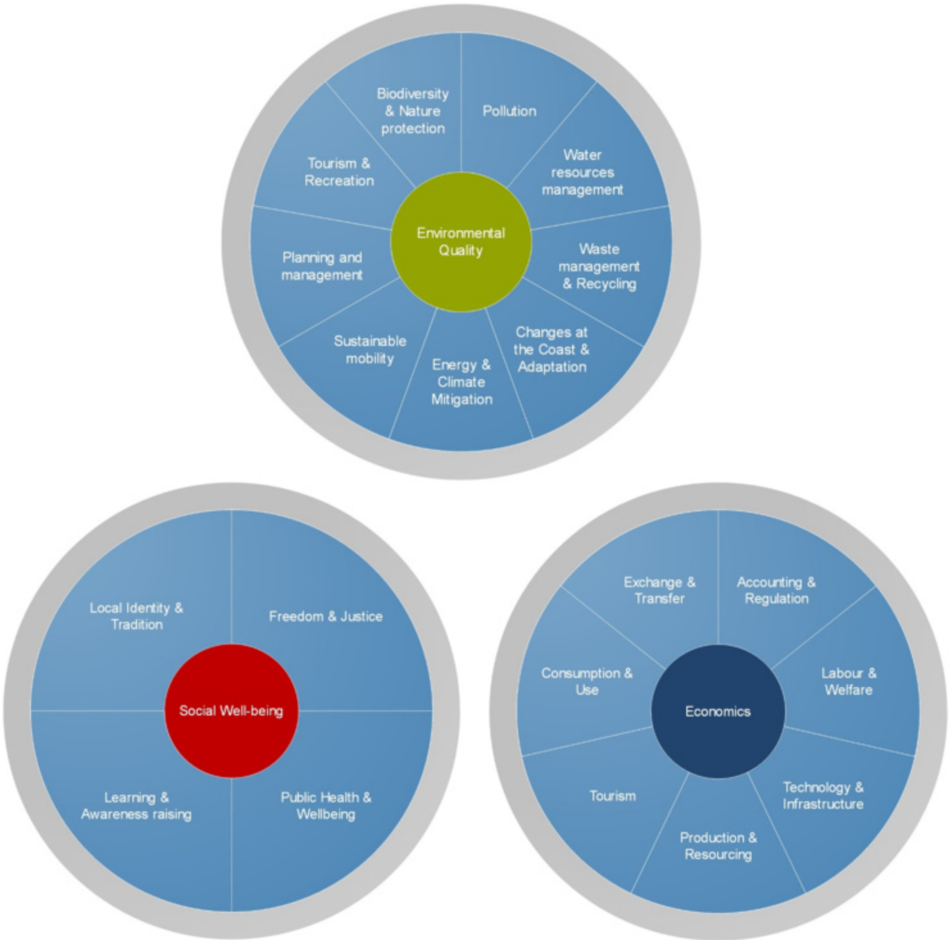

Figure 3. The sub-categories of the sustainability indicators of the InSAT.

The indicator set of each sustainability category and equally sub-category is divided into core and optional tailor-made indicators and as an early warning signal helps to identify strengths and weaknesses within the quantitative assessment of coastal and marine management initiatives. The collective application and operation of core and optional indicators highlights any weaknesses in the management initiative.

2.2. Application Process

In the assessment and evaluation step (Figure 1, Step 5), each application is carried out with experts who are actively working in the field of coastal and marine management or experts who form part of the research case studies and students possessing local knowledge. Experts were chosen from different institutions based on backgrounds and knowledge of the study area. The InSAT, the description of the tool and written explanation of the application procedure are provided to evaluators before the assessment. An indicator set application process is based on a two-step methodology [30–32,36]. The application process starts with data collection (Figure 1, Step 4). Following collection, the data is scored using the Likert scale, ranging from a minimum value of −3 (strong negative effects) to a maximum value of 3 (strong positive effects) for all sustainability categories and from 0 (no, not at all) to 4 (yes, fully) for governance categories (P). The scores inserted in the InSAT will be calculated automatically, and an average, represented in decimal numbers, will be generated [30]. One of the assessment procedure requests is to choose the 5 most suitable optional indicators for each sustainability category to express management initiatives' specificities. In supplementing the indicators, following the research carried out by Yaylaci et al. [25], experts and other evaluators are also asked to assess the importance of economic, social, and environmental categories, upon calculating the final sustainability score of the management options by considering the weak and strong sustainability concepts. For this purpose, one needs to consider the UN's (2015) definition for weak sustainability where "the total value of the aggregate stock of capital should be at least maintained or ideally increased for future generation" [37]. Strong sustainability, on the other hand, is referred to as "conserving the irreplaceable stocks" [37].

For the purposes of this study, 9 experts (18 applications) and 2 student groups (6 applications) were involved. Two applications were carried out by students (group with 20 persons) who attended the BONUS project BaltCoast Summer School 2017: "System Approach Framework (SAF) for Coastal Research and Management: from theory to practice" in Latvia. Additionally, four applications were carried out by students (group with 12 persons) from Klaipeda University who attended the intensive "Coastal and Marine Management Course 2018" in Klaipeda (Lithuania). For the assessment, evaluators assessed management options, which differed from the main aim, objectives, and implementation level (see Table 1). The assessments with students were conducted over two days. The students received a lecture about sustainability and coastal indicator systems as well as the InSAT and how to apply it. Furthermore, the students were given one day to apply indicators to all case studies, for which they were divided into groups. Following the assessment, they had a one-hour round table discussion where they could interpret results, come up with solutions as to how the tool, indicators, or CS could be improved, and present their findings. Through the process, the students could apply their local knowledge since all case studies were in Lithuania, while also being able to use all internet resources. Furthermore, the experts had a week to carry out assessment and the time used for an assessment evaluators planned individually. Following the assessment process, all experts were contacted, either by phone, email, or face-to-face round table discussions. The latter discussions helped to address any uncertainty, which arose in the comment cells with reasons explaining why particular scores were assigned to specific indicators as well as to find out about the total time used for assessment. In fact, the scoring indicator process did not take more than one day. Furthermore, discussions took place to obtain a better understanding of the evaluators' view and insight over the scoring and result interpretation. The assessment results did not change as a result of the discussion, but they helped in analyzing misunderstandings and any possible shortcomings of the indicators and tool.

2.3. Description of the Study Sites

We present three study sites with management options covering different measures and implementation levels, ranging from fully implemented to implementation in progress as well as hypothetical scenarios, all of which were located in Lithuania: (1) a liquefied natural gas (LNG) terminal in Klaipeda; (2) the renewal of the port of Sventoji; (3) the opening of a new beach in Nida. These were chosen to explore how the appropriate use of indicators can assess whether coastal and marine management initiatives lead to a more sustainable development and to qualify the management process (Figure 4, Table 1).

Figure 4. Locations of research study sites: (**a**) Port of Šventoji; (**b**) Klaipėda LNG floating storage and regasification unit; (**c**) Nida beach.

MO implementation levels present are as follows: (1) fully implemented; (2) implementation in progress; (3) not yet implemented, with hypothetical scenarios being proposed.

