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Marina development and environmental impact assessment requirements - the case of Lefkada Marina

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Abstract

Increased tourist trade and pleasure boat activities in the Ionian Sea have led to new constructions and expansion of existing marina facilities. The site selected for marina development on the island of Lefkada is near the main town, on location "Alykes". This shallow and protected area was not maintained after the closure of the salt work activities and the area was flooded by sea water, creating an ecosystem characterized by high primary production and depths not exceeding 70 cm and as shallow as 20 cm. Salt work activities, as well as materials used for recent land fill efforts, have increased concern about the physicochemical characteristics of the seabed sediments and dumped land fill soil. Marina development dictated extensive dredging in order to obtain operating depths for pleasure boats ranging from 4 to 8.5 meters. Previous studies performed as required by the Environmental Impact Assessment (EIA) procedures in order to obtain planning and construction permits, described in great detail environmental indicators of the marine and coastal pre-construction environment. Dredged materials were also analyzed in order to assess the quality and therefore the management/disposal strategies in order to avoid the dispersal of potentially contaminated sediments. The paper presents and compares the environmental data obtained before and after marina construction, the objective being to quality review the Environmental Impact Assessment process and investigate the degree to which a linear system such as an EIA is adopted and applied to a dynamic environment such as a marina. Based on these findings, conclusions and proposals as to how the EIA process might, more effectively, highlight and therefore mitigate significant environmental impacts due to marina construction and dredging are made.

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1 Introduction

For most of the Greek islands, tourism is becoming the main driving force for economic and commercial development. Lefkada Island has lagged behind compared to other Ionian Islands such as Corfu, but recent trends in overnight stays for the island over the last decade, indicate that Lefkada is becoming a favourite and promising tourist resort in the area. As shown in Figure 1 overnight stays in Lefkada island have increased steadily during this period attaining the highest yearly average increase, compared to the other Ionian islands, the Ionian islands totalling about 4.500.000 overnights per year for this period. It has become apparent, that such increases may undermine tourist development especially when the hotel sector is not able to provide adequate and high quality accommodation, unless other developments leading to an upgrading of tourist services are also instigated on the island. In this context, it is believed that the Marina development plan will be a serious asset for the island.

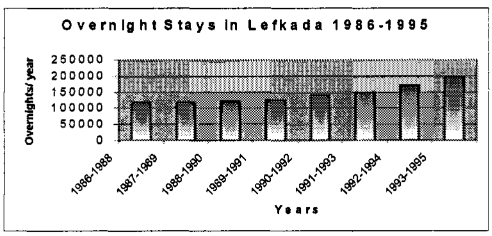

Figure 1: Overnight stays in Lefkada for the period of 1986-1995 [1]

In designing the layout and facilities of any marina (floating docks, canal, bunkering stations, repairs and maintenance area, hotel), many parameters have to been taken into account and particularly the specific characteristics of the physical and anthropogenic environment. Some of the most important elements in choosing the site in Lefkada Island to develop and build this marina were the following:

- ✓ Boaters are usually of medium or high income and are prepared to spend in order to enjoy their holidays, either at sea or land, thus enhancing tourism in Lefkada
- ✓ Most of the potential activities associated with boaters and yachts, can be found in and around the town of Lefkada
- ✓ The town is connected with mainland Greece by airport and road utilizing a bridge
- ✓ The demand for building marinas around Greece is increasing due to the competition of Mediterranean countries as far as pricing and the quality of their services is concerned

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✓ The excellent natural protection of the region provides an ideal mooring area

✓ The town of Lefkada has become one of the most famous “bases” for cruising in the Ionian Sea, due to the fact that the island is centrally placed [1].

The new marina in the town of Lefkada will also have the following advantages and benefits for the town itself:

✓ Immediate economic benefits (through foreign exchange) arising from marina facility development and usage

✓ Invigoration of commercial business in the town and increase of employment opportunities in the area, since there will be a need to staff operations at both the construction, as well as for the operation phase

✓ Development of tourist businesses associated with the operation of the marina, such as fuelling, catering, brokerage, etc. [1].

As the owners of the marina declare, “The marina’s construction philosophy is the welfare of people and the environment. The high quality specifications, for the areas of public use as well as for the entire marina, are founded on stringent rules governing health, aesthetics and environmentally friendly development.”[1]. Thus, measures have been made in both phases and are being presented. This paper presents the environmental data collated before and after construction of the marina. Based on the declaration of the owners and the fact that environmental considerations should be integrated into the construction and operational phase of the marina, an attempt is made to assess the impacts due to the construction process, as well as assess the conclusions and recommendations of the EIA, performed before construction.

