Marinas and Recreational Harbours. Environmental Management for Sustainability. Case Studies

(Master Thesis Extended Abstract)

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Abstract

The objective of this dissertation is to evaluate the search for sustainability of nautical infrastructures. Therefore, a survey of good practices adopted at national and international level was done and thresholds based on the criteria of LiderA system were created, to obtain the class of environmental performance of Troia Marina, located in the Troiaresort complex.

Sustainable economic development is based on the regard for sustainability criteria, which are measurable by environmental certification systems such as LiderA and others.

The implementation of this measures allows recreational nautical infrastructures to gain economic benefits through the use of innovative technologies on their premises, by improving the cost efficiency and reinforcing the cooperation with business partners and other stakeholders. These benefits are not only for the port authorities and companies located in its grounds, but also to the local communities by creating job and business opportunities and requalifying local degraded areas.

Taking all of this into account, and based on the general concept of sustainability, it is possible to define port development with strategic thinking, innovative technologies, investment decisions and continuous improvement.

This dissertation proposes to find a brief portrait of the environmental challenges and good practices adopted on the search for sustainability in the recreational nautical sector worldwide and Portugal's positioning on this issue.

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1. Introduction

Increasingly the processes of planning of the maritime space are considering as a principle an ecosystem-based management, recognizing them as a necessary tool to ensure the maritime sustainable development [1].

Environmental management practice is increasingly looked at as an essential component of a business plan of any operation that aims to be sustainable, efficient and compatible with the legislation. This is particularly evident in port activities to ensure a safe and sustainable performance.

Although nautical activities contribute significantly for the economic development of the country, it is also recognized that they can represent adverse impacts on the air, water, soil and sediments [2].

Marinas and ports have environmental impacts on the coastal area, due to their consumptions and discharges, among others. These infrastructures have been trying to implement good practices of environment and sustainability, for which it is important to refer various cases of Marinas, such as Vilamoura and Troia, for example, which have a strong position on this matter.

Therefore, it is essential to ensure that marinas and recreational ports evaluate good practices of environment and sustainability in a verifiable and integrated way.

The evaluation of the environmental effect of nautical infrastructures has been mandatory in the environmental strategic assessment of the plans and programs (although in a reduced way) and in the environmental impact assessment projects and voluntary in the case of environmental management systems like ISO 14001 and EMAS, among others.

However, these don't consider the integrated assessment of good sustainability practices and its environmental positioning.

For the effect, voluntary systems of evaluation and certification of sustainability have been used, such as the LiderA system, which has been applied since 2005 for the

constructed environments in Portugal. Its application involved various building typologies, not only nautical infrastructures, like marinas.

This dissertation proposes to approach a problem: The voluntary and certifiable evaluation of good practices of environmental sustainability in marinas and how they can integrate in LiderA and traduce their application in opportunities of improvement.

2. Approach and Methodology

The objective of this dissertation is to contribute to evaluate the search for sustainability of nautical infrastructures, namely marinas, in a national study case and to assess its possibility of adjustment to the LiderA system, as well as the potentiality and utility of this application to recreational infrastructures.

The methodology of the work had the following stages:

1) Review and analysis cases of what has been done for environmental management and sustainability in marinas and recreational ports, comparing the approaches in national and international cases;
2) Systematization of environmental good practices existent in national marinas and ports;
3) Adjust the specifications (performance levels - thresholds) of how nautical infrastructures can be assessed in LiderA system's approach;
4) Application of a test to a marina, in this case to the Troia Marina, which already has evidence of good practices;
5) Discuss the its application and potentialities;
6) Evaluate critically how the applications can include marinas and recreational ports;
7) Conclusion and preparation of the final test version of the dissertation.

3. Challenges and Good Practices

3.1. Environmental challenges

With the global increment of commerce, ports and marinas reveal more and mores the necessity of new investments, in order to adapt to the current demands, either by expanding or improving their facilities.