Table 1. The list of study sites and their main targets.

Case Study (CS)	Objective of CS	Implementation Level: Application Objectives	Management Options (MO)
Klaipeda liquefied natural gas (LNG) floating storage and regasification unit terminal construction	To implement the LNG terminal which allows Lithuania to import natural gas from various countries around the world	Fully implemented: to assess the indicators' suitability in identifying strengths and weaknesses of the implemented initiative and to measure the success of the implementation process; to assess the indicators' suitability as a monitoring tool	LNG terminal is in place
Port of Sventoji renewal	To renew the port of Sventoji to develop and increase tourism	Implementation in progress: to demonstrate how indicators could be used in the planning process; to assess changes in sustainability comparing the situation now and after renewing port; to illustrate advantages and disadvantages of renewing a port; to identify the implementation shortcomings (the port renewing process was stopped)	Situation after renewing a port
Beach opening in Nida at Curonian Lagoon site	To establish the new beach for prolonging the bathing season	Hypothetical scenarios being proposed: to assess the indicators' suitability in measuring sustainability of proposed hypothetical management options	Advertisement campaign: Advertisement campaign combined with change in infrastructure

2.3.1. The Liquefied Natural Gas (LNG) Terminal at Klaipeda Harbor

Discussions of the need for reliable gas supply and energy independence from Russian gas supplies commenced back in 1990, with various subsequent initiatives focused around the Eastern Baltic gas market (Finland, Estonia, Latvia, and Lithuania) [38]. This resulted in an LNG terminal being established in the Port of Klaipeda (Lithuania) (see Figure 4). The implementation of an LNG terminal initiative in 2010 caused much debate and controversy on a national, regional, and international level [38]. Different alternatives for terminal locations were discussed and comparative multi-criteria analysis applied considering social, environmental, economic, and technological factors [39]. The 'Kiaules nugara' island was chosen as the best location to build the LNG terminal, it being situated within the territory of a seaport. The terminal was officially opened at the end of 2014 and at the time of writing was running successfully.

2.3.2. Port of Sventoji

Inaugurated in 2011, the port of Sventoji's operation was short-lived as it suffered severe consequences upon the first storm strike, as a result of which the navigation canal was fully stacked with sediment, and boats could no longer enter it (Figure 4). The aim of the port construction was to significantly develop and boost tourism. It was expected that the port would host about 70 recreational boats or ships and that the fishing yield of local fishermen would increase up to fivefold. However, presently there are only about 20 local enterprises. In the beginning of 2017, the Lithuanian government and local enterprises agreed on making this issue a priority. About €10 million were invested with a further €50 million required, primarily to build a long breakwater that would change the direction of sediment transport.

2.3.3. Beach Opening in Nida

The Curonian Lagoon area is in need of both economic and touristic development. A brief bathing season in the Baltic Sea is seen as one of the main reasons for the short tourism season in the Neringa (Lithuania) (Figure 4). A solution to this problem would be to develop beaches in the Curonian Lagoon that have higher water temperatures than the Baltic Sea. The municipality has assessed the beach area on the southern part of the lagoon site (preparation framework—Neringa City Council 2013-01-24 decision No. T1-12, "Due to Nida south lagoon coast close to Neringa sport school detailed planning," and 2013-03-08 planning framework No. AS1-12 for conducting a detailed work plan program) and sees it as an option to attract Lithuanian families post- and pre-season [23]. We are using the following management options for our assessment: MO 1—'Advertisement' (cheaper renting prices for accommodation; discounts for ferry tickets (Klaipėda —Nida); bird watching during migration; camping sites along the Curonian lagoon; additional events to attract nature lovers); MO 2: 'Advertisement & Infrastructure' (beach place preparation (beach cleaning; sand nourishment; water purification; building up benches, trash bins, changing rooms, toilets; rescue station; information boards about air and water temperature and other conditions; the sign "Beach"); renewing old and building new nature paths).

3. Results and Discussion

3.1. InSAT Assessment Process: Indicators as Early Warning Signals

The primary version of the indicator system for coastal sustainable development was initially applied by Schernewski et al. in 2017 [31] as an outcome of the SUSTAIN project. Later on, the QualityCoast indicators were submerged into the SUSTAIN spreadsheet-based assessment method [32], but the results were not easily reproducible, and it was difficult to compare them with those related to other destinations as well as with indicators with too strong a focus on tourism [32]. As a consequence, tailor-made indicators were chosen to cover three categories of sustainability (environmental quality, economics, and social well-being), and process indicators were included to measure the success of

ICZM [21]. The new tailor-made sustainability indicators covering a wide spectrum of coastal issues were developed. In addition to this, the indicator development process resulted in the rewording of indicator definitions as well as the reduction number of indicators from previous methodologies [21]. In this study, the indicators were split into *core* and *optional* with the aim to improve previous study gaps and to avoid significant differences in the results [21]. The results of this study showed that the selection process of optional indicators had both pros and cons. The benefit of having optional indicators for the assessment is that they served as objectives to assess particular case studies by showing their specificities. Being able to apply the InSAT on a wide spectrum of coastal and marine case studies provides flexibility. However, due to a misunderstanding, the evaluators incorrectly selected optional indicators by applying the tool on the hypothetical management option of CS 3 (the beach opening in Nida) (see Table 2). In fact, the evaluators chose exactly the same optional indicators for both management options (MO 1 and MO 2), even if the selection process was clearly described and given in written form before the evaluation actually started. In this regard, the selection of optional indicators should be clearly highlighted in the tool to allow for more accurate findings and to also facilitate the detailing of specificities of the different hypothetical management options. The results prove that the selection analysis of optional indicators is useful to extract differences between management options addressing sustainability [40].

In terms of determining the optimal number of experts that should be involved in the assessment procedure to obtain clear and reliable results, by comparing the results obtained by experts with those provided by students, it seems that such an optimal number is between 4 and 5 experts for one case study. In fact, having a greater number of experts can overly complicate the process, making discussions last longer than they should. The comment cell of the InSAT helped to (a) provide more or better background information, (b) settle possible misunderstandings in bilateral discussions, and (c) facilitate a joint discussion between experts.

In applications, the experts and student groups could choose between seven scores, defined as a "strong," "considerable," or "weak" negative effect, "no change," or a "strong," "considerable," or "weak" positive effect with respect to sustainability contribution. The Likert scale will always allow for an element of subjectivity, but it is well known that this is the biggest problem with qualitative assessments. However, the tool is good to use in the case of hypothetical scenarios because, with no data available, the indicators and their corresponding results can still support modeling. The quantitative assessment is useful when you are trying to understand a certain outcome. The discussions with evaluators after assessments are very important because, even when evaluating the same case study, evaluators may end up with different or even conflicting results. Therefore, the qualitative information is important and sometimes more valuable compared with quantitative information because it involves human interpretations. In fact, there is a need for interpretation, especially when one is assessing hypothetical scenarios and needs to decide what kind of hypothesis is needed. The application results showed that the experts who are working in the coastal and marine field brought forth better knowledge and perception on the study site in comparison with the results of assessments carried out by students. All in all, the assessment results were collected from all evaluators, and averages were calculated as a percentage for the final result of each category.

