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Possibilities of Sustainable Development of Small Recreational Ports

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Development of small ports for recreational purposes is one of the most discussion perspectives in both Lithuania and Western Europe. There is no single opinion on the possibility to accomplish this development without badly affecting natural systems. Different methods that estimate sustainable development are suggested for large ports that have loading docks, ship repair units, etc. These methods cannot be applied to small recreational ports. The analysis suggests newly developed methods that allow to evaluate sustainable development of recreational ports and to calculate certain indicators on an example of Sventoji small port. The systematic analysis of port activity consists of existing port operations and processes, technogenic port processes identification, evaluation of the significant natural environment and technogenic environment aspects. According to the values of selected aspects the evaluation of current and planned situation is carried out and the factors mostly affecting the environment are identified. Effective use of energy and waste in port activity and the change of indicators for reaching the balance are evaluated.
Keywords: *recreational sea port, sustainable development.*

1. Introduction

The marine environment constitutes two thirds of our planet and due to its significant recourses, on which many economic activities relay, it provides tremendous opportunities for the welfare of the population of the Earth. While developing its activities each country's maritime sector must promote an integrated ecosystem approach because it is one of the ways to reconcile sustainable maritime activities in promoting economic growth with environmental preservation, so that increasing needs of maritime transport, tourism, coastal development, fisheries and aquaculture, safety, maintenance, etc. would not endanger the marine environment and biodiversity (COM 2008-534).

The construction of Sventoji small port which is ecologically sensitively located poses long public debates in Lithuania. Restoration of the port is an important step in developing Lithuania's as a maritime country needs. However, in achieving eco-efficiency the coherent and rigorous environmental assessment is to be carried out, which would reflect the environmental parameters change over time, so that possible effects on the environment caused by Sventoji small port could be predicted.

One of the most important tasks while operating the port is to assess how the natural environment will be affected by the built environment, it is also important to decide how the natural environment will be protected from physical, chemical, biological and other adverse effects or consequences. Nevertheless, it is quite difficult to assess the status of the marine environment by applying traditional methods of monitoring. When separating the changes in the ecosystem affected by human activities and those caused by nature, environmental parameters and their determinants should be monitored and measured within the widest possible range, both in time and space. One of the methods used in the environmental assessment of the subject is the use of eco-indicators which summarize a large amount of environmental data and provide a summary of concentrated information. Such indicators guarantee a quick access to the information for the people who make decisions and identify either positive changes or weaknesses. Unfortunately, most of the eco-indicators are made redundant in evaluation of small ports which are not involved in handling cargoes. For this reason it is necessary to select the main criteria that allow evaluating small ports activities and to provide appropriate methodologies for further calculations. A number of scientific work deals with sustainable development of sea ports. A. Kutkaitis, J. Čepinskis study the development of port security and technological factors. I. Lips, V. Fleming, S. Kaitala use Ferrybox Measurements for the Baltic Sea Environment Assessment. M. Peris, J. Diez, K. Ibanez, P. Alvarez present suggestions for developing a system of indicators for sustainable port management. The biggest problem is that scientific workers pay too little attention to small recreational sea ports and their environmental assessment.

Based on the already created methodology it would be possible to organize the primary environmental assessments of Sventoji small port, also to select the most dangerous aspects of its eco-sustainable recreation and to offer its development model.

The aim of the paper is to carry out the environmental assessment of Sventoji small port which is still planned to be constructed. During the analysis acceptability of the indicators will be verified according to the methodology for recreational ports prepared by the authors.

2. Methods

Organization of Sventoji port environmental criteria and their aspects. Initial environmental assessment of the object is a starting point of implementation of the environmental system by applying the sustainable development principles. Environmental analysis is usually carried out in an attempt to find out and consider all the variables that reflect environmental changes over time. Ports being complex and dynamic objects, it is difficult to track variations in their parameters, therefore when evaluating activities of a small port only the most influencing ones are selected. A limited amount of these indicators simplifies the analysis; it also creates a possibility to flesh out the controlling processes. Systematic analysis is done according to the following methods:

1. Identification of existing port operations and processes - size of the area, number of vessels, location of embankment, natural environment at sea and on land, physic-chemical parameters and biological parameters. Analysis of the current situation is carried out according to the statistical and environmental monitoring data;
2. According to the technogenic port processes the environmental aspects of port activities - waste and sewage transference from vessels, pollution from ships and energy consumption at the port are determined;
3. Evaluation of the significant natural environment and technogenic environment aspects. Selected natural environment (ecological) aspects are counted according to the MPC (maximum permissible concentration) or limit values of the natural environment. The current values of these parameters and their changes after the port construction are determined (e.g. current concentration of oil hydro carbonates in the port environment is 0.18 mg/l. and the concentration of MPC is 0.04, in this case the aspect will be 4.5 units). When evaluating the aspects for the technogenic effect the increased load for one thousand people is calculated (for example, the amount of waste for 1000 citizens and 1000 tourists is 1.304 tons per year; while with the existence of port there will be approximately 2076 tons per year, thus the aspect of the effect will be 1.59);
4. According to the values of selected aspects the evaluation of current and planned situations is done and the factors mostly affecting the environment are identified. The amount of pollutants at a certain stage of the activity is found out as well as their effect on the existing natural and living environment;
5. Evaluation of possible measures such as technological load reduction to reduce dangerous aspects and calculation of the change of aspects;
6. Environmental aspects as general criteria units of environmental quality can be added together and the effect may be defined as $K_{Apl.=}\Sigma A_1+ A_2+ A_3+...+ A_{Apl;}$.
7. Aspects of the environmental technological impact as well as criteria of potential impact of human activities may be added together while determining total criteria $K_{Th}=\Sigma A_{T1}+ A_{T2}+ A_{T3}+...+ A_{Th}$;
8. General criteria of the effect made by the port is calculated as the sum of the following criteria: $U_{K1}=K_{Apl.}+ K_{Th}$.