Taking into account the requisites for development, planning and management of a nautical recreational infrastructure, these are specially influenced by natural conditions, namely factors such as the wind, precipitation, waves, currents, water depths and sediment dynamics.

It is important to highlight that climate has great importance in the development of a recreational infrastructure, making the difference in the attractiveness of a residential or hotel complex, because even if there are conditions for the shelter of boats, a windy area with high precipitation and humidity will hardly be considered to be attractive.

As for the sediment dynamics, what happens often is that the alluvium regime is altered with the construction of port areas that intersect the solid littoral flux [3]. In Portugal, the Expo Marina in Tagus estuary is a perfect example of this problem, as the floating breakwater has proven its little effectiveness in sustaining the waves caused by the storms and the constant silting would increase the necessity of dredging, leading to successive changes of the location of lashings by the clients. The solution for this problem was the substitution of the floating breakwater by a fixed one.

The local ecology and its natural habitats are a precious asset and must be respected. The construction of this kind of infrastructures shouldn't compromise the habitats and local species, so it is necessary to implement measures to protect them [4].

Landscape integration is relevant, because the insertion of infrastructures may be done in distinct location regarding the landscape. In case the implementation is done in sites classified as world interest heritage, it is necessary to have a good landscape integration, to ensure the compatibility between the demands of the infrastructure and of the heritage. In this perspective, one resorts to local materials and colors that blend into the present landscape [4].

Regarding water quality, legislation demands that a recreational infrastructure possess a water fit for bathing, a demand that makes the authorities have perspectives of improvement of the water quality. Discharge and basic sanitation conditions have influence in the local water quality and must be carefully analyzed, because they affect the local ecosystems, aquatic and terrestrial [5].

Port activities may have a significant impact over environment resources. Still in this scope, the impacts that come from construction activities and port rehabilitation are, for example, the moving of ships and their navigation, which have direct impacts on air and water quality, biodiversity, greenhouse gas emissions, sediments, waste treatment, energy consumption and noise pollution.

Regarding air pollution, the number of port activities may contribute to a decrease of the local air quality. For example, ports are highly dependent on ships, trucks and cargo equipment, working on diesel motors which release particles, organic volatile compounds, nitrogen oxides and Sulphur oxides to the atmosphere. Reducing this emissions, it is possible to decrease the risk of adverse effects on human health, including asthma and bronchitis [6].

Regarding the quality of water, an inadequate maintenance on the port operations may affect water quality in local aquatic ecosystems. One of the biggest problems concerning the quality of water in ports and / or marinas is from contamination by ballast and sewage water. When ships discharge their ballast water, they may inadvertently introduce non-native species, which may pose a threat to indigenous and environmentally sensitive species. [4]

The common garbage from ships that have direct impacts on water quality and waste treatment are: ballast dirty water, tank waste, sludge from fuel oil filtration and domestic waste.

Discharges from hot processes and ballast water can harm the local aquatic life.

In addition to the environmental issues related to pollution of air and water, port activities contribute to an increase of noise and light pollution. Many ports operate 24/7 and the noise and light they emit during operation can be a nuisance to neighboring populations. The decrease of the loud noises of ships, cranes, trucks and trains, can reduce the effects of prolonged noise pollution, such as hearing loss, sleep deprivation and arterial hypertension [7].

3.2. Good practice and benchmarking worldwide

Benchmarking is a process to search the best practices in a given industry, leading to superior performance. This is a positive process by which a company examines how others perform a particular function in order to improve the way to perform the same or a similar function [8].

Today there are many different types of energy technologies that can be used in port facilities. There is such a large number of available technologies that sometimes makes it difficult for port authorities to choose the best suitable technology, hence the importance of an environmental impact study to choose wisely the best technology to apply.

The geographical location of ports and marinas is very important because the development of nautical activities generates several economic and social benefits, such as the promotion of economic activities in coastal communities, improving quality of life to all citizens, the increase in revenue from tourism and more employment in industrial, trading and services sectors linked to the nautical recreational activities.

