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ENCOURAGING RESEARCH IN MARITIME EDUCATION & TRAINING

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Abstract
Education and training are vital to the development and success of today's knowledge society and economy. The EU's strategy emphasizes countries working together and learning from each other while the EU education and training policy underlines that knowledge, and the innovation it sparks, are the EU's most valuable assets. Innovation projects aim to improve the quality of training systems through the development and transfer of innovative policies, contents, methods and procedures within vocational education and training. This paper intends to discuss innovative MET (Maritime Education and Training) projects to encourage future research collaboration which might be of interest to other higher education and training institutions.
Keywords: *higher education, innovation, MET Programmes, research projects*

Introduction

Shipping is perhaps the most international of the entire world's great industries and one of the most dangerous. World transport and shipping are a derived demand of world economic development [13]. There are very large volumes of goods and materials, as well as people, which are transported daily from one geographical location to another. Considering the types and volumes involved, the demand for shipping becomes clear. Over 90% of total world cargo is transported by ships and volume of maritime trade is increasing every year [8]. Shipping therefore, is an overwhelming means of allowing economic resources to be transported, and hence a major facilitator for economic development worldwide. The global economy is built on integrated supply chains that feed components and other materials to users just before they are required, and just in the right amounts. If the supply chains are disrupted, it will have repercussions around the world, profoundly affecting business confidence [1].

Safety of life at sea, the marine environment and over 90% of the world's trade depends on the professionalism and competence of seafarers [15, 7]. It has been reported that over 80% of accidents and incidents are due to human error [10]. A close investigation of casualty analyses considered approved by IMO[1] (sub-committee minutes, 12th session, 2004), particularly focusing on the causes of accidents clearly indicates that standards are not applied correctly and when human factor issues are studied carefully, there are omissions in the education and training programmes received by the seafarers involved in accidents [7, 17]. IMO has passed the responsibility for delivery and assessment of these programmes to member countries and does not take part, in any shape or form, in the inspection, evaluation or delivery of these programmes. It is a welcome development that EMSA[2] has been involved in visiting MET providers in many EU and candidate countries to audit the education and training practice against STCW requirements.

Today the development of a Maritime Education and Training (MET) system is a dynamic process under the pressure of rapidly improving maritime technology. Technological developments will almost certainly continue to create the potential for innovation in international shipping, but creating the conditions required to capitalize on that potential is likely to demand new ways of thinking, new ways of working, and a new framework for understanding reality [12].

An ideal development cannot be achieved by considering the existing practice and internal processes and procedures only, and needs to have a wider perspective by reviewing best practices to establish the necessary benchmark. Rapid introduction of IT (Information Technology) into navigational equipment and ship operation supporting systems such as AIS (Automated Identification System), ECDIS

[1] IMO (International Maritime Organization)
[2] EMSA (European Maritime Safety Agency)

(Electronic Chart Display Information System), IBS (Integrated Bridge System) or introduction of an e-Navigation system requires inclusion of marine-related IT technologies in respective MET (Maritime Education and Training) Programmes [6]. However, there is no doubt that this shall increase the number of dedicated hours of respective units, not only for the classroom theoretical training, but also for the extensive use of simulators for the familiarization and skill enhancement. On the other hand, sea training onboard a ship is a must for all seafarers of various types and ranks and plays a very key role in the education and training of cadets. However, the training opportunities aboard ships offered by shipping companies have been significantly reduced, and due to commercial pressures in recent years resulting in minimum manning levels together with increasing level of automation, the nature and the quality of training on board have significantly changed for the worse. These have not been good signs for a cadet trainee as training onboard also plays a vital role for related research issues. The socialization process experienced on the ship would probably affect one's recognition as to whether one fits the environment and further affect one's intentions to remain in the profession after graduation, as it is considered that the fit between one's character and work environment is the basis for one to choose a career [9].

Aim and Objectives

Research is an effective means of underpinning further and higher education programmes, developing and motivating staff, establishing working relationship with industry and commerce and developing independent and self learning while preparing students for the future. Recent research has shown that the response of International Bodies to address identified deficiencies on STCW content, language competence, automation, emergency situations and environment are generally slow, sluggish and/or lacks resources [5].