Environmental criteria described in this paper are meant to evaluate the environmental state (either positive or negative) and the impact of measures. Each impact must be evaluated and the level of its significance must be evaluated in percent. Each area of assessment is compared to the current situation, thus it is possible to presume how the port operation will affect the environment. Most important recreational port aspects have been chosen and analyzed:

- Amount of waste for 1000 people in tons per year;
- Water consumption for 1000 people (thousand m^3 per year);
- Amount of wastewater for 1000 people (thousand m^3 per year);
- Number of vehicles for 1000 people (units);
- Pollution caused by vehicles (CO, CH, NOx, SO_2 and the amount of particulate emissions in tons per year), converted into CO_2 equivalent;
- Pollution caused by vessels (waste water, waste, solid household waste, CO, CH, NOx in tons per year) converted into the amount of CO_2.

According to these data it possible to evaluate the changes in energy and waste flows from the residents and recreation. Applying this methodology we suggest evaluating all changes in efficiency which is calculated by means of the following formula:

$$N = (\log A/\log M_{max})*100,$$

$$\text{or } N=(A/M_{max})*100\% \quad (1)$$

Where:

A – recycled materials or energy obtained from the alternative energy sources.

M_{max} – a maximum amount of waste and emissions.

Maximum efficiency can be equal to the unit or to 100%. While assessing the usefulness it is possible to compare the amount of energy and materials used at the present time to that which would be used with an alternative energy and when sorting the waste. It is also possible to realize the amount of energy and materials used if the flows of materials and other sustainable development methods were balanced. A given method is called the AEA model (analyze - evaluate - adjust), the sequence of actions of this method being: first the situation is analyzed and the aspects making an impact on the port activity are chosen, during the next stage the impact aspects that occurred during the port operation are evaluated and according to the calculated aspects technologies are adjusted, the aspects and criteria are recalculated.

3. Results and Discussion

Sventoji small port is located at the mouth of the Sventoji river and on the Baltic Sea coast. In 1989 the reconstruction project for Sventoji small port was prepared. According to this project a four to five meters deep yacht harbor is to be built, however up to the present day the port is not operating. In 2003 the *Sventoji Port Restoration Feasibility Study* was carried out which presented the main port activities and development priorities:

- To create Sventoji and Butinge oil terminal ships pier, so that in stormy weather vessels coming to Butinge would have a possibility to moor not only in the distant Klaipeda port, but also in the nearby located Sventoji small port.
- Sventoji small port is recognized as a fishing port, also as a mooring place for Coast Guard cutters, tourist boats and yachts (Smailys 2003).

The main purpose of Sventoji small port is to receive and provide services to recreational, small and sport boats, also to fishing boats, small-scale sea cruise and RO-RO passenger vessels. Its other purpose is also to serve Lithuanian State Border Guard vessels, specialized rescue boats, special vessels for the oil spill collection, fire and marine environmental protection, navigation and control of fishing ships. Sventoji small port will also serve Butinge oil terminal auxiliary fleet and the emergency release measures, it will also carry out the initial processing of fish and develop fishery trade (Seaport of Sventoji).

There is a proposal to divide Sventoji port into two parts: the southern - for recreational tourism and the northern - for commercial purposes. Reconstruction of the southern - recreational part of the port (southern pier), which would be adapted for tourist yachts, passenger cruise ships, fishing boats, powerboats, etc., would create a possibility to divert a large part of passenger traffic from the port of Klaipeda. The other reason of usefulness of the Sventoji port construction is that the Butinge oil terminal buoy and its sea-water part are dangerous objects from the environmental point of view with a relatively high degree of risk of accidents. Currently, main technical measures for elimination of accidents are completed in Klaipeda port.. Nevertheless, the latter is unable to solve problems related to small international tourism development. To attract foreign tourists traveling by sailing yachts and small cruise ships it is necessary to have at least one port where such tourists would be able to stay (Vasiljeva and Lebedeva 2008).

According to the documents in preparation, a few versions of the Sventoji port project are discussed. There is a design of two alternatives: the first option - northern pier of 400 meters length, the depth of channel - 6 meters. The second option is to construct a northern pier of 800 meters length with the depth of channel from 6 to 8 meters.

There are two options of the port operation:

- Total number of vessels in the port would be 319; 133 of which would be up to 6 meters of length, 140 vessels would be from 6 to 9 meters, 36 vessels from 9 to 12 meters and 10 vessels would be from 12 to 15 meters of length;.
- Total number of vessels in the port would be 650; 266 of which would be up to 6 meters of length, 280 vessels would be from 6 to 9 meters, 84 vessels from 9 to 12 meters and 20 vessels would be from 12 to 15 meters of length;

Calculations are provided for the maximum impact on the environment under the second option of the port operation. Figure 1 presents the spread of the port infrastructure in accordance with the expected types of vessels; it also allows us to see the main port infrastructural objects. According to the estimated number of places and provided area, small recreational vessels (sea yachts) should become main visitors, vessels and yachts of a port yacht club are also included in this number of recreational vessels, they will be provided a separate area close to the yacht club. Mooring of service boats, vessels serving Butinge oil terminal and other vessels will be organized at the closest point of the entrance gate. The mooring zone for fishing boats is arranged at the rear of the port area and nearby a building for fishing boats crews will be built. It is planned to create other objects of infrastructure providing all necessary utilities - oil station, electricity, water, waste disposal station, etc.