It is also important to consider the access to port facilities both by road, railway and sea, these accesses need to be dynamic and flexible linking the port or marina on a global level.

The most common practice in this phase of the project is to conduct an environmental impact study in order to know the positive and negative impacts in the area where you want to build the port and the marina. It is therefore possible to have a better understanding of its environmental features such as climate, geological and sedimentary environment, water resources, planning and management, ecology, landscape, air quality, noise, heritage and socio-economic situation, to choose correctly the best location [4].

In the construction phase some good practices can be implemented in order to avoid rehabilitation in the near future. These practices are related to the use of sturdy, durable and sustainable materials in the construction of port facilities and buildings around them, avoiding problems of infiltration and humidity, since the buildings and facilities are close to the sea. Similarly, the preferred use of sustainable enterprises as contractors (companies with sustainable certification or environmental management systems integrated into company policies), will be another good practice to consider, such as has been used in the expansion of Rotterdam's port [9].

In the rehabilitation phase various measures may be set out to achieve sustainable and environmental success of the port and marina. Such measures may be the installation of a smart grid. A smart grid is simply an intelligent network of controlled electrical transmission, managed and monitored using technologies of communication and information (IT). [10] In other words, computers, communication and other IT technologies have been introduced to better monitor, control and manage the power distribution system.

In short, smart grids have the ability to provide and collect data in real time, allowing the network owner to make quick decisions when necessary. Thus proving to be an advantageous technology when compared with older network control systems, once the decision-making is performed based on the collected information, thereby improving the efficiency and sustainability of the network [10].

Figure 1 shows the evolution of electricity production in the port of Hamburg in Germany for the past 15 years and the forecast for the next five. It is possible to see that most of the electricity produced is from renewable sources, hence the importance to have an intelligent network [10[1]].

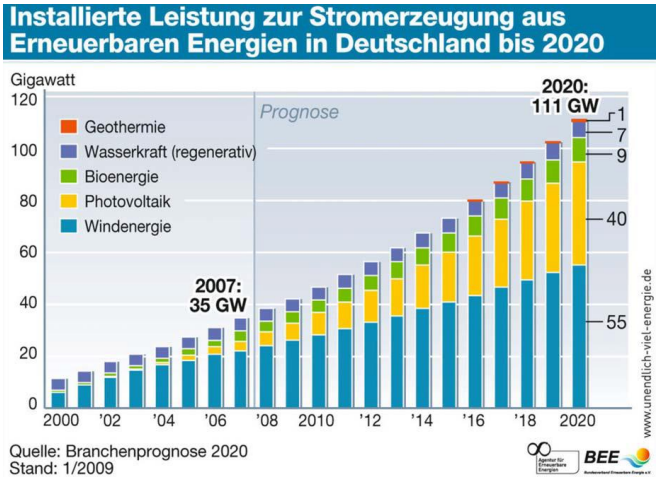

Figure 1 - Development of renewable energy in electricity production in the past 15 years and forecast for the next 5 years [10[1]].

Many renewable technologies can be implemented in the rehabilitation phase of a marina or port. A major goal of renewable technologies is to increase the sustainability of ports and / or marinas, promoting the use and facilitating the uptake of renewable energy and green fuels. The idea is to use the energy produced from local and endless natural resources. This will provide great economic, environmental and operational benefits to any port and / or marina, such as: heat pumps, solar photovoltaic energy, solid waste treatment energy, biomass and biofuels, energy from natural marine resources (waves / tides) and others [10].

The use of electric vehicles in a port and / or marina can have multiple benefits. If conventional combustion engine vehicles are replaced by electric vehicles, an improvement of air quality in the vicinity of the port can be reached. Noise levels, reduction in operational costs (electricity is cheaper

than fuel) and other localized environmental parameters can also be improved. This is especially true for large scale ports, where many electric vehicles could be used in load/unload operations and in the mobility of employees and passengers. When power is available that can be re-used in electric vehicles, such as in the heating, cooling systems, freezers, hot water tanks, among others [15]

The electrical mobility applications described above may be used and applied to electric mobility in navigation, such as electric boats and hybrid electric boats [12].