Table 2. Final scores of Lithuanian case study (CS) assessments for different management options (MOs) proposed.

Case Studies (CS)	Management Option (MO)	Indicators Used: Sustainability (S) or Process (P)	Optional Indicators Selected for the Assessment							Final Sustainability Score (%)
			1	**2**	**3**	**4**	**5**	**SG 1**	**SG 2**	
CS 1	**MO 1**	**S, P**	**Environmental Quality**							
			2, 3, 7, 13, 20	2, 3, 7, 13, 20	2, 3, 7, 18, 20	2, 3, 6, 13, 20	–	2, 3, 7, 14, 20	–	25.33
			Economic							
			1, 4, 7, 8, 11	1, 4, 7, 8, 11	1, 2, 4, 8, 11	1, 4, 7, 8, 11	–	1, 2, 4, 8, 11	–	41
			Social Well-being							
			1, 2, 4, 5, 6	1, 2, 4, 5, 6	1, 2, 4, 5, 6	2, 3, 4, 5, 6	–	2, 3, 4, 5, 6	–	27.67
			Process							
			not applicable							70.25
CS 2	**MO 1**	**S, P**	**Environmental Quality**							
			7, 11, 12, 14, 18	4, 7, 8, 11, 19	7, 11, 12, 14, 18	4, 7, 8, 11, 19	–	7, 11, 12, 15, 18	–	3.2
			Economic							
			1, 4, 5, 8, 11	1, 4, 6, 10, 11	1, 4, 6, 8, 11	1, 5, 8, 10, 11	–	1, 5, 8, 10, 11	–	58.67
			Social Well-being							
			1, 3, 4, 6, 7	1, 2, 3, 4, 5	1, 2, 4, 6, 7	1, 2, 4, 6, 7	–	1, 2, 4, 6, 7	–	50
			Process							
			not applicable							50
CS 3	**MO 1**	**S**	**Environmental Quality**							
			1, 4, 11, 12, 16	4, 6, 9, 16, 19	2, 4, 9, 13, 20	1, 11, 12, 16, 17	1, 4, 11, 12, 16	1, 4, 7, 11, 12	1, 4, 11, 12, 16	51
			Economic							
			2, 3, 4, 10, 11	1, 4, 5, 10, 11	3, 4, 5, 10, 11	1, 5, 10, 11, 12	1, 4, 5, 10, 11	1, 4, 5, 10, 11	1, 4, 5, 10, 11	56
			Social Well-being							
			1, 2, 3, 4, 6	1, 2, 3, 4, 6	1, 2, 3, 6, 7	1, 2, 3, 6, 7	1, 2, 3, 4, 6	1, 4, 5, 6, 7	1, 2, 4, 5, 6	75
CS 3	**MO 2**	**S**	**Environmental Quality**							
			1, 4, 11, 12, 16	4, 6, 11, 16, 17	2, 4, 9, 13, 20	1, 11, 12, 16, 17	4, 6, 11, 16, 17	1, 4, 7, 11, 12	1, 4, 7, 12, 16	63
			Economic							
			2, 3, 4, 10, 11	1, 4, 5, 10, 11	3, 4, 5, 10, 11	1, 5, 10, 11, 12	1, 4, 5, 10, 11	1, 4, 5, 10, 11	2, 3, 4, 10, 11	83
			Social Well-being							
			1, 2, 3, 4, 6	1, 2, 3, 4, 5	1, 2, 3, 6, 7	1, 2, 3, 6, 7	1, 2, 3, 6, 7	1, 4, 5, 6, 7	1, 2, 3, 4, 5	85

The table shows which type of indicators (sustainability (S) or process (P)) were applied and what kind of optional indicators were selected by experts (1, 2, 3, 4, and 5) and student groups (SG1 and SG2). The final sustainability scores of all sustainability categories are presented in percentage and discussed in the results chapter of this study.

3.1.1. Implemented Measures: The LNG Terminal in Klaipeda

Like many other countries in Europe, Lithuania is facing challenges in the energy sector in terms of the security of energy supply, competitiveness, and the sustainability of the energy sector. One of the national tasks for sustainable economy development has been to decrease gas consumption by replacing it with renewable energy sources, while ensuring gas supply alternatives in the short term [41]. For this purpose, the construction of LNG floating storage and a regasification unit terminal was implemented in Klaipeda. LNG allows Lithuania to import natural gas from various countries around the world and as such has an effect on the Lithuania economy. The assessment results of the case study on the LNG terminal showed weak positive effects on environmental quality (25%) and social well-being (28%) and showed considerable positive effects on the economic category (41%) (Figure 5). CS 1 strongly contributes to the economic sub-categories: accounting & regulation, labour & welfare, technology & infrastructure, and exchange & transfer.

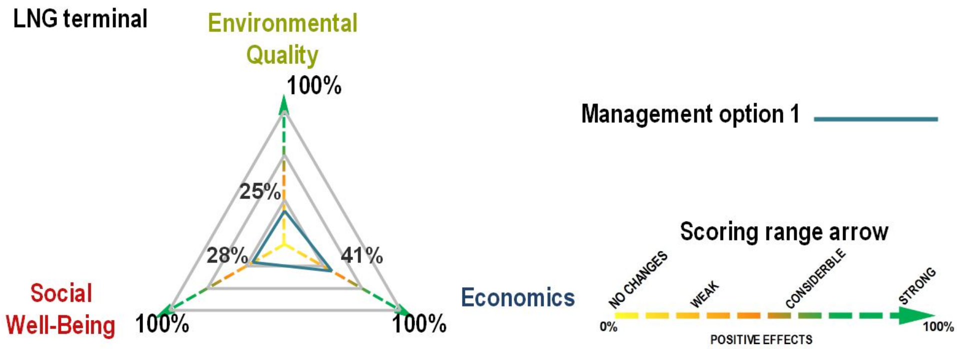

Figure 5. Comparison of the situation before and after construction of the LNG terminal in Klaipeda.

The assessment results demonstrated that the LNG terminal affects financial policies and instruments that support economic stability and resilience and ensures acceptable employment and training opportunities for local residents. As a consequence of the LNG terminal construction in Klaipeda, the new full-time Bachelor study program "Engineering of Liquefied Natural Gas Terminals" is offered at the Klaipeda University. The programme aims to prepare specialists of marine engineering and provide them with the knowledge required for the developing sector related to the use of LNG. The LNG terminal construction contributes to the learning sub-category and provides educational opportunities, supports life-long learning, and increases awareness of sustainability. The comprehensive engineering training at Klaipeda University ensures wider employment opportunities for graduates at offshore and onshore LNG terminals. Moreover, regarding social well-being, CS 1 has weak positive effects on the public health & wellbeing sub-category by improving quality of life as well as on the local identity & tradition and freedom & justice sub-categories. However, there are several negatives associated with CS 1; it has weak negative effects on resident access to natural sites due to the visual pollution of the Curonian Lagoon brought about by LNG storage. In addition, the environmental quality indicators were helpful in evaluating environmental progress towards sustainable development. The case study has weak negative effects on environmental quality categories such as changes at the coast & adaptation, planning and management, and biodiversity & nature protection. CS 1 affects natural habitats, biodiversity, and its quality as well as land use planning and management. The shipping and maintenance activities of the location in question increased. The LNG terminal has considerable negative effects on the conservation of key natural sites.