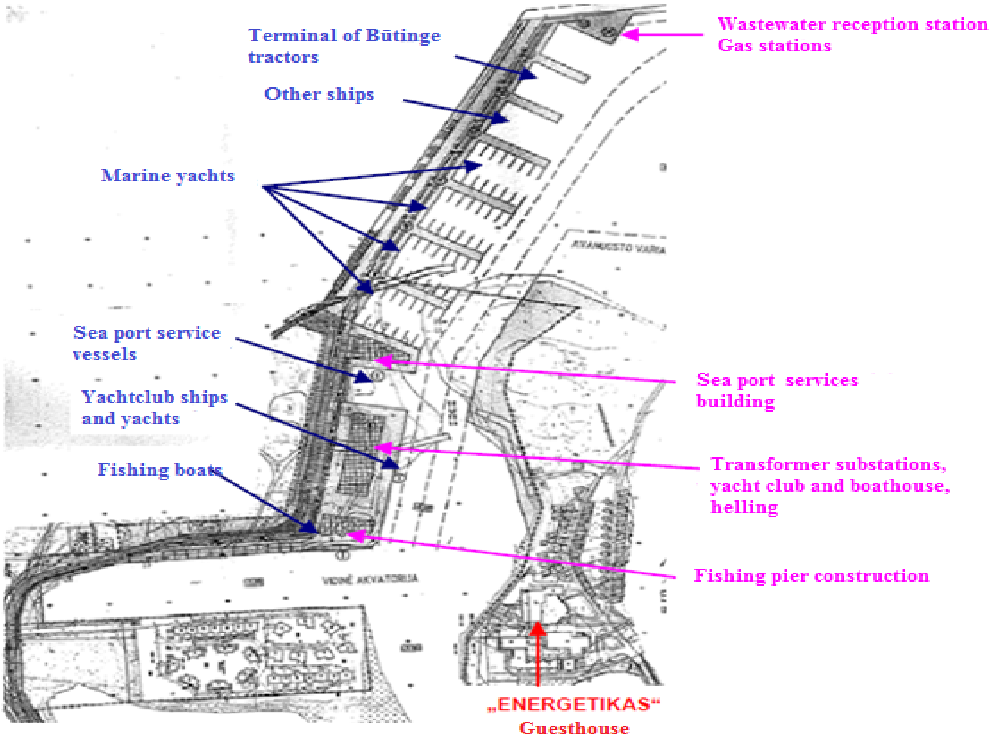

Fig. 1. Layout of the Sventoji port

It is difficult to assess the status of the marine environment by using traditional methods of monitoring because the water systems are heterogeneous in terms of space and also there are rapid changes in the pelagic communities. One of the possible ways to evaluate environmental port activities is to use eco-indicators (Lips *et al*. 2007; Eco-Indicator 99).

Environmental indicators may help:

- To set environmental improvements at various periods;
- To provide opportunities for optimization of the activities;
- To provide the goals of environmental protection;
- To measure the effectiveness of environmental protection in comparison with other activities of similar profile;
- To maintain the systems of environmental management (Peris et al. 2005).

Environmental indicators may also be used in accordance with the aspects of economical sustainable development, requiring the development of an economic system with all resources used wisely and with well organized distribution of an ecologically productive space. Thus, the harmonious living space is created as well as business and industry based on the ethical principles. The purpose of sustainable economic activities is not to bring profits for a few persons, but to create an ecological welfare that does not violate the rights of the companies. In accordance with the aspects of ecological sustainable development the balance between physical environment and protection of its resources must be assured. At the same time the proper quality of present and future life style must be guaranteed (Mohammad *et al.* 2010).

In 1994 the *Organization for Economic Cooperation and Development* created a model of indicators called P-S-R (pressure- state- response). According to it all indicators are set in the groups that state whether they describe the effect on the environment made by companies (pressure indicators), quality of the environment (state indicators), or indicate response to the environmental changes (response indicators). This model might be extended to the D-P-S-I-R (driving - forces - pressure - state - response). Two additional categories are introduced: basic element - public influence and activities which are related to the environmental conditions and cause changes in the environment. Effect is the result of pressure (Bazar et al. 1996; EEA 2002; Bazar et al 1996).

No single model of evaluating and adapting the principles of sustainable development exists usually for this purpose various techniques are used. Such models do not allow full evaluation of changes in small port activities, because it is very difficult to select appropriate environmental, economical and social components and to evaluate them equally in the context of sustainable development, especially in analyzing the objects that are still planned to be constructed and operated.

While analyzing the above mentioned methods, which are based on the usage of environmental indicators, we face the problematic fact that many environmental indicators have neither limited values nor goals to be achieved. So far most commonly used indicators can quantitatively evaluate conditions and changes of the environment. Problems cannot be solved when dealing with the consequences only. First of all it is necessary to remove the causes. Therefore, to prepare effective measures for the urgent solution of environmental problems it is necessary to realize the causality of various phenomena and processes (Winkelmans et al. 2007).

While analyzing various methodologies for identifying sustainable development of organizations, it is useful to create an original assessment model for a particular cargo seaport. The assessment of economical indicators is organized every year. The purpose of such assessment is to realize the material benefits, fulfilled tasks of the protection policies and to calculate taxes paid to the government. Determining the indicators which reflect economical activities best, we will rely on the reports provided by the national seaport and statistical data on common port activities. According to the general agreement of the European Community, the EU member states having an access to the sea are to declare the data on the port activities which are declared in the *Eurostat* common database. The indices of the port social sustainability dimension are identified while adapting the national sustainable development indicators of the Republic of Lithuania (Kutkaitis *et al.* 2011; Čiegis *et al.* 2010; Čiegis et al. 2008; OECD 2001; Eurostat 2001).

Current situation is evaluated through the environmental monitoring data. To select the most important ecological aspects with the biggest impact on this recreational port, the nutrients (general nitrogen, general phosphorus, nitrate, and phosphate) were analyzed; and the changes of heavy metals and oil hydrocarbon concentrations were also analyzed. The state of ichtyofauna, a representative of the highest nutrient level, was also estimated (Stakėnienė *et al 2010).*

Water parameters of the Sventoji zone are influenced by the Sventoji River and salinity indicators - by the Baltic Sea, for this reason frequent fluctuation in the concentration of polluting substances is noticed. Nitrate, general nitrogen, general phosphorus and phosphate concentrations are an important element when defining loads. Trends of these materials are described in Figure 2.