Power supply on ground to ships moored to the pier is an important technology that can reduce emissions from ships which are powered by diesel engines. This is due to the vessel, even when docked, needing to keep their supplied electrical needs (light, heating, appliances, etc.), which implies a diesel power consumption. Thus, with power supply on land, it becomes possible to reduce these consumption and emissions [13].

Another measure is the creation of voluntary programs with compensation for drivers and transport companies to replace their trucks by "green trucks" and the use of locomotives powered by an engine of low greenhouse emissions in the transport of goods in and outside the port (PG, 2015).

Regarding the measures to improve water quality, the most used during the operation and maintenance of a port and marina are the pump-out system and treatment of rainwater, thus preventing rainwater (which are more acidic) to contaminate water near the facility. Waste and oily wastewater should be directed to this pump-out system which is at the dock, and should never be discharged into the marina. Vessels without retention basin may not use their toilets when docked. It is possible to check this pump-out system in the Port of Rotterdam, for example (www.seijsener.com).

The prohibition to dump into the sea waste and water untreated from the nearby villages to the port and from the activities of the port and the monthly monitor of water quality in the harbor are procedures that are currently made in all the nautical infrastructures, mentioning the example of the port of Virginia, USA (PV, 2015).

3.3. Good practice and benchmarking in Portugal

The relationship between Portugal and the oceans is old, dating from the fourteenth century with the expeditions to the Canary Islands in the reign of King Afonso IV (1341 AD), although there have been the Portuguese discoveries in the fifteen century that lead Portugal for systematic and notable oceanic navigations, making knowledge to all the world an alternative to the trade routes in the Mediterranean and in the Atlantic and Indic oceans (W, 2015)[1].

Nowadays the importance of the role of nautical activities is recognized, both in leisure as in sports. Portugal is a country with a length about 2830 kilometers in coastline, over about 620 kilometers inland basins which include rivers, reservoirs, lakes and others, it can be said that this type of activities won a social role relevant. In addition, Portugal is exposed to good weather conditions for navigation, with a very favorable geographical location to the practice of nautical activities and possessing an undeniable natural beauty, both in the continent mainland and in the islands of Madeira and the Azores.

From an economic point of view, nautical activities lead to different sources of revenue and employ people in the marine industry, construction, repair of vessels in various ports services and the associated tourism industry.

The construction of new infrastructure with expertise to support nautical activities had its beginning in the 70's, with the creation of the first marina on the south coast, the Vilamoura marina (MV, 2015). It is common sense that Portugal has always had an active fishing activity, but since the 70's this activity has given way to recreational boating. With the increasing number of tourists to visit the Portuguese coast, there was a great need to create conditions and infrastructure concerning the development for those activities [3].

Figure 2 is related to the increase in the number of berthing places in Portugal from 1970 to 2005 spread over 50 units on the mainland (marinas, harbors, docks and nautical recreation centers).

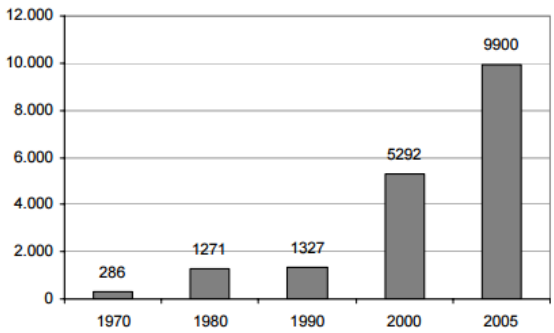

Figure 2 – Evolution of berthing places in Portugal mainland between 1970 and 2005 (From: Cabral, 2007).

Next is referred a detailed description of the best available technologies currently present in the marinas and ports in Portugal. Although the information available in this area is not extensive, it was possible to collect several similar points through sustainability reports and from websites of marinas and / or ports.