We applied the process indicators to assess the success of the management process. The results indicate that this case study covered quite a number of SAF steps and reached a high score in managing the implementation process (70.3%). The factors leading to success were namely the fact that a management team with broad competence and sufficient representation was built to lead the planning process, that stakeholder groups were determined, and that a strategy was developed on how to assess the economic, ecological, and social consequences of different scenarios. An environmental impact assessment (EIA) was carried out before the construction of the LNG terminal. Moreover, the feasibility, costs, and efficiency of scenarios were reviewed and evaluated. In addition to this, some data relating to the project was missing; for example, it is not known whether there was a strategy to tackle issues of missing data and uncertainty during the implementation process. The case study implementation demonstrated several weaknesses. The problem identified by process indicators points towards a lack of communication with society and public in general. The concept was implemented but not fully accepted by the public and consequently caused many demonstrations and discussions. Moreover, whereas the entire process was documented, only part of the information was publicly available. As a case in point, the EIA is no longer publically accessible, though during the implementation procedure it was available on the website of the Klaipeda Nafta organisation. While LNG terminal construction has several shortcomings, it is fair to say that it also presents a number of positive effects in terms of the regional and national economy. The InSAT assessment results of the LNG terminal in Klaipeda (CS 1) proved that both indicators and the tool are suitable to identify strengths and weaknesses of the implemented management initiative.

3.1.2. Measure Implementation in Progress: The Port of Sventoji

We applied the InSAT to demonstrate that indicators are suitable in the planning process to assess changes of sustainability and to illustrate advantages and disadvantages of renewing a port of Sventoji (CS 2). The main aim for renewing the port of Sventoji is to develop and increase tourism in the area and contribute to the local economy. The port renewal process was stopped only after it had been operating for ten days (June 2011).

The InSAT application results showed that CS 2 considerably contributes to the social well-being (50%) and economic (59%) categories but just weakly to the environmental quality category (3%) (Figure 6). CS 2 contributes negatively to the environmental quality sub-categories such as pollution, biodiversity & nature protection, and tourism & recreation. The port renewal has weak negative effects on air, water, and land pollution, natural habitats, biodiversity, and their quality and increases coastal erosion. Moreover, CS 2 has considerable and strong positive effects on land use planning and urban development but increases pressure due to coastal and marine recreation, which leads to increased amounts of beach and marine litter.

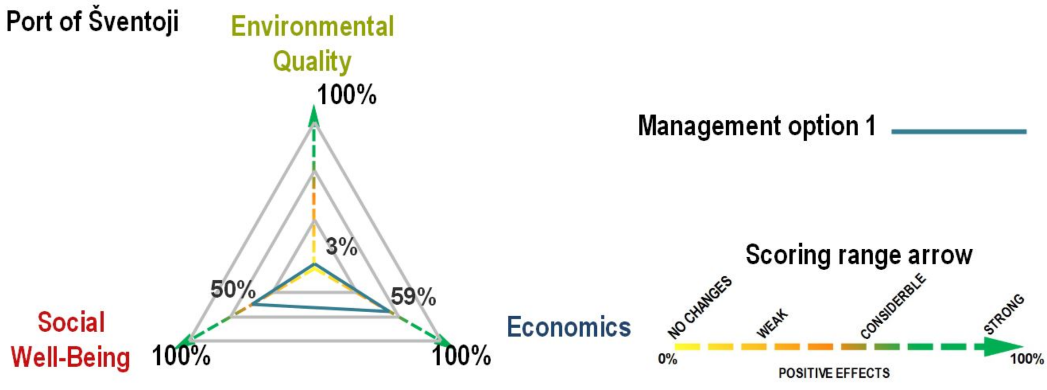

Figure 6. Comparison of the situation now and the future of a fully renewed port of Sventoji.

In addition, CS 2 positively affects the sub-categories of social well-being: public health & wellbeing, local identity & tradition, freedom & justice, and to some extent learning. The Port of Sventoji improves quality of life and increases awareness about sustainability. It promotes communication and cooperation between citizens and local authorities. Furthermore, this case study increases the production of local and fair-trade goods and services. In addition, the optional indicators indicated that CS 2 boosts public events, concerts, and festivals organised to strengthen the area's local identity. The renewed port encourages visitors to volunteer or contribute to community development, cultural heritage, and biodiversity conservation. The higher number of tourists increases the consumption of goods that are locally produced. Additionally, CS 2 supports providing interpretive information at the site, with the information being communicated in relevant languages.

The assessment results demonstrated the importance of port renewal for the local economy. The case study considerably affects financial policies and instruments to support economic stability and resilience, while it ensures an acceptable level of employment by providing more new job positions in the region. Additionally, CS 2 enhances investments in coastal management, promotes infrastructure development, and increases environmental friendly transport. CS 2 has strong positive effects on tourism management and its strategy. As a result, there is a plan to use bicycles and small boats on site to limit air, water, and land pollution. The optional indicators selected from the economic category showed that CS 2 considerably increases the volume of port traffic because of incoming and outgoing passengers as well as the volume of goods. In addition, it increases recreational boating and seasonal tourism pressure.

The assessment of CS 2 indicates that the process has not been implemented fully, and several weaknesses were identified. As a case in point, a management team with broad competence was built to lead the planning process, but there is no information relating to stakeholder involvement in the plan development and management initiative implementation process. Likewise, assessments were not made of impacts on different stakeholders. Furthermore, there is no strategy relating to the issues of missing data and uncertainty in the implementation process. As a result, the entire process was not documented or made publicly available, and the success of the measure was not evaluated. The weaknesses identified could be improved upon in the future, perhaps in the eventual management procedure when renewing the Sventoji port. The assessment identified shortcomings in the implementation process, which could be improved through future planning at the Palanga municipality level as well as at a national level.

3.1.3. Hypothetical Scenarios: The New Beach Opening in Nida

Based on research conducted by Schernewski et al. (2017) [23], while the present state of bathing water quality does not allow the opening of a new bathing site with a beach at the lagoon, one town has still decided to do so. The socio-economic analyses did show that lagoon water quality and the possibility to swim is not sufficiently important for tourists on the Curonian Spit to warrant the expense of the opening of a beach [23].