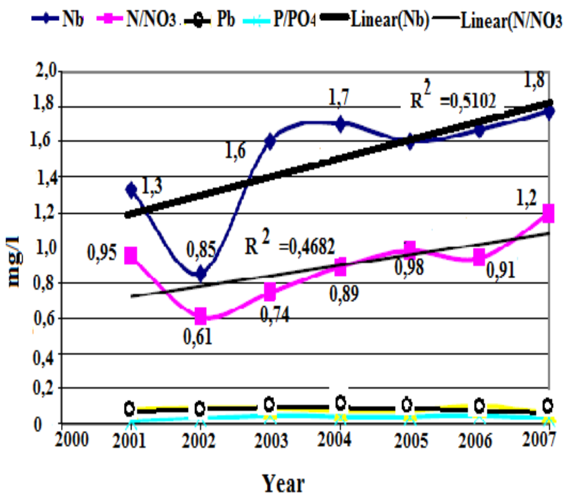

Fig. 2. Average annual changes of nutrients concentrations (general nitrogen, general phosphorus, nitrates and phosphates) 2001-2007

Here according to this scheme general concentration of nitrogen and nitrates is increasing, while the amount of general phosphate and phosphorus remains stable. Thus, it is possible to suppose that in the future during the operation of Sventoji port the settings of these parameters may increase (Stakėnienė et al. 2010).

Knowing that the port operations increase heavy metals concentrations in water, the changes of these materials are evaluated. It is noticed that copper and lead concentrations at the mouth of the Sventoji River decrease, while those of nickel increase, yet at present heavy metal concentrations do not exceed the maximum permitted ones. A tendency of heavy metals to change is demonstrated in Table 1.

Analysis of physical and chemical parameters of water dynamics shows an increase in suspended substances in the concentration of nitrogen, variations in heavy metals concentration within the MPC, also a big amount of oil hydrocarbons with an excess of MPC up to five times.

The evaluation of physical-chemical parameters shows that concentration of oil hydrocarbons is a significant aspect. The content of these materials in water exceeds their maximum allowed concentration therefore it is necessary to carry out an evaluation and control of this parameter in Sventoji port.

Table 1. Average annual concentrations of Cu, Zn, Cr, Ni, Pb, Cd and Hg metals at the mouth of the Sventoji River, 2001-2007

Year	Average of heavy metal concentration in the Šventoji river, µg/l						
	Cu	**Cr**	**Zn**	**Ni**	**Pb**	**Cd**	**Hg**
2001	3.4	18.89	0.54	0.83	1.46	0.04	0
2002	2.5	21.54	0.47	0.26	0.68	0.03	0
2003	2.64	28.83	1.4	0.4	0.9	0.01	0
2004	1.95	22.5	0.15	0	0	0	0
2005	1.99	47.3	0.65	0.86	0.34	0.01	0.01
2006	0	0	0.3	1.15	0	0	0
2007	0	0	0.5	2.32	0	0.15	0
MPC	10	100	10	10	5	5	1

An increasing concentration of oil hydrocarbons creates a threat to fish population. The Sventoji River plays an important role in recovery of the salmon population, because salmon and brown trout are artificially bread there; 18 more different fish species live in this river, including the species protected by the Berne Convention. For this reason the concentration of oil hydrocarbons is to be controlled so that it would not exceed the lethal limits. Recently fish population in the Sventoji River has started to decrease, therefore preservation of the natural environment, fish biomass and a variety of species becomes an important aspect in the analysis of Sventoji port impact on the environment. Changes in fish biomass are illustrated in Figure. 3.