To overcome these deficiencies, TUDEV (Turkish Maritime Education Foundation) established a partnership with well-known and well-respected international maritime institutions and universities in UK and in other European Union member states and through working with organisations such as BTEC/Edexcel (Business and Technology Education Council), MNTB (Merchant Navy Training Board), NVQ/SVQ (National Vocational Qualification) authorities and professional institutions such as IMarEST (Institute of Marine Engineering, Science and Technology) developed a set of most up to date programmes for Deck officers as well as Senior Deck officers and similar programmes for Marine Engineers and senior Engineer officers [2]. These co-operations and partnerships, including staff and student exchanges, not only provided opportunities for collaboration and joint programme and unit design and developments, but also initiation of a number of funded European Union projects. These European Union funded projects, which TUDEV is either leading or is a partner in, have been used as catalyst for programme and unit development. The outcomes of such projects are reflected in the programme development process of which onboard training and use of advance simulators forms the focal part of [5].

European Strategies for Vocational Training and EU Projects

European integration and the creation of a united economic area has resulted in convergence of legislation of EU countries as well as the candidate countries as a first step towards the harmonization of different national conditions and standards that now have to be incorporated into a single environment. Safety at work constitutes one of the EU's most important social policies. The European council stressed that Europe was going through a transition to a knowledge based economy, marked by profound changes effecting society, employment and safety at work. The European Commission's recent adaptation of "investment in people" and the Commission's "investment in quality" are two policies that the proposed programmes are supporting. The EU strategy relating to both policies is based on consolidating a culture of risk prevention, and 'on right first time' philosophy, as well as on combining a variety of tools, with training and awareness, being the most important ones.

The recent decisions made by the European Council requires EU membership countries to complete alignment with EU maritime legislation in safety and non-safety areas and to improve maritime safety, in particular improve the performance of maritime safety administrative institutions, firstly as a flag state, and then as a port state, and guarantee their independence. The EU also expects countries to implement a programme of adaptation of the transport fleet particular in maritime transport to Community technical norms. The candidate countries have to ensure effective implementation and enforcement of transport legislation, particularly as regards to maritime safety.

The achievement of harmonising the education and training programmes [13] with specific emphasis on improvement of training relating to safety topics as well as accredited and internationally accepted programmes for assessors and verifiers (the teacher/trainers and those who verify compliance, both internal and external), and finally the provision of transnational multilayer pathways for transfer of students/cadets as well as teacher/trainers are the main innovative aspects of the all new projects. The provision of integrated diplomas and degrees incorporating vocational and ancillary skills, which are recognised worldwide, are also considered innovative. For this reason a new EU Funded project was initiated by TUDEV named UniMET [18]. UniMET (www.unimet.pro) intends to harmonize the MET, go beyond the IMO STCW minimum standards, and in the process identify good practices for future implementation.

Methodology

Safety at sea is an international issue and safety is as strong as its weakest link. Many countries often due to lack of resources, have not been able to improve their safety records. The quality of the education and training programmes of seafarers from these countries should be on the national agenda of all flag countries and those operating ports worldwide. The weakness in one flag state could have, and often does, an adverse impact in another geographical location.

To resolve the identified deficiencies [15,16,17,18] in education and training of merchant navy personnel a partnership was established between TUDEV and C4FF (www.c4ff.co.uk), called as MarEdu (www.maredu.co.uk). To understand the problems in detail, a pilot project SOS (Safety On Sea, 2005-07), funded by the EU Leonardo programme, was launched. A partnership initially consisting of Turkey, Scotland, England and Norway was formed to identify major problems and good practices in the partner countries by using Pareto analysis and cross-referencing techniques. The partnership developed integrated world-class programmes of education and training both for navigation engineering and marine engineering cadets wishing to acquire internationally recognised qualifications as officer of watch [18]. The Project also developed pathways to progress onto higher qualifications viz., chief mates and chief engineers as well as becoming a master and captain of ocean going vessels. Several other EU projects were also instigated in parallel to SOS. A summary of SOS and other related projects are presented in the following paragraphs.