As a result of the survey, it is noted that 15 marinas and / or ports have been awarded the *Blue Flag* prize (BA, 2015) as proof of its quality and environmental commitment. It is also

[1] To facilitate the reading of the text, all information in this chapter, were found in their sites of marinas and / or marinas, being referenced in the bibliography.

important to highlight the Lagos Marina and the Oeiras Recreation Port which, in addition to this award, add *Blue Star Marina, Euro Marina* and *5 Golden Anchors*, which is the highest rating assigned to this type of infrastructures.

As part of the environmental management system (EMS) and quality management system, there are several marinas in which EMS is implemented in accordance with ISO 14001 as well as ISO 9001, PO001 (Port of Sines) and EMAS. Examples of this can be seen at the marina and Troia complex, the nautical recreation port of Sesimbra, the Amieira Alqueva marina, marinas of Albufeira and Vilamoura, and the nautical recreation port of Sines.

A major concern in environmental management of infrastructures is minimizing consumption, especially water and electricity. The goal is the optimization of consumption, reducing without affecting the level of comfort for all users. All projects and revamping are integrated into the concept of sustainability, giving preference to low environmental impact materials. Thus, the equipments installed are chosen according to their energy efficiency and water consumption, aiming to minimize those consumptions on a daily basis.

In buildings that are part of the marina complex and / or port, lighting is optimized making the most of natural light (locker room of Vilamoura) and using low consumption lighting and / or triggered by motion sensors (locker room of Vilamoura and buildings in Alqueva). The installation of photovoltaic panels is also an increasingly recurring measure, existing in the Amieira-Marina Alqueva, in Oeiras Recreation Port and Vilamoura Marina.

Still regarding electricity consumption, it is considered good practice if the marina or port enables a ground source of power and water for their vessels, preventing them of using their own engines as a source of power, with a great reduction in the emissions to the atmosphere in operation, as in Troia Marina among others.

Comparatively to the assessment of drinking water consumption, a set of good practices that contribute to the optimization of water consumption stand out, such as installing flow controllers in the hoses of berths (hose nozzles in Troia Marina), the installation of pressure reducers in the same equipments and flow reducers in bathrooms in the administrative building with the placement of toilet flushes with dual flushing system and the reinforcement of operational control that can be seen, for example, in Troia Marina, Vilamoura Marina and Oeiras Recreation Port.

Several measures have been implemented to rationalize the consumption of drinking water, for example, in Sesimbra Recreation Port by controlling and minimizing losses in the water network, or such as in Setúbal Port by replacing the supply line and the installation of fixed or removable water meters and also installing taps with timers in toilets. In both ports of Sesimbra and Setúbal, investments have been made in improving irrigation efficiency, adjusting the time and duration over the seasons and increasing the green area equipped with automated irrigation system.

Some port authorities have planned for the future investments in remodeling the municipal wastewater treatment plant for the use of grey water for irrigation, as is the case of the Troia Marina and Vilamoura. In connection with these two marinas, there is the monthly monitoring of the water to check its quality.

Regarding the washing of hulls and decks of ships, they should be made using authorized and environmentally friendly products (product list "environmentally friendly" in the marina of Lagos). In any case, it is always advisable to use a minimum amount of detergent in order to save product, but also to reduce the amount of residue remaining in the water. Users who do not use this type of products are subjected to penalties under the law.

Repairs or work on vessels involving the use or release of pollutants, cannot be made at the mooring, at the risk of groundwater contamination and consequent effect on marine species, according to the provisions of art.º. 6, paragraph 1, item h) of the Regulations of Lagos Marina.

In case the Recreational Port or Marina has an area reserved for repairs and washing of boats, the waters from these activities should have a suitable destination, not entering in the main sewer system, neither on the floor of the Port or Marina nor in water in the surroundings.

The Lagos Marina and Troia Marina received ECOLUB certification, responsible for the collection and processing of used lubricating oils produced in Marina. The certification comes from adherence to the collection system of ECOLUB, promoting the correct routing of this hazardous waste to preserve the environment.