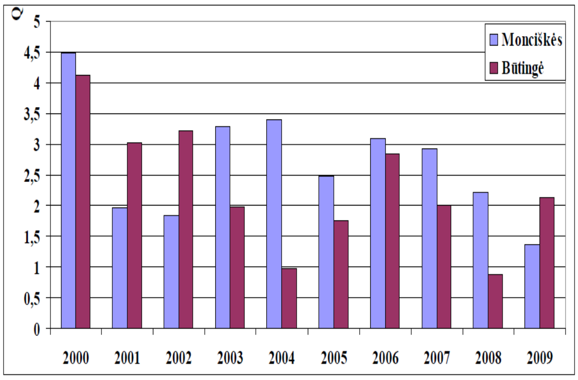

Fig. 3 Changes in fish biomass at Butinge and Monciskes 2000-2009

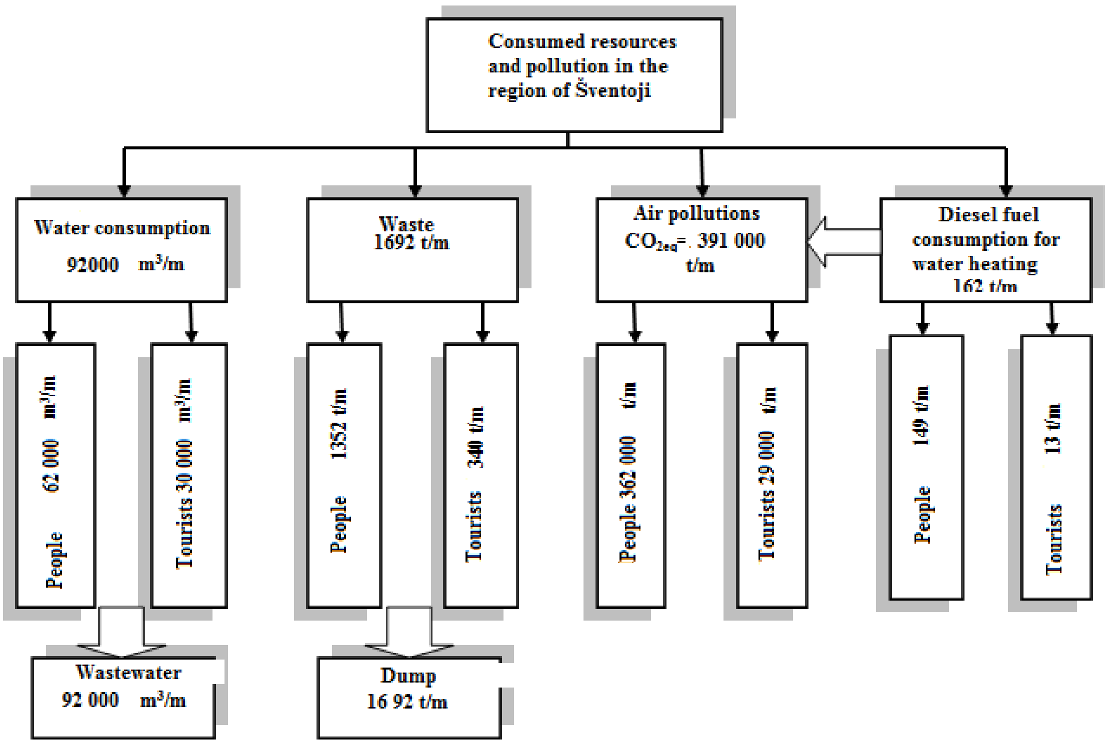

Fig. 4. Scheme of a current situation of technogenic parameters

Since 2000 fish biomass has decreased twice. The value of this aspect after evaluation of changes is equal to 4.7 units. After the port reconstruction in a long time period this aspect may get worse without reduction in loads, therefore when calculating a long time perspective this parameter must be increased twice.

The aspects of the physical and chemical effects will be evaluated according to this new methodology. Thus, knowing the calculated load when small ships are arriving or berthed, it is possible to evaluate the increasing amount of materials in suspension (30% of the current level) and oil hydrocarbons (10 % from the current level of fuel consumption according to the ratio). The value of this aspect is equal to 7.6 units.

Technogenic aspects are analyzed according to the statistical data. The amount of waste, its types, air pollution, water and waste water consumption are also evaluated.

After evaluation of all natural and technogenic parameters, a scheme of the current situation of technogenic parameters has been developed, Figure 4.

It is planned that in future the operating Sventoji port will create new jobs and its population will grow from 1400 to 1700, while the number of tourists will increase twice up to 100 000 per year. According to the calculations the increasing population will influence the growth of regional tecnogenic load: the amount of waste will increase to 37%, water consumption - up to 47%, diesel fuel for water heating - up to 36%, air pollution - up to 49%.

The aspect values have been counted according to the sum of changes or changes for a 1000 citizens. The sum of technogenic effect aspects reaches 1.62 unit, according to the pollution of water consumption it is 1.52 unit, according to the air pollution it is 1.77 unit, in total it is 4.91 units.

3.1. Recommendations for reducing technogenic load of Sventoji port

Environmental situation in the Baltic Sea is constantly deteriorating due to ineffective operation of pollution balancing mechanisms. To make Sventoji port attractive not only to small boats and yachts, but also to promote tourism, it is necessary to ensure the balance in port activities, to regulate waste flows as well as to ensure port activities based on the principles of sustainable development.

Population of the Sventoji region use both renewable and non-renewable energy sources. Thermal energy for heating is obtained by burning diesel fuel, electricity is supplied by LESTO Ltd distribution network. Non-renewable energy sources are chiefly used in the region, thus the usage of an alternative energy sources is not promoted.

One of the ways to use an alternative energy source is use of solar collectors for water heating. To provide comfortable conditions for tourists traveling by personal vessels it is planned to install them showers and other auxiliary facilities. It is planned that about 50 thousand tourists will visit the port each year, approximately 11 thousand of them will be one day tourists, the others will stay longer. Approximately 6 thousand m³ of water per year is needed to satisfy the needs of tourists and the staff. To heat such an amount of water 306 thousand kWh is necessary; 26 tons of diesel fuel would be used. Currently, water in Sventoji region is heated by diesel fuel, therefore the efficiency of energy is equal to zero. If water is heated by renewable energy, e.g. the solar energy produced by thermal collectors, the efficiency of energy will be equal to 10%. Air pollution there will be reduced to: CO - 3.38 tons per year, CH_4 - 1.058 tons per year, SO_2 - 0.026 tons per year, solid particulates - 0.112 tons per year. General CO_2 equivalent will be reduced to 34 tons per year. After the evaluation of used technology, the aspect of air pollution will be reduced to 1.47 unit.

Nowadays approximately 1691.15 tons of waste is produced in Sventoji, out of which 750.87 tons per year are biodegradable waste, 275.66 tons per year is paper and cardboard, 33.82 tons per year - metals, 162.35 tons per year - glass, 140.37 - plastics, 8,46 tons per year - dangerous waste, 113.31 tons per year - various combustible waste, 206.31 tons per year - non-combustible waste. All types of waste are collected and transported to regional Dumpiai landfill, where 54.59 Lt. for each ton of non-sorted waste and 58.67 Lt. for household waste the “gate” tax is paid when accepting it. Thus, 191 thousand Lt is paid every year.

If Sventoji port were operated, the amount of waste in the region would increase up to 2323 tons per year. 263 thousand Lt would be paid as taxes for waste collecting. To save the energy and materials preventive environmental measures are to be integrated and it would help increase efficiency and reduce risks for people and the environment. One of the ways to reduce the amount of waste in the region is to optimize waste management systems. The optimization of such a system is possible by re-using recycled products or safely burning production and obtaining thermal energy.