Projects

SOS (Safety On Sea) Project

The first task of SOS Project (www.surpass.pro) was to review existing programmes in the partner countries to identify the differences and discover a methodology for harmonising education and training systems and practices in collaboration with the relevant authorities in each of the member countries [3]. The review of the programmes led to many productive discussions and adaptation of cross-referencing methods developed as part of an earlier EU programme, EUROTECNET. The cross-referencing tables provided a means of comparing programmes in different countries in the partnership. In doing so, with no disrespect to organisations involved with validation and accreditation of these programmes, it was realised that there are serious differences in standards being applied, and even in the pathways chosen to satisfy the requirements of the same awarding body or even the same licensing authority. The content and standard of the sea service record books were also very different.

The unifying factor was the IMO syllabuses which are the basis of all MET programmes in the world. The partner countries' programmes have integrated these syllabuses to varying degrees of complexities into their own national programmes. To harmonise and at the same time to improve the standard, for instance, the Turkish project team using the syllabuses developed by northern European countries, which in turn are based on IMO's, revised programmes and at the same time, applying cross-referencing techniques also satisfied the requirements of the national authorities as well as those of a major international awarding body (BTEC/Edexcel) for the award of a higher national diploma (HND). HND graduates, who also carry out their sea training according to recognised standards, for instance, Merchant Navy Training Board (MNTB) as part of the National/Scottish Vocational Qualification (N/SVQ) programme, provided they successfully conclude the required ancillary courses are exempt from any written examination when applying for their certificate of competency.

Project MarTEL (Maritime Test of English Language)

This project makes an attempt to overcome the problem of not having international or European standards for Maritime English (www.martel-tests.org, and www.martel.pro). The project [15] intends to establish a set of standards by transfer of innovation from existing English language standards and maritime English model courses such as International Maritime Organisation's (IMO) SMCP (Standard Maritime Communication Phrases, 2001). Review of the arguments from the recent IMO meetings (IMO MSC, 2006) considering MSC 82/15/2 and MSC 82/15/3 had identified that 'there is a compelling need to promote a high level of working maritime English language skills'. Several EU member states have invited STW sub-committee to consider how the requirements in the STCW-Code can be strengthened in this connection. It was noted that deficiencies in maritime English causes accidents and therefore needs to be seriously taught in the basic and the main training of all Chapters of the STCW Code of practice. This Project therefore is a maritime language competency assessment project for the language certification with the main aim of developing a series of maritime English language standards incorporating also the IMO's SMCP.

GMDSS (Global Maritime Distress and Safety System) I and II Projects

The GMDSS I Project (www.egmdss.com) focused on provision of vocational education and continuing vocational training for Short Range Certificate (SRC) which is mandatory for seafarers operating vessels of up to 300 GRT within 30 NM from coast. To obtain the SRC award a candidate must be able to competently operate four different GMDSS communication devices (VHF DSC, NAVTEX, EPIRB and SART). These devices are only used for emergencies at sea which occur rarely. Therefore, the knowledge of operation of these devices tends to fade over time and should be regularly refreshed to ensure safety of crew, passengers and freight (even though this is not a legal requirement). After the successfully conclusion of GMDSS I, GMDSS II Project was launched for the LRC (Long Range Communications). The intention is to cover all aspects of GMDSS Communications in the future projects.

TRAIN 4Cs I and II Mobility Projects

To try and test the pathways developed in the SOS project a Leonardo Mobility programme was developed in conjunction with MarEdu. The project aimed to improve safety at sea through a mobility programme (TRAIN 4Cs I) involving the transfer of cadets from TUDEV in Turkey to Glasgow College of Nautical Studies (GCNS) in Scotland, on a pilot basis. The period of placement is for 14 weeks. Some of TUDEV Cadets were also transferred onto the final year of the Plymouth University's BSc (Hons) Degree in Nautical Science and all were successful and received their degrees.

M'AIDER Maritime Aids Development

M'AIDER project (www.maider.pro) was developed as a follow-up to the former SOS Project in coordination with several partner countries in Europe. This project proposal concerns transfer of innovation from existing reports concerning accidents and incidents for creation of a range of scenarios for applications in simulators relating to emergency situation. It is acknowledged that emergency situations and use of simulators have not been fully taken into consideration and that industry would immensely benefit from a user-friendly and accessible training tool and programme for its sea-going personnel focusing on emergency situations; the causes for this situation arising and how they are handled.