Within waste management it is important to emphasize that in all ports and / or marinas it is common to have a plan and waste management control in all areas of activity enclosing the handling of hazardous waste, monitoring and recording their collection, transportation and final destination. Plans allow the quantitative framing of the associated impacts and to meet the applicable legal requirements.

There are specific containers for the disposal of toxic waste, such as waste oils and batteries in the marinas of Lagos, Vilamoura, and Troia, among others.

Encouraging the reuse and recycling is also reinforced by placing awareness posters for users and staff, as well as the provision of drop-off recycling containers to all.

Also important to note, that the existence of pumping suction equipment for ballast water and ship basements and the existence of pumping equipment for waste water from toilets vessels are considered mandatory in a port or marina to be registered in the Blue Flag program.

In Vilamoura marina, among others, there is a pump-out system, which is located on the fuel dock. This system collects the oily water which accumulates at the bottom of the vessel and the waste water stored in the retention basin. Oily water is stored in a special container and subsequently collected by an entity duly licensed and sent for treatment at the WWTP of Vilamoura. This service operates with its own chips that can be obtained in the marina reception, free for customers who have their boats on their facility.

Admission of animals is not prohibited in this type of infrastructure, but a fundamental obligation for owners has to do the cleaning of the solid waste on public roads. Thus,

there are in the marina of Lagos special containers to deposit waste of domestic animals in the marina walkway.

In the area of security and services, a port or marina must take safety precautions such as CCVT 24h / 24h surveillance, access cards reserved for owners of vessels, lockers, adequate night lighting, timetable of opening / closing in areas whose security / criminality is difficult to control, existence of fire detectors, among others (marina of Vilamoura).

For services, it is important that the project has considered distances easily travelled by foot (up to 1000 meters), with better quality of life for employees and site visitors if more local amenities are in place (Pharmacy, Police, food stores, balneary, ATM, restaurants, post office, bikes, etc.). We see all in the marinas of Vilamoura, Lagos and Albufeira, Oeiras Recreation Port, Cascais Marina, among others.

3.3.1. Environmental Behavior Code

Given the predominant location in beach environments, dunes, salt marsh, estuary and pine woods, port authorities must develop projects where protection and enhancement of environmental heritage are present. Thus, it can be considered a good practice to have an Environmental Behavior Code, which establishes a set of principles and values of environmental ethics, which should be recognized and adopted by all users and workers in marinas and recreational ports.

In Troia, with the existence of a population of bottlenose dolphins in Sado river, an Environmental Behavior Code was created for users to raise awareness of the behavior to adopt in case of sightings.

Other infrastructure also resorted to raise awareness of users through an Environmental Behavior Code recognizing that the need for preservation of the environment is closely linked to the concept of efficiency and undertakes to adopt environmental stances contained in the code, as in Lagos, Vilamoura, Alqueva, Lisbon, Troia, Cascais and Sesimbra.

4. Troia Marina

To study the developed and adapted system LiderA for buildings, Troia Marina was chosen as a case study.

Troia Marina is located in Troia Peninsula, in the western coast of Carvalhal parish in Grândola municipality, and between the Atlantic Ocean to the west and the Sado estuary to the east, as can be seen in Figure 15. In the last decades of the twentieth century were built in Troia several tourist developments, such as Soltroia and Troiaresort. Two river terminals ensure the shortest connection to the city of Setúbal: South Pier (Ferries) and Ponta do Adoxe (Troia Marina - Catamarans).

Troia is characterized by a sandy sandbank bathed by ocean and river, giving it wealth, in an environmental point of view. In this sense, given this privileged location with beach environments, salt marsh, dunes, estuary and pine woods, there was built the Troiaresort where the marina is an integral part of the complex.

The marina has a planned capacity for 184 boats, and it is possible to dock more 3 or 4 vessels depending on the size of the vessels on the marina at the time. Also part of the Marina is an administrative building and locker rooms that are located in a street parallel to the Marina about 50 meters, which can be seen by the plant in Figure 3.