2 Environmental impacts

The coastal sea zone of the marina is 165,000 m^2 and total berthing capacity 630 yachts of various categories. On the land area of 72.000 m^2 an wintering area will accommodate 285 vessels, as well as offer maintenance and repairs facilities. The marina also provides safe moorings, electricity, water, phone, bunkering, sewage and waste oil reception facilities, and easy hauling/launching through travelift and ramps. Additionally, there are information desks, administration offices, medical desks, showers and toilets, bank branches and ATM’s, chandlery, shops, car parking, restaurants, a small hotel, and boat renting stores.

This region served as a salt works area till the late 50’s. Reports indicate intensive salt production, utilising several hundred pits, which the calm seawater of the narrow passage between the island and mainland Greece flooded regularly. Salt work activities, as well as materials used for recent land fill efforts, have increased concern about the physicochemical characteristics of the seabed sediments and dumped landfill soil. On the other hand, during the construction, dredging was necessary in order to increase the depth, as well as to build a canal through the marina that will enable the recycling of the water.

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Dredged materials were also analysed in order to assess the quality, and therefore the management/disposal strategies (land or sea).

Generally, marinas are potentially significant sources of pollution in coastal waters often being hot spots for coliform bacteria and other pathogens, aliphatic and aromatic hydrocarbons (PAH) and heavy metals. The use of antifouling paint and other chemical preservatives, used mainly during operational phase, are toxic to numerous organisms. Benthic communities usually incur the most acute effects, with significant changes occurring in species composition, abundance and diversity at marina sites. Operating craft frequently lack onboard sanitation devices and release raw sewage to coastal waters. Oil and fuel leakages, as well as engine exhausts are sources of PAH's. Such pollution input degrades water quality, especially in shallow estuaries and coastal embayments with poor water circulation [3].

It is, therefore, recognised that environmental considerations are of outmost importance to any coastal development interventions involving marine constructions such as pleasure boat marinas, as well as during operational phase. Nevertheless, differences still exist as to the extent and type of this integration. In most countries the implementation of Environmental Impact Assessments (EIA), is enforced by legislative and administrative regulations, whilst others integrate it as part of general planning schemes. EIA's aim is to mitigate significant impacts, including the minimisation of undesirable impacts.

2.1 Environmental impact assessments

Although EIA systems are comprised of many significant, integrated and interrelated parts, one of the most important sections that not until recently has been sufficiently investigated, is the post-auditing methodologies. As Wilson [4] states, "an environmental impact assessment (EIA) audit evaluates the performance of an EIA by comparing actual impacts to what was predicted". Several authors [5,6] have identified four basic auditing types focusing on post-project appraisal:

1. Implementation audit, that examines whether mitigation measures and/or any other imposed conditions have been established.
2. Project impact audit that serves to highlight all the environmental impacts that have been taken place due to the development of the project.
3. Predictive techniques audit, that compares and reveals the accuracy and utility of various predictive methods used in EIA.
4. EIA procedures audit, that evaluates the overall efficiency of the EIA system at a macro-level.

The efficient and systematic use of post development auditing, especially in the case of a marina development, can result in a number of significant benefits and advantages, the most important of which are [6,7,8]:

❖ The results from post auditing can be used as an effective tool for sustainable environmental management over the life of the project.

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❖ By revealing some special, as well as unpredicted impacts caused by a specific type of development (such as a marina development) post auditing can provide a basis for improving the existing predictive techniques.

❖ Finally, post auditing can be used as a feedback to the entire EIA system. In this way, the "reinvention of the wheel" is avoided and improvement of future practice by "learning through experience" can take place.

On the other hand, several researches have highlighted the fact that post-auditing studies based on various project types, are still very limited, inconsistent and not at all widespread. Carrying out a post-auditing study can be hindered by a variety of problems:

- First of all, as Dipper *et al.* [9] states, the availability of pre-existing monitoring data is a pre-requisite for any post-auditing study. In many cases, the almost absolute lack of any kind of impact monitoring data is acting as a prohibited factor to the conduction of a post-auditing research.
- Secondly, the EC Directive 85/337/EEC (as amended by 97/11/EC) does not require any mandatory monitoring and auditing program in a case of a proposed development. Consequently, the majority of the developers seem unreluctant to establish any monitoring schemes, mainly due to the increased cost of monitoring activities. Therefore, a lack of perception among EIA participants is established. Even when monitoring data can be located it is frequently inaccurate, inadequate and biased.
- Moreover, many impact predictions found in the Environmental Impact Statements (EISs) are presented in a rather vague and ambiguous way, thus hindering the efficient interpretation and usage of this data.
- Lastly, another vital problem is the potential existence of impacts that had not been predicted and therefore stated in the EIS, as well as several project changes that may take place in a rather late stage of the EIA process and therefore, the impacts caused by those modifications are not examined whatsoever.