An existing software and internet platform will be used to transport these simulation trainings for greater access throughout the partnership as well as outside of it. The platforms have got facilities for e-learning as well as e-assessment for self assessment.

Project SURPASS (Short Courses Programme for Automated Systems in Shipping)

The main aim of this project [17] is to fill the gap created as the result of the emergence and application of the automated systems in the education and training of seafarers by provision of a training course enabling them to have a full understanding of automated systems, and these systems' weaknesses and limitations. This aim will only be achieved if a well-planned literature review of, on the one hand, the automated system and components, and on the other hand, the accidents and incidents, such as that by Savannah Express (2005) [17] or the very recent sinking of Glorious (2007) in the Istanbul Strait, are carefully and meticulously carried out. The former accident was due to engine failure and the latter due to navigation (steering, rudder) failure.

Conclusions

The development of the integrated and unified programme for the education and training of merchant navy personnel under the SOS programme has led to a set of programmes which include all good practices both for Deck and Marine Engineering. The programmes were developed with support from major awarding bodies such as BTEC and several universities, accrediting bodies such as IMarEST and licensing authorities including the UK's MCA. The programmes have now been reviewed by EMSA and are now completely in compliance with EMSA requirements [4].

All projects summarised above are in line with the EU's policy and strategy (IMP and Knowledge 2020) which emphasizes countries working together and learning from each other and the EU's education and training policy which underlines that knowledge and the innovation it sparks as the EU's most valuable assets. An attempt was made to ensure that there is an e-learning and assessment platforms for all projects for wider dissemination purposes.

The development of newly revised programmes, within the European Qualification Framework (EQF) addressing the overall problems concerning safety at the source viz., education and training of cadets and the existing officers working in industry [18] is expected to make a major impact. The success of the MarEdu initiative has led to other projects being instigated and thus helping industry to update its skills and hence maintain the current efforts in improving safety at sea and in ports.

Developments are on-going and it is expected that many other organisations involved with education and training of merchant navy officers including awarding, accrediting and licensing bodies would join the partnership. There are now over 30 major centres working with TUDEV supporting various European Projects.

The Turkish Chamber of Shipping has been investing on Maritime Education and Training for a long time not only for own interests but also to become a major seafarer supplier of the worldwide shipping. As a result of these initiatives, Piri Reis University was established by TUDEV as a continuation of a former Maritime Institute for higher degree programs in maritime related issues. In the second half of the next decade, world maritime will witness the rising quality of the Turkish seafarers who are poised to carry world shipping to highest standards. TUDEV's experience on research programmes are also transferred to Piri Reis University along with staff transfers, and they will also continue full speed ahead to bring innovative solutions to the most critical issues of the maritime industry. At the end of the next decade we can foresee more unified MET Programmes, enhanced communications levels and hence better understanding and cooperation among those working in the water transportation sector which will reduce all losses significantly. Piri Reis University will be looking forward to any co-operation with and/or partnership invitation to any innovative MET related research project.

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ANALYSIS OF STRUCTURE OF CARGO TURNOVER AT LATVIA'S PORTS

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Abstract
Ports play a crucially important role in the development of national economy as they generate stable tax flows and duties, providing direct positive effects on GDP, Balance of Payments and Balance of Trade. Sometimes their impact on regional economy may be significant also. The analysis of the structure of cargo volumes (annual throughput) transshipped by the port and changes in commodity mix can provide an invaluable insight in the trend of port development. The comparative analysis of the structure of cargo volumes at Latvia's ports has been done in the paper and the degree of its dissimilarity was statistically evaluated.

Keywords: *cargo, Latvia, ports, structure*

Introduction

Transport is of fundamental importance to human society, providing mobility and facilitating industry and trade. The essential economic and social benefits, which are so difficult to balance against the high social and environmental costs, make transport a crucial sector for sustainable development, as recognized in the EU sustainable development strategy. [22]

Actually, transport is one of the most important and dynamic sectors of economy in the Baltic States. Increasing volumes of export explicitly demonstrate the role of the transport sector in the economic growth of those countries. It is acknowledged that high quality of transport services provides the national economy with various benefits, inter alia improved logistics (reduced level of inventories, more reliable supply of goods, higher delivery quality etc.) and better mobility that leads to the higher profitability of business [14] However, in spite of the optimal location of transport infrastructure in Latvia, its low quality still influences the competitiveness of the provided transport services. [12; 15] In addition, not only the total volume of throughput determines the effectiveness of port activities and impact on national or regional economy but also the change in the commodity mix as different types of cargo require different handling methods, use of labour, material and service input.