We applied the indicator-based tool for the case study of the new beach opening in Nida (CS 3) to analyze which management option out of two (advertisement campaign or advertisement campaign combined with change in infrastructure, see Table 1) is better in terms of sustainability for the strategic goal of establishing a new beach, taking into consideration the main aim of prolonging the bathing season. The main aim of this assessment was to assess the indicators' suitability in measuring the sustainability of the proposed hypothetical management options. MO 1 was based on advertising the newly established beach, the possibility for cheaper off-season accommodation rental prices, and on offering discounts for the Klaipeda-Nida ferry. Tourists are attracted to bird watching during the migration season, to the possibility to stay at camping sites along the Curonian lagoon, and to an increased number of concerts and activities, especially designed for nature lovers and kids. The difference between the two management options is that MO 2 also includes a change in infrastructure. It covers beach preparation such as beach cleaning, sand nourishment, water purification, constructing benches, trash bins, changing rooms, toilets, and a rescue station and involves setting up information boards about air and water temperature and other conditions and setting up a sign that reads "Beach." Moreover, MO 2 covers renewing old, and building up new, nature paths for nature lovers.

As a result, the "advertisement campaign" (MO 1) and the "advertisement campaign combined with change in infrastructure" (MO 2) have considerable and strong positive effects on sustainability (Figure 7). The results of MO 2 assessment, to a greater extent than results of MO 1, demonstrated that all sustainability categories have strong positive effects (EQ 63%, E 83%, SW 85%). Moreover, MO

1, showed strong positive effects on social well-being (75%) and considerable positive effects on the environmental quality (51%) and economics (56%).

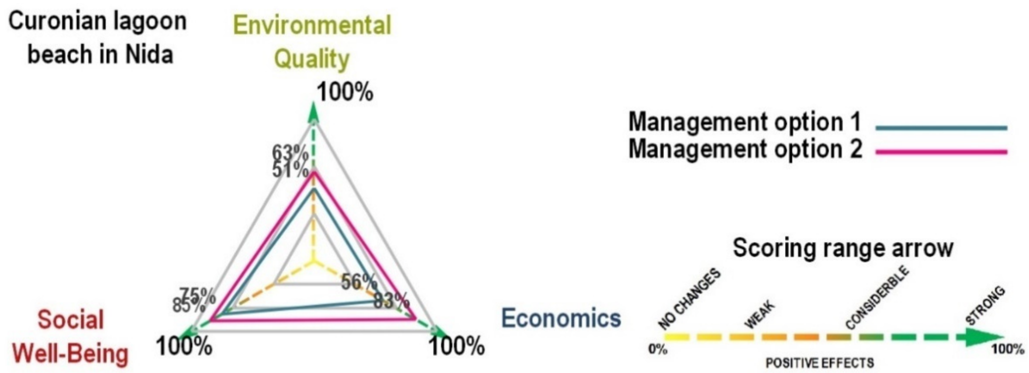

Figure 7. Comparison of two management options for opening a new beach in Nida on the Curonian lagoon site.

The results of screening through indicators showed that both management options have some positive and some negative effects on environment quality. For example, there are some negative effects posed by the increasing number of tourists who come to the Curonian Spit by road transport (car and motorcycles). People will most likely come with cars, as the indicators identified that it will increase air pollution. In fact, during summer, different measures are implemented to increase green travel options, including bicycle promotion, a fast ferry from Klaipeda, and a waived ecological fee for hybrid cars. Consequently, there are fewer options and fewer financial advantages when reaching the area in spring and autumn. In the case of the official beach opening, some measures will be applied to ensure that pollution by litter and other organic matter (macroalgea, fish, insects, etc.) affecting the soil and water quality will be removed and monitored more often. In fact, the results showed a very small and local positive effect. MO 2 has a significant effect on land use planning, urban development and management because the beach establishment area belongs to the city and the city infrastructure will be slightly changed. Both management options increase pressure on coastal and marine recreation due to the increasing number of tourists in the pre- and post-season periods. However, when we focus on natural habitats, biodiversity, and the quality of them, the area is too small to be affected significantly. Moreover, both management options contribute to increased environmental awareness among the population since one of the planned main attractions is to promote nature sights. Moreover, the management options increase opportunities to observe coastal and marine fauna, with one of the activities being related to bird watching in spring and autumn.

Firstly, MO 1 showed that it could attract more tourists without significant expense. The expenses are much higher for the beach establishment and maintenance of MO 2, which will not be covered by increased tourism. Secondly, there needs to be a minor investment for MO 1 for advertising and significant investment in beach infrastructure for MO 2. Additionally, the management options affect patterns of sectoral employment in that people can be employed for a longer period, which increases seasonal employment. The new jobs created by the beach establishment have positive effects on the economy and social well-being in the area. However, according to Schernewski (2017), the beach opening will not create economic value [23]. In fact, according to the assessment, the beach opening has a very small effect on the local economy but significant positive effects on social well-being. The indicator-based assessment showed that the case study implementation of MO 2 compared to MO 1 contributes more to sustainable development and would increase the attractiveness of the municipality, reduce seasonality, have minimal effects on environmental quality, lower economic costs, and enhance inhabitant satisfaction.

During the process of the development of management options, the InSAT can help initiate discussions between stakeholders and society. As a result, it will help decision-makers to generate information, to compare effects on the sustainable development of the municipality, and to provide a common understanding about the specific problems and the requirement for potential solutions. Moreover, the indicator-based tool has been proven to be applicable and efficient in raising awareness about sustainability by helping to initiate discussion on identified hot spots. However, while the tool indicates the management measure weaknesses, the assessment results do not indicate what kind of solutions should be undertaken. The tool is also valuable in the evaluation of concrete management initiatives by helping to provide a deeper look into environmental, social, and economic objectives. To this effect, the InSAT could be used together with the Stakeholder Preference and Planning Tool in supporting different aspects and levels of stakeholder engagement within ICZM [13].

While the local regional case studies provided valuable insights, we highlight the merit of our approach that it is relevant beyond the study area, including the possibility to transfer results to other coastal regions for assessing and comparing management initiatives' success and sustainability.

3.2. Indicators along the SAF Process: Are We Moving toward Success?

In this study, we analyzed to what extent, how, and when, along the SAF multi-step process, the InSAT could be applied to support the SAF and how the tool can be applied within other integrated approaches. It is good to note that following the SAF framework is considered to be an efficient way of structuring the coastal and marine management process. The SAF contributes to better management in terms of sustainability priorities. The information on how to use sustainability and process indicators together with the InSAT are publicly available in "The System Approach Framework (SAF) Handbook" (http://www.safhandbook.net/). The SAF handbook provides a stepwise guide to sustainable Integrated Coastal Management and was developed as part of the BONUS BaltCoast project. The core of the SAF is the Ecological-Social-Economic (ESE) assessment [17], and the assessment steps are shown on the left hand side of Figure 8. The structured and stepwise SAF and ESE are suitable methodology to identify problems of coastal or marine management initiatives and to develop possible solutions to the problem.