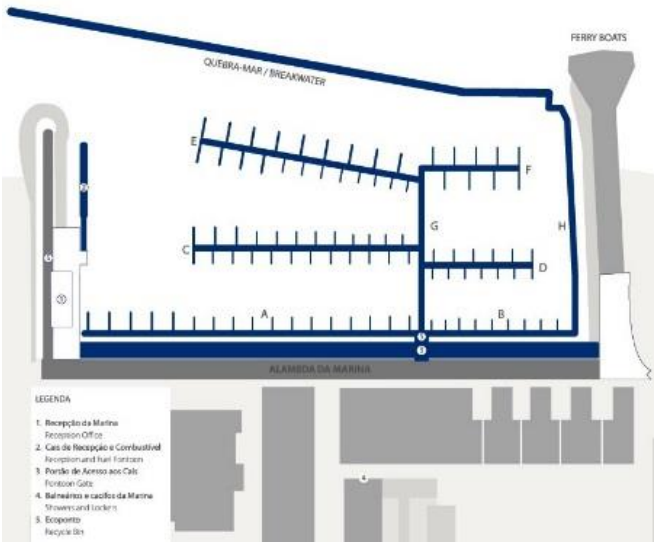

Figure 3 – Plant of Troia Marina.

The Troia Marina is on the list of marinas with the Blue Flag award since the beginning in 2008, a symbol of environmental quality awarded annually by an independent entity. This recognition implies compliance with a set of criteria covering different areas - water quality, environmental information and education, environmental management, equipments, safety and services.

It was also distinguished - only case in Portugal - in the environmental management system of the Troiaresort, with ISO 14001 certification and registration in the Community System Eco-Management and Audit - EMAS.

5. Performance Achieved

This point is intended to the evaluation of implementation of the proposed LiderA model with adjustment for marinas, applied to Troia Marina that evaluates performance in all 43 criteria LiderA.

In terms of Local Integration, includes criteria C1 to C6. There is an excellent performance in all criteria except for the protection and enhancement of heritage (C6) which presents a class E in environmental performance.

The territorial valuation criteria (C1) and landscape integration (C5) present a performance class A ++, criteria relating to environmental optimization of implantation (C2)

has a class A and the remaining, except for C6 as mentioned previously, have a class A + performance.

In the aspect that relates to Resources, taking part the criteria C7 to C15, there is generally good performances, with class A or A +, except for the C7 and C15 criteria with respectively B and E classes, and in the case of C11 criteria it has an excellent class A ++ thanks to the existing pump-out system. The criteria obtained an A + rating were related to passive design (C8) and for materials, C12 and C14.

The criteria that have obtained environmental performance class A were the criteria for carbon management (C9), drinking water supply systems (C10) and local materials (C13).

Related to Environmental Loads, are the C16 to C23 criteria and the best measured performance comes from the criterion of noise sources (C22), which achieved class A ++. The assignment of class A + appears on the criteria of flow of air emissions (C18), management of hazardous waste (C20) and in illumine-thermal pollution (C23). To the criteria of waste water treatment (C16), waste production and waste recycling (C21) is attributed the performance Class A and the criterion of re-flow of waste water (C17) into class C.

In terms of Environmental Comfort, which includes criteria from C24 to C27, there is an excellent environmental performance, with highest rating A ++ in air quality levels criteria (C24) and illumination levels (C26) and a class A + in thermal comfort (C25) and acoustic / sound levels (C27).

In the area of the Socio-Economic Experience (C28 to C40), the best performances were evaluated on the criteria of access to public transport (C28), local amenities (C34) and participation and governance (C37), obtaining class A ++. In low-impact mobility criteria (C29), flexibility - adaptability to the uses (C31), economic dynamics (C32) and interaction with the community (C35) was measured Class A +. The remaining criteria obtained Class A, except for the costs in life cycle (C40) which obtained a class C.

The aspect of sustainable use achieved an excellent environmental performance and almost maximum in all criteria.