The paper aims to do a quantitative analyze of and to draw conclusions about dissimilarity and changes in the structure of cargo turnover at Latvia's posts. The tasks of the research are:

1) to study literature on the impact of ports on regional economy;
2) to analyze changes in cargo turnover and its most important components as well as statistically assess their significance at Latvia's ports in 2000 – 2010;
3) to forecast the future changes in cargo turnover in total as well as at both Latvia's freeports and small ports.

To achieve the aim of the paper several research methods were used, namely, deduction, induction, synthesis and analysis, statistical and monographic methods. The research object is the changes in the structure of cargo turnover at Latvia's ports; the research period is from 2000 to 2010. All the calculations are made by the authors of the paper and based on statistical data obtained from Central Statistical Bureau of Latvia as well as reports of Tallinn and Klaipeda ports.

Impact of ports on regional economy

About 90 % of world trade is transported by ship. The recent growth in trading commodities volume transported by sea – a 4.8 per cent increase year-on-year – was higher than recorded in the last decades.

Thus maritime transport has strong position in global supply chains, determining to great extent their effectiveness and elasticity. [10] It is argued that maritime transport will continue to be the most important transport mode in developing EU trade for the foreseeable future. [18] Demand for transport can be viewed as deriving from the changing nature of international trade relations. With the growth in world trade, international shipping is expanding. [11; 16] It is pointed out [20] that since international trade is carried predominantly by sea transport major container ports play a crucial role in regional economies. In the past the presence of a port meant not only traffic and transport activities, but also economic activities, ranging from industries that use mainly raw materials imported by sea and whose land transportation costs would have been too high, to those producing goods to be exported by sea and/or those whose optimal location was where the break of bulk took place. Nowadays it is not longer the case as many of these industries, no technologically restricted to port areas any more, and suffering from the relative scarcity and/or high prices of space and other inputs, have moved to regions where these inputs are available at better conditions. [1]

Therefore the general guidelines for conducting analysis of port's economic impact provided by G. R. Yochum and V. B. Agarwal [23; 24] are worth mentioning. The guidelines are based on different linkages between the port and the region's economy and depicture clearly the interdependence degree between above mentioned economic subjects.

1) Port required industry - employment in companies providing services for the movement of waterborne commerce. There are transportation services (e.g. freight forwarding, transport of cargo by rail and road) and port services (e.g. terminal operations, stevedoring, vessel supply, pilotage, towage, ship repair, diving services, insurance, legal services).

2) Port attracted industry - employment in companies attracted to the region because of the presence of the port and its facilities. If the port facilities were closed down, the companies would leave region. Usually these companies export commodities or import products or raw materials for assembly and distribution (e.g. steelworks, chemicals, refineries).

3) Port induced industry - employment in companies that have expanded their markets by exporting through the port due to reduced transportation costs. Such industries are typically located at a substantial distance from port facilities (because theoretically they could be located in the region regardless of the availability of port facilities) and can not be identified on the basis of a mere geographical criterion.

Some researchers have tried to discover the factors the impact of port on local economy depends on. After performance of empirical studies based on the port of Tampa (USA), J. S. DeSalvo and D. Fuller [2; 3] concluded that the impact of ports depends on the cargo volumes transshipped by the port and on the price elasticity of the demand for imports and exports channeled through that port. Although M. Benacchio et. al. [1] did not reveal an apparent relation between the estimated impact and the total volume of ports throughput, vital importance to distinguish between changes in cargo volumes, and changes in the commodity mix was stressed in their study. Different commodities require different handling methods and thus different use of labour, material and service inputs for their loading and unloading. It means that a rise in the share of containerized traffic would decrease aggregate direct labour inputs (stevedoring services), increase indirect effects due to logistic activities performed on high value goods, increase capital investments and expenditures on items such as fuel oil, in turn indirectly altering the structure of local economy. [18; 19]