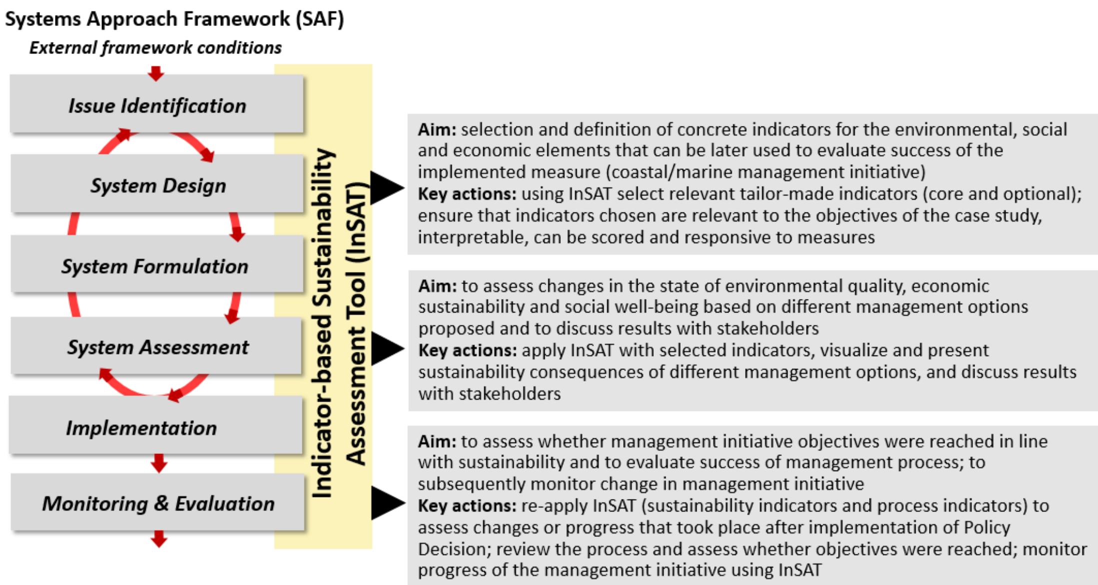

Figure 8. Indicators in the SAF process that can be assessed (http://www.safhandbook.net/).

Different tools have been used by decision-makers to minimize negative impacts and increase increasing positive outcomes of investments, leading to new management options. Among these tools, the one that was most widely used and studied is the Environmental Impact Assessment (EIA) [42]. The EIA aims to mitigate and minimize the negative environmental impacts of a specific project but has a limited capacity to equally consider and integrate the three pillars of sustainability (environmental, social, and economic) into decision-making. Therefore, motivation to use integrated approaches to overcome this issue has risen globally [42]. Furthermore, strategic decisions are made before the project scale, so consideration of strategic level alternatives is not possible in practice [43]. In this respect, early practicing and assessment tools and frameworks are necessary for the evaluation and comparison of the sustainability of alternatives in order to inform decision-makers about the different outcomes of possible alternatives, to mitigate the approval of sustainably unsound projects in the future, and to operationalize the concept of sustainability in practice.

Our assessment results indicate that the InSAT could be used as a supporting tool for the SAF and other integrated assessments and marks an important step forward to counteract the present-day lack of practical methodological and guidance tools [19,44]. The SAF and the InSAT working together can help decision-makers to better understand the sustainability concept and measure the level of sustainability of current, planned, or hypothetical management options. The ICZM planning and the SAF issue identification as well as the system assessment phase includes strong and intensive interaction and involvement of stakeholders. Initial tasks include the development of potential management options and scenarios. Further down the line, the focus is shifted towards comparing and discussing alternative options and choosing the most suitable one. Therefore, InSAT indicators could be used as early warning signals to discuss and avoid possible problems in the future.

The InSAT can be used in several steps of the SAF (system design, system assessment, and monitoring & evaluation) (see Figure 8). The first step of the SAF is issue identification, which initiates the SAF process to achieve sustainable ICZM. We highlight that indicators could be used in this step as well as in tandem with the Stakeholder Preference and Planning Tool [13]. Both tools working together can identify success criteria and contribute to the identification of a problem or a conflict that needs to be resolved.

The second step in the SAF is system design. In this step, the concrete indicators should be selected from the InSAT list provided, as described in the InSAT application section of this paper. The potential management options should be discussed with stakeholders. The indicators selected for each success criterion are use at a later stage in evaluating the success of the management initiative. The management options will form the basis for scenario simulations in the next SAF step (system formulation). The step involving indicator selection highlights how stakeholder involvement plays an important role in that stakeholders could be helpful in reviewing and discussing relevant problems and issues and in further planning future management options.

In the system assessment step, the InSAT role is to provide easy-to-communicate results to stakeholders for further discussion. The application of the InSAT provides a good overview of consequences of potential management options in resolving the issue at hand. The InSAT increases awareness on aspects relating to sustainability. The tool provides an opportunity to compare sustainability scores at different layers, all the way from a category level through to sub-categories and down to the level of indicators, with particular objectives that allow us to adopt it to assessment needs while enabling an easy way to communicate results. Similar observations were identified testing other sustainability indicators [26]. After the implementation of management initiatives, InSAT assessment allows for an assessment of the success of measures following the SAF steps. Moreover, the last step of the SAF application is monitoring & evaluation, which involves agreement on the indicators to be used for the evaluation of sustainability and the success of the management measure and appropriate monitoring. During this step, it is necessary to go through the indicators of the InSAT list and check whether these are aligned with the objectives of measure. In the system assessment step, selected indicators could be included and re-applied in the monitoring plan to assess changes after implementation of the policy decision. The results of the assessment should be made visible to the stakeholders.

Considering that all human actions have impacts on the environment trade-offs, which have an effect on sustainability quality, are inevitable. Therefore, the possible negative consequences of potential trade-offs in terms of sustainability should be well analyzed to avoid misunderstanding. The information provided should be clear, comparable, and easily accessible during decision-making. To deliver results, the group of experts should be involved from the very beginning of the process.

The InSAT proved to be applicable and beneficial in raising awareness about sustainability and useful for visualizing results and discussing them with stakeholders. In fact, sustainability appears on three levels, starting from the indicator level, to the sub-categories, and to the final sustainability category level. The final scores can be presented to stakeholders with the triangle of sustainability, with all connected sustainability categories, which allows one to easily visualise and compare results. It is also a valuable tool in the success evaluation of the management initiatives process, from issue identification through to implementation and to the evaluation of success and monitoring. The tool helps to raise awareness on environmental, social, and economic issues. In the process, trade-offs must be clearly defined and the criteria on how to deal with them should be identified by choosing the most suitable indicators for evaluation and success.

3.3. InSAT as Decision Support Tool for Integrated Approaches

ICZM principles and approaches are well reflected and integrated into the MSP initiative, and we show that the InSAT can be used in different planning and implementation steps of each concept. The methodology seems to be useful to support strategic planning and to develop both a sustainability vision and a development strategy for the future. When data are not available for modeling, the InSAT provides a structure for collecting expert and local knowledge in a manner that can analyze scenario results of potential policy decisions. Furthermore, it supplements scenario results when modeling is possible in that it provides a more comprehensive view of the system in question.

Our application results have shown that the InSAT assessment is more suitable for supporting and guiding SAF discussion processes, rather than delivering explicit results. The InSAT assessments deliver quick results; this allows for comparison between management options and a subsequent discussion thereon with stakeholders. Typically, evaluations are time-consuming, requiring the involvement of experts. In this study, we present application results by local experts in relation to visualizing positive and negative effects of management initiatives and different management alternatives. The InSAT provided clear insights into the sustainability of management initiatives.