For reasonable use of waste there is a suggestion to set up a waste recycling system in the region rather than deposit it in the landfills. It is forecast that the amount of biodegradable waste would be 1031.29 tons per year, paper and cardboards - 378.61 tons per year, glass - 222.98 tons per year, plastics - 192.79 tons per year, dangerous waste - 11.61 tons per year, various combustible waste - 155.62 tons per year, various non-combustible waste - 283.37 tons per year.

It is possible to produce bio gas while composting biodegradable waste; paper, cardboard and other combustible waste could be burnt thus producing thermal energy. Heavy metals could be transferred to the waste handlers, non-combustible waste and other non-recyclable waste could be transferred to the landfill.

Efficiency could be calculated according to the before given formula (1). The higher efficiency, the bigger amount of waste could be recycled. At the present time all waste is transferred to a landfill, therefore without recycling waste efficiency is 0%.

If Sventoji port were operated, it would be possible to use 1611.98 tons of waste per year, thus responsible waste management would be ensured. With the formula N=(A/M_{max})*100% (1) efficiency would reach 69%. Waste transferring to landfills costs would be reduced approximately by 70% and it makes 80.4 thousand Lt. per year. Thus, recalculated evaluation of aspects makes 1.14 unit. Presumable amounts of waste and the proposed amount for usage are described in Table 2.

Table 2. Analysis of waste distribution

Situations	Waste generation, t/year	Waste from people, t/year		Waste from recreation, t/year		The efficiency
		Total amount	Amount for 1000 people	Current situation	Amount for 1000 people	
Current	1691.15	1352	965	339.15	6,7	0 (0%)
Planned	2752.13	1644.33	967	1108.8	11.1	0 (0%)
Promoting recycling	710.15*	568.15*	334*	142*	1.42*	0.96(74%)

* - counted only that waste which is transported a landfill, because the other is used.

During the analysis it has been noticed that the amount of waste for 1000 tourists is increasing. This happens because waste is not only accumulated in the zone of Sventoji, but also disposed of by tourists coming in personal boats. While recycling and sorting the waste, its amount transferred to a landfill would be reduced 3.8 times and efficiency would increase up to 74%.

After evaluation of the impact of the environmental pollution on the Sventoji region, it can be stated that water consumption will grow up, the amount of waste will increase, whereas the air pollution will be slight. To balance the pollution the alternative measures are to be applied that would make the port environmentally attractive. The proposed scheme of technogenic parameters for a planned situation is presented in Figure 5.

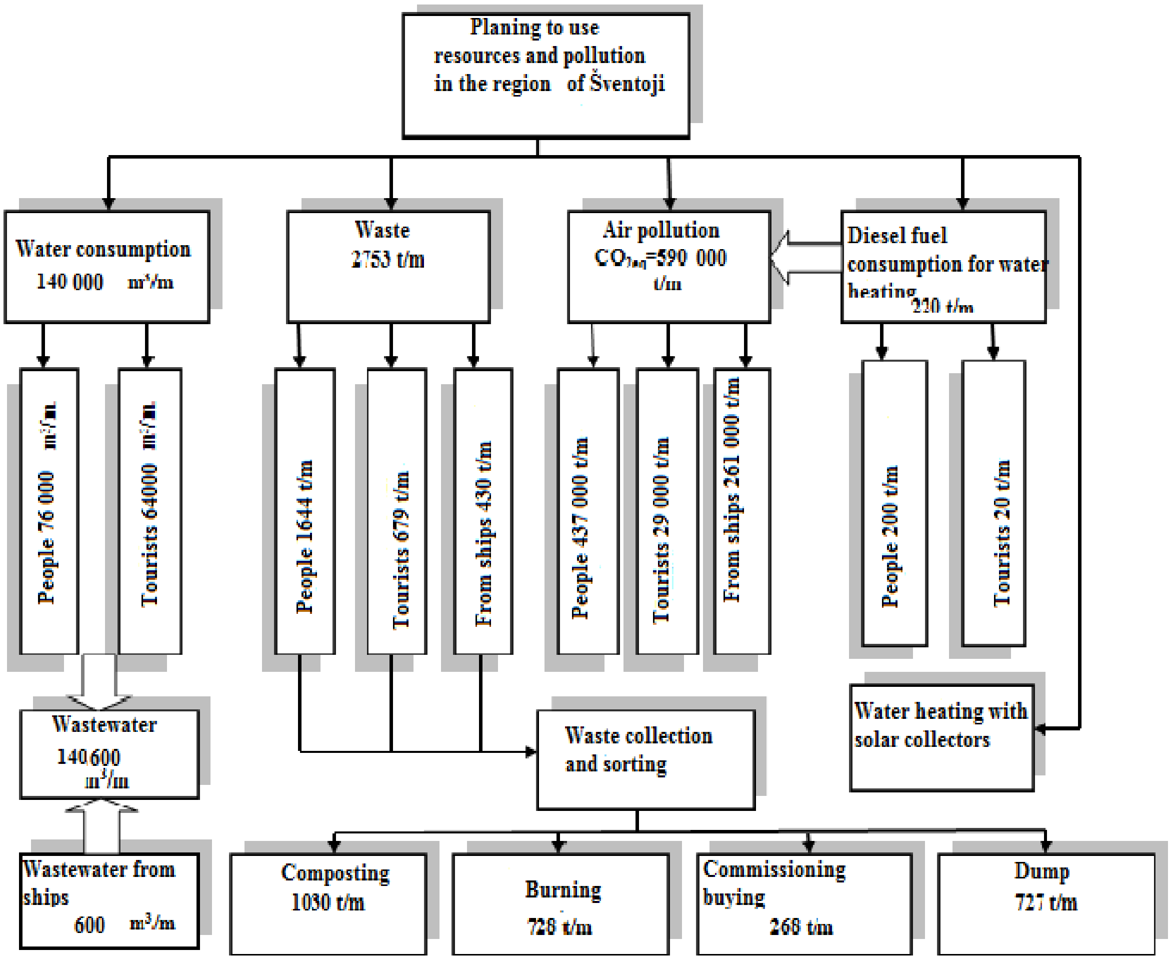

Fig. 5 Scheme of technogenic parameters for a planned situation in Sventoji port

The influence of Sventoji port can be reduced by adjusting its technogenic load. according to the given methodology in evaluation of all natural aspects, there is an eco-criterion made of the aspect of river bank effect - 1, physical-chemical aspect - 7.6, bio-ecological impact - 4.7, total - 13.3 units.