It is acknowledged [1] also that the employment structure (workers, professionals, engineers etc.) is an important indicator of the quality of the impact in terms of its added value. At the same time the growth in tons does not definitely lead to a comparable growth in terms of employment because the introduction of containerization and standardization of cargo could induce the transformation of ports from main service centres to simple transit points. Containerisation granted to shipping lines more freedom to serve markets from a wider choice of ports. They ignore the specific merits of a particular port and take into account just the economies of scale and conditions of the entire logistic chain. [18] Thus ports face the challenge to enhance the economic benefits from port operations as the transfer function alone is producing diminishing returns for the regional economy due to growing automation. The possible solution to this problem could be extended involvement in logistics. For instance, inventory control, data management, packing and processing are considered to be the modern value-added elements of physical distribution. [19]

According to R. O. Goss [6] there are at least four clear reasons for which port expansion or improvement is likely to be an inefficient tool of economic development strategy:

- Port benefits are likely to "leak" to users in inland locations;

- Assisting and investing public money in a port will probably mean assisting foreign exporters, some of whom will be able to compete more effectively with home producers;
- Any public assistance to a port is likely to lead to higher local taxes (local share of infrastructure financing), running the risk to make the area less attractive to residents and possible businesses too;
- Since the aggregate demand for labour within any given economy is determined by macroeconomics factors, ports are competing among themselves for a share of a reasonably fixed level of business (e.g. the expansion of a port belonging to a range could also be at the expense of lost trade in other regional or national ports belonging to the same range).

According to studies [1; 17] several monetary and non-monetary costs of the port impact on local economy can be mentioned:

- The local share of investments in maritime and port infrastructures, transport infrastructures;
- Opportunity costs of port industry inputs: capital, labor, space (coast and landscape);
- Negative "sunk" externalities: environmental aspects (air, water, acoustic pollution), landscape decay, irrecoverable investments in facilities, traffic congestion, costs for "conciliating" the presence of the port in a urban context, the risk of hazardous material handling (chemicals, petrochemicals);
- Eventually loss of managerial and leadership functions for local port economies that are quite no longer among the location selection criteria of holdings, corporations and administrative departments of the firms located within the port region.

P. Gripaios and R. Gripaios (1995, 1999) [8; 9] draw similar conclusions for UK ports and provided empirical evidence that nowadays the existing and potential role of ports in the regional development process is often exaggerated. However, ports still play a crucially important role in national economy generating taxes and duties as well as they often constitute growth centres for national industries (e.g. manufacturing, transport, logistics) and services.

Structure of cargo turnover at Latvia's ports

There are 10 ports in Latvia. Ports of Riga, Liepaja and Ventspils are mostly focused on transit cargo which accounts for almost 70 % of their total turnover. It can be assumed that the role of ports in logistic cluster is important. [5] Ports of Riga and Ventspils have been granted the status of freeports, but port of Liepaja is an integral part of Liepaja special economic zone. Small ports (Engure, Lielupe, Mersrags, Pavilosta, Roja, Salacgriva and Skulte) primarily service local clients who transport timber and fishing products. All the ports are engaged in various projects and reconstruction works with the aim to expand their activities, improve the quality of service and strengthen their competitiveness. Although co-operation between different ports in Latvia may increase their competitiveness in the Baltic region and the global market, ports demonstrate their reluctance and lack of interest in co-operation. [13] Inter-port competition is getting much stiffer on the international level as well. [19] Usually it is explained by standardization of port services. That means that ports cannot rely on specialization to maintain market share and generate revenues as much as they used to. Due to containerization, ports in the same region become closer substitutes, and hence are more exposed to competition from other ports and other routes. [17]

Ports are usually characterized by their annual throughput (i.e. port traffic in TEU, tons). [25] Other aspects analysts pay special attention to are changes in the commodity mix (for instance, the increase in containerized traffic, the decrease in liquid bulk, etc.) and future forecasts. However, as M. Benacchio et. al. [1] noted, the increase in port throughput does not necessarily mean that the port is creating "value" to remunerate inputs. It just means that port is either more effectively managed in comparison with others or it is more strategically located close to important hinterlands and/or maritime routes.