Several experts shared their perceptions in terms of assessing the sustainability of different management options. The ICZM planning, the SAF issue identification, and the system assessment phase include the intensive interaction and involvement of stakeholders. Initial tasks include the development of potential management options and scenarios. Later, the focus is shifted towards comparing and discussing alternative options and choosing the most suitable one. Therefore, InSAT indicators could serve as early warning signals to discuss and avoid possible problems in the future. After the implementation of management initiatives, InSAT assessment allows for an assessment of the success of measures following the implementation of SAF steps. The InSAT is an important tool for implementing ICZM in practice. We have acknowledged in previous publications that stakeholder participation in the management process plays an important role and that, as such, it is vital to involve stakeholders from the very beginning for a higher process success rate [30]. In fact, stakeholders are helpful in reviewing and discussing relevant problems, issues, and further planning of future management options.

The assessments conducted within the main aim of this research demonstrated different ways in which the InSAT could be used to support integrated approaches, such as ICZM, MSP, and land/urban planning (Figure 9). An integrated approach provides a means with which to draw together information from individual indicators; however, the reliability of its results relies on the suitability of selected indicators. By using an integrated evaluation method based on a sustainable indicator system of the coastal region, a fuller view of the coastal zone development process towards sustainability can be clearly achieved. The approach is effective, operational, and reasonable if the selected indicators appropriately reflect the status of the study region.

To integrate the sustainability criteria into a management process effectively, a comprehensive analysis is needed to ensure their incorporation within the strategic management initiative goals. This methodology can be a tool for the improvement of projects or initiatives when questioning their sustainability, allowing for the identification of their weaknesses and raising awareness about the aspects that make practices efficient from a sustainability point of view (economics, social well-being, environmental quality, and governance). Thus, it is possible to learn lessons and identify aspects in which practices can be improved and made more widely sustainable in each of the three categories assessed.

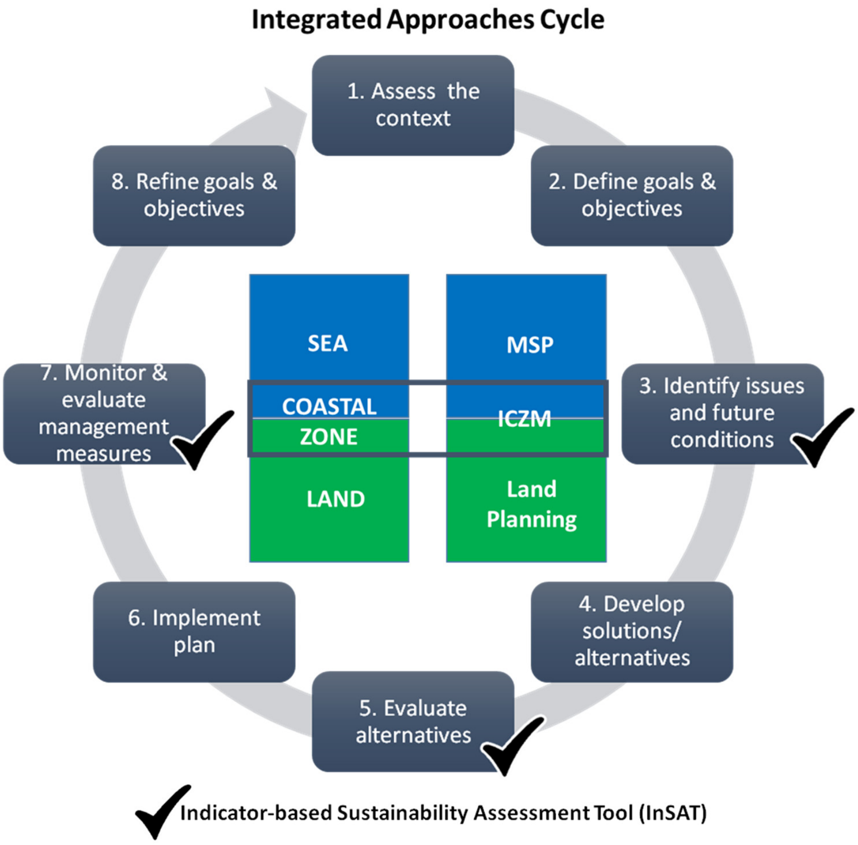

Figure 9. Integrated management approaches cycle and possible use of the InSAT.

4. Conclusions

The proposed InSAT framework serves as a tool to support coastal and marine management with particular focus on sustainability, the incorporation of environmental, social, and economic aspects, and stakeholder involvement. Moreover, used together, the core and optional indicators reveal the degree to which implementation of coastal and/or marine initiatives become sustainable. The indicators serve as early warning signals for identifying strengths and weaknesses within the quantitative assessment. In fact, the sustainability assessment provides insights into the sustainability of the management options proposed. The approach is effective, operational, and reasonable if the selected indicators appropriately reflect the status of the study region. Furthermore, it supplements scenario results when modeling is not possible and provides a more comprehensive view of the system.

Moreover, the InSAT could be used as a supporting tool for the SAF as well as other integrated assessments. To this effect, it marks an important step forward to counteracting the present-day lack of practical methodological and guidance tools. The InSAT provides a structure for collecting expertise and local knowledge in a manner that can allow for analysis of different management option results relating to potential policy decisions. Moreover, the InSAT converts scientific information into readable formats for stakeholders and can assist in the decision-making process. The lesson learned is that, while the InSAT assessment does not deliver clear-cut results, it is more suitable for leading the discussions in the integrated management processes. The indicator-based tool proved to be applicable and valuable for understanding and raising awareness concerning the issues covering sustainability categories.

In conclusion, the combination of core and optional indicators allows decision-makers to adjust the indicator set to the specific needs of their proposed management initiative. Furthermore, the assessment results assist in raising awareness and initiating discussions on changes with respect to sustainable development among stakeholders and society. It provides relevant and fast results, which is indeed a benefit when it comes to the decision-making process.

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Appendix A

Table A1. Environmental Quality.