Having stated the most important problems often associated with post-auditing in EIA, it is subsequently rational to anticipate that numbers of case studies focusing on post-auditing is rather limited. Even though search of the literature reveals some examples most of these case studies investigate big project types, such as power stations, chemical plants, incinerators, but not marina developments. A possible reason for this, may be the fact that proposals for leisure activities usually account for a small minority of all project proposals, while the construction costs, as well as the time and effort invested, are relatively small compared to the project categories mentioned above.

However, although a marina does not occupy relatively large areas, is situated at the land-sea interface, "in the heart" of very dynamical and fragile environments with substantial biodiversity, which are susceptible to rapid degradation due to human development. Moreover, studies on marina developments have highlighted many integrated, distinctive and irreversible impacts to the nearby environment. In this paper we attempt to apply the

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principles of the post-auditing process to Lefkada island marina, since we were involved with the estimation of all the relevant environmental data before the construction, as well as taken an active part in the prediction and recommendation processes.

3 Environmental data and results

Sampling positions are shown on Figure 2. Positions remained constant for the pre and after-construction sampling regime. At these positions, water and sediment samples were collected. The samples were transported to the laboratory and analysed following well-established environmental chemistry methodology and techniques. The data presented in this paper represent the pre-construction (**B**efore) environmental indicator (column B) and the post-construction condition (**A**fter) (column A).

The microbiological condition of the area seems to have changed to the better, since E. Coli and Enterococci levels are reduced, in most cases being within the levels specified by the Directive on bathing water quality and the Directive on shellfish water quality levels. It must be mentioned that due to the construction process many streams and rainwater drainage outlets, that inevitably accept illicit waste waters from nearby urban areas, were diverted away from the area. The post-construction picture is however, not clear as yet, since the sampling was performed in spring (March 2002), the marina only accommodating 40 – 50 vessels. Table 2 provides information on basic nutrient concentrations of the seawater before (column B) and after most of the construction activities have taken place (column A).

It is obvious that there is no statistically significant change to the trophic state of the sea, even though the dredging process removed the top layer of the sea bed (shallow depths of 0.5 m) that was composed of algae, seaweeds and a microcosm that was involved in biological degradation, a process that potentially could lead to the provision of some basic nutrients to the sea. Further sampling is required to describe the effects on these nutrients, probably highlighting a decrease, due to the restriction of fresh water streams to the area

As far as the basic oceanographic parameters are concerned (Table 3), the study showed that the results are as expected, normal, stable and with no fluctuations after the construction of the marina.

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Figure 2: Location of samples

Table 1. Analysis of sea water samples for microbiological contamination

Samples	E-Coli/ 100 ml		Enterococci/ 100ml	
	B[1]	A[2]	B	A
I 3	$>10^6$	41	300	<1
III 2	100	20	10	<1
IV 3	35	131	10	10
I 1	$>10^6$	285	200	<1
Γ	$>10^6$	203	$>10^6$	20

B[1] = Before construction A[2] = After construction

Clarity has increased due to the increase of the depth in the area and salinity data are almost stable for the entire sea area. The area was studied intensively for sediment heavy metal concentrations, as it is a well-known fact that sediments represent the sink of all elements entering the sea. A series of analysis were performed as previously stated in accordance to EIA requirements before the construction as well before dredging.

The data in column B (**B**efore) represent averages of at least four samples at each sampling point. Column A data, represent one sample at the same positions (see Figure 1). The surface sediment in most of the study area is composed of clay and in areas close to the docks it is fine-grained, in contrast to areas around the north breakwater, where it is muddy, black and coarser. This is to be expected, since during the construction phase a lot of grab dredging has been done and the process has affected the consistency of the sediment.

The concentration of the metals in the area is low, indicating that there are no significant anthropogenic inputs of heavy metals to the coastal ecosystem. Table 4 sums up the heavy metal concentrations before (column B) and after (column A) for the most toxic metals, of interest to all environmental impact assessment studies.