Analysis of base increment and chain increment in different types of loaded and unloaded cargo provides the opportunity to trace chronologically the changes in cargo turnover at Latvia's ports. [7] At Latvia's ports over the last ten years the volume of loaded cargo reached its peak in the year 2008, whereas the amount of unloaded cargo peaked in the 2007 (Table 1). The total increase in unloaded cargo was much more considerable compared to the one in loaded cargo – by 212 % and 113 % accordingly. However, the volume of loaded cargo demonstrated more stable trend of development since the annual fluctuations were less notable. The volume of the most significant components of loaded cargo decreased during the period in question except for oil products whose gradual growth compensated for the largest drop in crude oil as well as metal and metal manufactures. The components of unloaded cargo demonstrated the trend diametrically opposed to the mentioned previously. All but the volume of unloaded sugar grew during the period from 2000 to 2010 providing the remarkable change in the structure of cargo turnover. If at the beginning of the period the volume of unloaded sugar accounted for almost 20 % of the total unloaded cargo, in 2010 just for 2.5 %. It means that there was a shift in priorities. It resulted in oil products making up 20 % as well as grain and grain products together with mineral construction materials making up other 20 % of the total turnover of unloaded cargo in 2010.

Table 1. Changes in cargo turnover and some of its components at Latvia's ports in 2000 – 2010 (Ktons, increment rate in percent)

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Loaded cargo	**49276**	**54372**	**48735**	**50918**	**54101**	**55890**	**53069**	**55178**	**57654**	**57565**	**55724**
Base increment		*110*	*99*	*103*	*110*	*113*	*108*	*112*	*117*	*117*	*113*
Chain increment		*110*	*90*	*104*	*106*	*103*	*95*	*104*	*104*	*100*	*97*
# Oil products	15822	17609	18237	19586	19438	20094	19662	21061	20346	21957	19252
Base increment		*111*	*115*	*124*	*123*	*127*	*124*	*133*	*129*	*139*	*122*
Chain increment		*111*	*104*	*107*	*99*	*103*	*98*	*107*	*97*	*108*	*88*
# Crude oil	13631	14986	7566	3579	2196	423	1192	1233	1016	380	204
Base increment		*110*	*56*	*26*	*16*	*3*	*9*	*9*	*7*	*3*	*1*
Chain increment		*110*	*50*	*47*	*61*	*19*	*282*	*103*	*82*	*37*	*54*
# Dry chemicals	6554	6446	6430	6817	5967	6537	5123	5173	4562	3059	3750
Base increment		*98*	*98*	*104*	*91*	*100*	*78*	*79*	*70*	*47*	*57*
Chain increment		*98*	*100*	*106*	*88*	*110*	*78*	*101*	*88*	*67*	*123*
# Timber	6098	6121	6238	6471	6340	5664	4575	4644	3654	3444	5413
Base increment		*100*	*102*	*106*	*104*	*93*	*75*	*76*	*60*	*56*	*89*
Chain increment		*100*	*102*	*104*	*98*	*89*	*81*	*102*	*79*	*94*	*157*
# Metals and metal manufactures	3439	2619	1926	1293	859	1076	1065	1043	1079	904	839
Base increment		*76*	*56*	*38*	*25*	*31*	*31*	*30*	*31*	*26*	*24*
Chain increment		*76*	*74*	*67*	*66*	*125*	*99*	*98*	*103*	*84*	*93*
# Liquid chemicals	976	878	546	972	976	1114	994	1187	1430	964	686
Base increment		*90*	*56*	*100*	*100*	*114*	*102*	*122*	*147*	*99*	*70*
Chain increment		*90*	*62*	*178*	*100*	*114*	*89*	*119*	*120*	*67*	*71*
Unloaded cargo	**2567**	**2546**	**3420**	**3837**	**3299**	**4152**	**6428**	**7256**	**5995**	**4415**	**5436**
Base increment		*99*	*133*	*149*	*129*	*162*	*250*	*283*	*234*	*172*	*212*
Chain increment		*99*	*134*	*112*	*86*	*126*	*155*	*113*	*83*	*74*	*123*
# Sugar	500	701	988	1107	429	304	473	286	289	73	131
Base increment		*140*	*198*	*221*	*86*	*61*	*95*	*57*	*58*	*15*	*26*
Chain increment		*140*	*141*	*112*	*39*	*71*	*156*	*60*	*101*	*25*	*179*
# Mineral construct. materials	280	171	178	141	135	646	861	970	918	358	574
Base increment		*61*	*64*	*50*	*48*	*231*	*308*	*346*	*328*	*128*	*205*
Chain increment		*61*	*104*	*79*	*96*	*479*	*133*	*113*	*95*	*39*	*160*
# Grain and grain products	170	135	254	215	196	288	412	416	382	322	437
Base increment		*79*	*149*	*126*	*115*	*169*	*242*	*245*	*225*	*189*	*257*
Chain increment		*79*	*188*	*85*	*91*	*147*	*143*	*101*	*92*	*84*	*136*
# Oil products	145	71	223	255	194	503	1076	1126	565	982	1031
Base increment		*49*	*154*	*176*	*134*	*347*	*742*	*777*	*390*	*677*	*711*
Chain increment		*49*	*314*	*114*	*76*	*259*	*214*	*105*	*50*	*174*	*105*