Core Indicators (MO—Management Option)	Categories
1. The Management Option (MO) prevents air pollution and greenhouse gas emissions.	Pollution
2. The MO prevents water pollution.	Pollution
3. The MO prevents land and soil pollution.	Pollution
4. The MO improves the status of water (ecological and chemical) quality.	Pollution
5. The MO improves quality of water for human consumption.	Water resource management
6. The MO reduces waste and supports and stimulates material reuse and recycling.	Waste management and Recycling
7. The MO promotes flood prevention, protection, and mitigation.	Changes at the Coast and Adaptation
8. The MO increases coastal erosion.	Changes at the Coast and Adaptation
9. The MO increases the resilience and reduces vulnerability to climate change impacts.	Energy and Climate Mitigation
10. The MO improves the sustainable management of coastal erosion.	Planning and management
11. The MO effects land use planning and management.	Planning and management
12. The MO supports urban planning and affects urban development.	Planning and management
13. The MO increases the use of low-impact transport and supports sustainable mobility to the destination (including public transport).	Sustainable mobility
14. The MO supports natural habitats, biodiversity, and the quality of those habitats.	Biodiversity and Nature Protection
15. The MO supports policies and systems to conserve key natural sites (including marine and nature scenic, cultural, and wild landscapes).	Biodiversity and Nature Protection
16. The MO contributes to increasing environmental awareness of the population.	Biodiversity and Nature Protection
Optional Indicators	**Categories**
1. The MO supports environmentally friendly rural activities.	Biodiversity and Nature Protection
2. The MO increases use of renewable energies.	Energy and Climate Mitigation
3. The MO increases the local production of renewable energy.	Energy and Climate Mitigation
4. The MO increases the pressure for coastal and marine recreation (the number of berths and moorings for recreational boating).	Tourism and Recreation
5. The MO increases land take by intensive agriculture.	Biodiversity and Nature Protection
6. The MO promotes environmentally friendly processes and products.	Biodiversity and Nature Protection
7. The MO affects fish passage.	Biodiversity and Nature Protection
8. The MO extends the length of artificially defended coastline (the coastline that has hard coastal defences).	Changes at the Coast and Adaptation
9. The MO increases green buildings in the area.	Changes at the Coast and Adaptation
10. The MO increases forested land area.	Biodiversity and Nature Protection
11. The MO increases the amount of beach and marine litter.	Tourism and Recreation
12. The MO improves bathing water quality.	Tourism and Recreation
13. The MO contributes to wastewater treatment.	Waste management and Recycling
14. The MO affects oil spill on the ecosystem.	Pollution
15. The MO improves the quality of coastal rivers.	Pollution
16. The MO increases opportunities to observe coastal & marine fauna.	Biodiversity and Nature Protection
17. The MO increases the number of beaches and marinas awarded with a Blue Flag.	Tourism and Recreation
18. The MO improves the status of marine fish stocks.	Biodiversity and Nature Protection
19. The MO supports wildlife protection.	Biodiversity and Nature Protection
20. The MO increases energy efficiency.	Energy and Climate Mitigation

Table A2. Economics.

Core Indicators (MO—Management Option)	Categories
1. The MO affects financial policies and instruments to support economic stability and resilience.	Accounting and Regulation
2. The MO ensures acceptable employment and training opportunities for local residents.	Labour and Welfare
3. The MO increases economic diversification (the diversification of income sources away from domestic economic activities (i.e., income from overseas investment)).	Accounting and Regulation
4. The MO increases payments and investments in coastal management.	Accounting and Regulation
5. The MO promotes infrastructure development and increases environmental friendly transport.	Technology and Infrastructure
6. The MO increases investment in innovation for a green economy (an economy that aims at reducing environmental risks and ecological scarcities and that aims for sustainable development without degrading the environment).	Production and Resourcing
7. The MO increases investments on climate change adaptation and flood risk management.	Accounting and Regulation
8. The MO supports local entrepreneurs and fair trade.	Production and Resourcing
9. The MO affects direct investment (government, private sector, foreign direct investment, etc.).	Accounting and Regulation
10. The MO affects tourism management and its strategy.	Tourism
11. The MO increases culturally and environmentally friendly, low-impact tourism.	Technology and Infrastructure
12. The MO increases total economic value (the value derived from a natural resource, a man-made heritage resource, or an infrastructure system).	Technology and Infrastructure
Optional Indicators	**Categories**
1. The MO increases the volume of port traffic (e.g., incoming and outgoing passengers and the volume of goods handled per port).	Exchange and Transfer
2. The MO financially affects the setting up and managing of an Marine protected areas (MPA)	Accounting and Regulation
3. The MO ensures beaches with eco-labels.	Tourism
4. The MO increases recreational boating.	Tourism
5. The MO increases bed occupancy rate.	Tourism
6. The MO increases vehicle ownership.	Consumption and Use
7. The MO supports accessibility in island territories.	Technology and Infrastructure
8. The MO affects aquaculture and fisheries production.	Production and Resourcing
9. The MO supports the construction and modernization of fishing boats (including scraping).	Production and Resourcing (Consumption and Use)
10. The MO increases tourism seasonal pressure (intensity of tourism).	Tourism
11. The MO affects patterns of sectoral employment (full time, part time, and seasonal employment).	Labour and Welfare
12. The MO increases productivity and the use of sustainable agriculture and fisheries.	Production and Resourcing

Table A3. Social Well-being.

Core Indicators (MO—Management Option)	Categories
1. The MO promotes social justice and equal opportunities for all members of society.	Freedom and Justice
2. The MO improves quality of life (all people have a home and access to basic infrastructure and services).	Public Health and Wellbeing
3. The MO provides educational opportunities, supports life-long learning, and increases awareness about sustainability.	Learning
4. The MO protects, monitors, and safeguards local resident access to natural, historical, archaeological, religious, spiritual, and cultural sites.	Local Identity and Tradition
5. The MO supports the conservation of cultural heritage (includes rural heritage).	Local Identity and Tradition
6. The MO increases the production of local and fair trade goods and services.	Local Identity and Tradition
7. The MO promotes communication and cooperation between citizens and local authorities.	Freedom and Justice
8. The MO reduces the vulnerability of people to climate change and promotes comprehensive risk-based assessment and prioritised action in an area.	Public Health and Wellbeing
Optional Indicators	**Categories**
1. The MO increases public events, concerts, and festivals, organised to strengthen the area's local identity.	Local Identity and Tradition
2. The MO encourages visitors to volunteer or contribute to community development, cultural heritage, and biodiversity conservation.	Local Identity and Tradition
3. The MO supports providing interpretive information at key natural, historical, archaeological, religious, spiritual, and cultural sites (the information is communicated in relevant languages).	Local Identity and Tradition
4. The MO supports community and enables tourism-related enterprises to support community and development initiatives.	Local Identity and Tradition
5. The MO supports cultural heritage actions (relevant cultural projects that the local authority or municipality are involved with—staff time or funding).	Local Identity and Tradition
6. The MO increases consumption of goods that are locally produced (local products).	Local Identity and Tradition
7. The MO affects provision of health care services.	Public Health and Wellbeing

Table A4. Process Indicators.

Management Process Indicators
1. A management team with broad competences and sufficient representation was built to lead the planning process.
2. Human activities and associated stakeholder groups were determined.
3. The issue was chosen driven by ecological, social, or economic needs, and targets were set.
4. All possible measures were identified and compiled into alternative hypothetical scenarios.
5. A strategy was developed how to assess the effect and the ESE (Economic-Social-Ecologic) consequences of different scenarios (e.g., modeling).
6. Different alternative scenarios were simulated, and results were discussed with stakeholders
7. Impacts on different stakeholders were assessed.
8. Costs were calculated for different optional measures considered in the scenarios.
9. There was a strategy for the issues of missing data and uncertainty in the implementation process.
10. The feasibility, costs, end efficiency of scenarios were reviewed and evaluated.
11. The entire process was documented and made publicly available.
12. The concept was implemented and accepted by the public.
13. Effects of implemented measures were monitored on a regular basis with respect to identified targets.
14. The success of the measures was evaluated.

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