It is possible to conclude with assessment of environmental positioning for each criterion presented in the preceding paragraphs, that Troia Marina is part of an environmental performance class A +, which means, being the common practice as Class E, an environmental performance four times better than the reference (Figure 4).

Figure 41 – Global Environmental Performance achieved by Troia Marina, adapting LiderA.

5.1. Limitations

One aspect to consider in this thesis is if this approach achieved the goal: "to contribute to the assessment of demand of the sustainability of nautical infrastructures", including Marinas, in a national case study to assess possibility of adjusting to LiderA system, such as the potential utility of this application to recreational infrastructures.

The application made demonstrated that it allows contributing to the evaluation of sustainability, applying to a Marina and having results that show this need. Among the limitations, the lack of data sometimes led to develop prescriptive thresholds that are sometimes indicative.

The application methods already incorporate the principles of objectivity, various evaluators reach similar conclusion, although it is considered desirable in the future to increase the precision of the proofing and data to improve this aspects, including the logic of life cycle.

This application typology shows what was applied, what limits (and credits) are ensured by the Marina and the good practices that have not been applied, which if applied could turn out to be opportunities for improvement, i.e. identifies opportunities for improvement.

As for the potential application to other recreational infrastructures, this is possible although it is desirable, as defined in LiderA, that tests to the applications are made and then translated into standard applications specific to this typology.

Therefore, the approach achieved the desired goals, and to their application and standard development for this typology, it still needs to generalize the tests and adjustments of the thresholds.

6. Conclusions

This work has the aim of contributing to the evaluation of the search for sustainability of nautical infrastructures, including Marinas, in a national case study and assesses their possibility of adjusting LiderA system, as well as the potential

and usefulness of this application to recreational infrastructures.

It was concluded that this methodology contributed to the assessment of demand of sustainability of nautical infrastructures, to identify good practices implemented in the case study (Troia Marina) and getting to assess them in the spreadsheet developed based on LiderA system.

The worksheet created and adapted from existing on the LiderA System for the classification of buildings, was considered applicable to the case study, and this work from the academic point of view achieved its objectives. The result was excellent in the perspective of sustainability, since the marina obtained an overall environmental performance class A +, on a scale from G to A ++ (G being the least efficient and more efficient A ++).

However, it is important to highlight the fact that the various classifications were based on data from different information sources, with different levels of detail in the fragmentation of consumption. Therefore, in some cases, hypotheses were assumed based on data from a particular source, in order to estimate the consumption values with the desired level of detail.

Finally, it is noted that all of the estimates and the final characterization of environmental performance Class of the marina, is based on data relating to Environmental Impact Statements and Troia Marina Sustainability Reports, conducted by Troiaresort, so it is data from a source that can be considered as a "good marina" and from these data, the thresholds for environmental performance classes of 43 criteria were deduced, (very briefly, in the technical visit to the Troia Marina it was verified if it had these features, if so then it would be a point in favor, and after that all the other nautical infrastructures were verified for the same features).

Following the foregoing, it would be interesting to create most complete databases on support infrastructures to recreational boating in Portugal. To this end, it is necessary that this information, including construction costs, maintenance costs, water and electricity consumption, can be made available by the authorities.

Regarding the applied approach, it is essential to carry out studies on the environmental and economic impacts caused by recreational infrastructures, so that it is clearly understood the importance of assessing the sustainability of those infrastructures, by qualified companies to develop solutions and sustainability assessment of construction, such as the Portuguese brand LiderA - Sustainability Assessment System.

Nomenclature

APA – Agência Portuguesa do Ambiente

DS – Desenvolvimento Sustentável

CO_2 – Dióxido de Carbono

CO2-eq – Dióxido de Carbono Equivalente

SO_2 – Dióxido de Enxofre

NO_x – Óxidos de Azoto

CFCs – Clorofluorcarbonetos

UNEP – United Nations Environment Programme

WWF – World Wildlife Fund

ADENE - Agency for Energy

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