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Table 2. Concentrations of basic nutrients at selected sampling points

Samples	Phosphate μg-at / l		Nitrates μg-at / l		Nitrites μg-at / l		Ammonium μg-at / l	
	B[1]	A[2]	B	A	B	A	B	A
III 2	0,49	0,25	0,76	0,89	0,12	0,05	0,98	0,78
I 3	0,12	0, 37	0,92	0,81	0,05	0,03	0,23	0,62
I 1	0,22	0, 44	0,38	0,17	0,15	0,05	0,42	0,55
Γ	0,22	0,39	1,72	1,13	0,18	0,07	0,35	0,88

B[1] = Before construction A[2] = After construction

Tributyl tin (TBT) is also included, since it has been associated with pleasure boat activities. Although the area had limited pleasure craft, it is believed that these data will act as a good background reference in order to assess impacts due to antifouling paints, when the marina is in full operation. Results concerning the other metals represented in Table 4, although statistically not significant (due to limited sampling points), indicate a reduction for most metals in most of the surface sediments analyzed. Some positions with higher levels than pre-construction values, could be due to the fact that the dredging process (grab) resuspended the fine sediment and allowed the transfer of the adsorbed heavy metals to areas of the marina where sedimentation rates was high. It is obvious, however, that further sampling and analysis of sediment samples must be performed in order to assess in a more precise way the environmental effects of the construction process. The organic carbon content of the post-construction area is significantly lower that the pre-construction ones, a fact to be expected, since the dredging process removed the surface sediment layer where most of the previous organic matter decomposition activities deposited their products. It must be pointed out that biological monitoring was not performed in the area, since the species inventory of the pre-construction area was not detailed and long-term enough, to perform comparative studies.

In conclusion, it is evident that the construction process has not seriously altered the environmental indices that were selected for the study, following EIA methodology. Any small alterations observed, seem to be in the direction of improving the environment, and in this respect we can state that the conclusions and recommendations that followed the environmental assessment before the construction, were withheld to a high degree. It is obvious, however, that further measurements and a systematic monitoring regime must be implemented, as it is important to monitor with extreme care both the impacts arising from the construction process, as we may still be expecting delayed effects, but also more importantly the effects during the operation of the marina. The marina is expected to be fully operational in 1-2 years.

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Table 3. Basic oceanographic parameters

Samples	pH		Temperature ^0C		Salinity ‰		Clarity (m Secci)		Dissolved oxygen (ml / l)	
	B^1	A^2	B	A	B	A	B	A	B	A
K	7,98	8,36	16,1	16,3	36,3	38,2	<15	1,9	5,01	-
III 2	8,1	8,33	21,5	16	37,0	38,2	-	2	5,13	5,0
I 3	8,22	8,32	19,2	15,4	30,2	38,4	-	2	4,05	3,1
I 2	8,02	8,3	22,2	15,4	36,7	38,5	-	2,6	4,28	4,8
I 1	8,18	8,27	23,8	15,4	38,3	38,4	-	2,5	3,81	6,3
Γ	7,9	8,34	23,2	16,2	37,9	38	-	2,2	3,97	-

B^1 = Before construction A^2 = After construction

Table 4. Metal concentrations and organic content of sediments

Samples	Ni ppm		Pb ppm		Cr ppm		Cd ppm		Zn ppm		Hg ppm		TBT ♣ ppb		Organic content %	
	B^1	A^2	B	A	B	A	B	A	B	A	B	A	B	A	B	A
K	43	37,5	15,4	32,5	62,3	23,2	ng♦	ng	151,1	221,3	ng	ng	ng	ng	5,1	3,2
III 2	62	75,2	24,3	72,3	56,7	19,4	ng	ng	140,4	185,2	ng	ng	ng	ng	6,1	2,9
B	49	68,1	20	22,2	44,2	35,2	ng	ng	135,7	98,3	ng	ng	9,1	ng	5,3	3,5
I 3	86	22,2	33,3	13,5	77,3	72,3	ng	ng	187,9	93,8	ng	ng	5,4	ng	4,1	2,2
Γ	56,7	56,7	29,7	42,7	45,9	28,3	0,11	ng	48,6	105,7	ng	ng	ng	ng	6,6	2,8

♣ tributyl tin ♦ non detectable B^1 = Before construction A^2 = After construction

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