Having calculated the reduced load and introduction of alternative technologies made according to the aspects of technological parameters, 1.14 unit will be obtained and according to an air pollution reduction it will be 1.47 unit.

Evaluating the aspects of technogenic impact according to the sum of aspects composed of water and air pollution and amount of waste the sum of 4.91 units is obtained. The eco-criteria of an impact on the whole port are equal to 18.21 units.

For sustainable development of the port the technogenic impacts have been corrected by offering alternative technologies. The reduced impact aspects are calculated and after integration of measures it is noticed that eco-criteria of Sventoji port are decreasing to 17.43 units.

Based on the schemes of technogenic parameters the management methodology for a small port has been developed which will work according to the principles: Analyze-Assess-Adjust (AAA) The proposed model for a sustainable development of a small port is described in Figure 6.

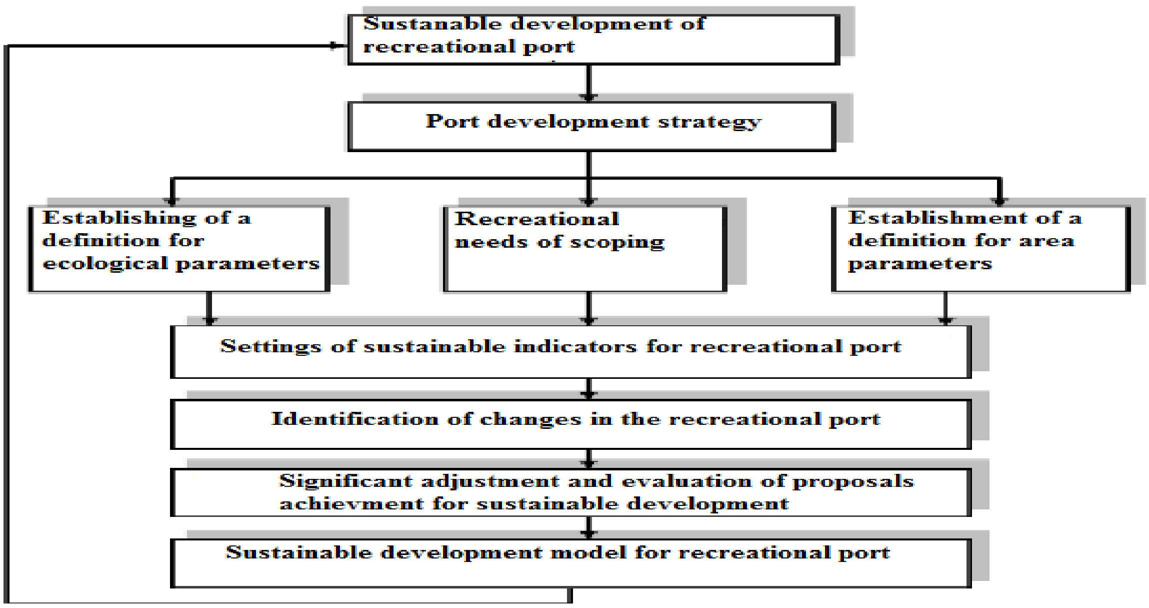

Fig. 6. Model of sustainable development of a small port

4. Conclusions

1. Following the analysis of the natural environment in respect of the amount of heavy metals (copper, chromium, zinc, nickel, lead, cadmium, and mercury), nitrates and phosphates, nitrogen phosphorus, petroleum hydrocarbons and also in respect of the changes in hydro biological parameters, the problematic aspects have been determined. Currently, an increase in 62.5% of solid suspensions is noticed in Sventoji port. During the last 5 year period general growth of nitrogen and nitrate is up to 50%, during the last 17 years the concentration of oil hydrocarbons has increased five times. The control of all these ecological aspects is of great importance in preservation of the natural environment, moreover that the amount of these materials has a tendency to increase.
2. An increasing amount of hydrocarbons in water creates a real threat to fish population. Recently fish population in Sventoji region has decreased twice, therefore in saving the natural environment fish biomass and variety of species become an important aspect. After the evaluation of changes the value of this aspect is equal to 4.7 units. In a long time perspective, after establishment of the port this aspect will only get worse and then this parameter will increase twice.
3. Special methodology adapted to small ports has been developed. This methodology works according to a principle: Analyze - Evaluate - Adjust (AEA). The model of sustainable development of small ports is presented in Figure 6. The aspects of sea water physical-chemical parameters are calculated. Their value is equal to 7.6 units, the value of fish biomass aspects is equal to 4.7 units; the sum of technogenic impacts is equal to 4.91 units. General eco-criteria of the port impact are equal to 18.21 units. According to the calculations the growing population will influence the growth of regional technogenic load: The amount of waste will increase to 37%, water consumption up to

47%, diesel fuel for water heating up to 36%, air pollution up to 49%.

4. Proposed solutions of reducing the port load and the impact on the environment are based on the fundamental principles of sustainable development by applying the methods to usage of recycled waste, thus regulating the waste flows and applying alternative technologies for water heating, waste management and air pollution control. According to the proposed technologies, after the calculation of costs and changed aspects, it can be stated that eco-criteria of Sventoji port will decrease to 17.43 units - it will be 6%.

References

BAZAR, C., HOLMBERG, J., LINDGREN, K. Socio-ecological indicators for sustainability. Ecological Economics, 1996, 18 (2), p. 89-112. http://dx.doi.org/10.1016/0921-8009(96)00028-6

BITINAS, A.,ŽAROMSKIS,R., GULBINSKAS, S., DAMUŠYTĖ, A., ŽILINSKAS, D. The results of itegrated investigations of the Lithuanian coast of the Baltic Sea: geology, geomorphology, dynamics and human impact. Geological Quaternaly, 2005, 49(4), P. 355-362.

COM 2008-534. A European Strategy for Marine and Maritime Research A coherent European Research Area framework in support of a sustainable use of oceans and seas.URL:http://ec.europa.eu/research/mmrs/documents/pdf/the_strategy.pdf. [Online:accessed 18th October].

ČIEGIS,R.,RAMANAUSKIENĖ,J., ŠIMANSKIENĖ, L. Sustainable development of Lithuania regions, 2010. P. 136. Klaipeda: KU.

ČIEGIS, R.,ZELENIŪTĖ, R. Lietuvos ekonomikos plėtra darnaus vystymosi aspektu. Taikomoji ekonomika, 2008, 1(2), p. 12-28.

ECO-INDICATOR 99. URL:http://www.pre.nl/download/ei99_manual.pdf . [Online: accessed 15 th December].

EEA 2002. Testing indicators for the Marine and coastal environment in Europe. Part 1: Eutrophication and integrated coastal zone management. Technical report No. 84. Copenhagen, p.48.

EEA 2002. Testing indicators for the Marine and coastal environment in Europe. Part 2: Hazardous substances. Technical report No. 85. Copenhagen, p.36.

Eurostat 2001. Environmental pressure indicators for the EU. Official Publications of the European Comunities. Luxembourg.

JOKŠAS, K.; STAKĖNIENĖ, R.; GALKUS, A.; LAGUNAVIČIENĖ, L. Metals in bottom sediments of Šventoji Port area (Lithuania). Geologija, 2008, 50 (3), p. 143-155. http://dx.doi.org/10.2478/v10056-008-0040-3

KUTKAITIS, A., ČEPINSKIS, J. Sustainable development in seaports management. Management theory and studies for rural business and infrastructure development, 2011, 2(26), p.85 -95.

LIPS, I., LIPS, U., FLEMING,V., KAITALA, S., JAANUS, A. Use of Ferrybox Measurements for the Baltic Sea Environment Assessment. Environmental Research, Engineering and Management, 2007, 3(41), p. 3-8.

MOHAMMAD, I., REZA, S., SAIFUL, A. Regional Index of Ecological Integrity: A need for sustainable management of natural resources. Ecological Indicators, 2010, 11 (2), p. 220-229.

OECD 2001. Organisation for economic Cooperation and Development. Key environmental indicators. OECD Envirinmental Directorate, p.36.

PERIS, M.; DIEZ, J.K., SUBIRATS, A., IBANEZ, K., ALVAREZ, P. Development of a system of indicators for sustainable port management. Marine Pollution Bulletin, 2005, 50, p. 1649-1660. http://dx.doi.org/10.1016/j.marpolbul.2005.06.048

Smailys, V. ir kiti. 2003. Šventosios jūrų uosto atstatymo galimybių studija. LR susisiekimo ministerija, vandens transporto departamentas. 72 p.

STAKĖNIENĖ, R., JOKŠAS, K., GALKUS, A.; LAGUNAVIČIENĖ, L. Pollution of Bottom Sediments in Šventoji Port. Environmental Research, Engineering and Management, 2010, 1(47), p.13-23.

VASILJEVA, A.L., LEBEDEVA, R. 2008. Šventosios uosto rekonstrukcijos perspektyvos ir prognozės. Vadyba, 2008, 2(13), p. 179 - 183.

WINKELMANS, A., VERBEKE, M., MEERRSMAN, E.; Van de VOORDE, Van hOOYDONK, J., TYEDMERS, P., PELOT, R. Contrasting and comparing sustainable development indicator metrics. Ecological Indicators, 2007, 7(2), p. 49 - 61.

SEAPORT OF ŠVENTOJI. URL: http://www.portofklaipeda.lt/lt.php/aktualijos/sventosios_uosto_teisinis_reglamentavimas/11968 [online: accessed 21th October].

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Darnios plėtros galimybių pritaikymas mažuose rekreaciniuose uostuose

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Mažųjų uostų plėtra rekreaciniams tikslams šiuo metu yra viena iš plačiai diskutuojamų perspektyvų tiek Lietuvoje, tiek Vakarų Europoje, tačiau nėra vieningos nuomonės, kaip galima įgyvendinti šią plėtrą darant kuo mažesnį poveikį gamtinėms sistemoms. Didiesiems uostams, užsiimantiems krova, laivų remontu ar kitais darbais, siūlomos įvairios metodikos, vertinančios subalansuotą plėtrą, tačiau jos nepritaikomos mažiesiems rekreacijai skirtiems uostams. Darbe pasiūlyta naujai sukurta metodika, kuria vadovaujantis būtų galima įvertinti rekreacinio tipo uostų tvarią plėtrą, paskaičiuoti tam tikrus indikatorius Šventosios mažojo uosto pavyzdžiu. Darbe įvertintas efektyvus energijos ir atliekų naudojimas uosto veikloje ir indikatorių pokytis siekiant darnios plėtros. Uosto sisteminei analizei atlikti identifikuojama esama ir planuojama situacija, atrenkami svarbiausi aplinkosauginiai ir technologiniai aspektai bei įvertinamas jų pokytis pritaikius subalansuotos plėtros principus.