Source: authors' calculations based on data obtained from Central Statistical Bureau of Latvia[3]

Over the last decade the proportion of different cargo in cargo total turnover at Riga port underwent changes (Table 2). The proportion of coal increased notably and accounted for almost 40 – 50 % of the cargo flow at the end of the analyzed period. On the contrary, the proportion of mineral fertilizers and timber declined gradually from 12 % to 5 % and from 31 % to 10 % accordingly. The most constant proportion fluctuating at the level of 6 – 8 % (coefficient of variation Vσ = 12 %) was demonstrated by cargo containers. Compared to the year 2000 when the proportion of other cargo made up a fifth of the turnover it was just a tenth in the last years. Thus it indicates that the concentration of cargo assortment has been taking place since the beginning of the century.

Table 2. Structure of cargo turnover at the port of Riga in 2000 – 2010, percent

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	Vσ
Coal	0	8	14	24	39	44	42	40	47	47	38	54
Oil products	21	23	29	23	18	14	19	18	18	22	21	19
Mineral fertilizers	12	10	10	9	6	6	5	8	7	7	5	31
Timber	31	29	23	21	18	16	12	11	7	6	10	51
Cargo containers	6	7	6	6	6	6	6	7	6	6	8	12
Woodchip	3	3	5	5	5	5	5	3	3	2	4	26
Roll-on, roll-off cargo	1	1	2	3	2	3	1	2	2	2	2	34
Construction materials	4	2	1	1	1	2	3	3	2	1	1	51
Other	22	16	11	8	5	5	7	8	9	7	11	53

Source: authors' calculations based on data obtained from Central Statistical Bureau of Latvia[4]

Significant changes were observed at Liepaja port also (Table 3). The proportion of grain and grain products reached a peak of 41 % in 2009 compared to just 2 % in 2000. However, the proportion of other most important cargo groups decreased more or less notably. For instance, since 2004 the proportion of roll-on and roll-off cargo demonstrated a downward trend and resulted in a total drop of 10 percent points (from 15 percent in 2000 to 5 percent in 2010). The proportion of metals and metal manufactures went down by 8 percent points, timber – by 5 percent points, but oil products – by 4 percent points.

Table 3. Structure of cargo turnover at the port of Liepaja in 2000 – 2010, percent

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	Vσ
Grain and grain products	2	6	11	11	11	22	24	30	34	41	32	64
Metals and metal manufactures	20	18	22	17	19	18	20	19	14	14	12	18
Timber	25	22	18	18	18	16	14	13	11	13	20	25
Oil products	13	16	17	15	13	10	19	14	13	9	9	25
Roll-on, roll-off cargo	15	17	15	17	16	10	0	0	0	8	5	75
Scrap metal	2	0	0	0	2	4	5	5	9	4	6	79
Crude oil	0	0	2	6	5	5	5	5	7	4	3	58
Chemicals	3	1	1	1	1	1	1	1	2	3	2	60
Construction materials	2	2	1	0	1	2	2	4	3	1	6	81
Other	17	19	13	15	16	12	11	10	8	5	5	40

Source: authors' calculations based on data obtained from Central Statistical Bureau of Latvia

[3] Available (accessed on 15.03.2012): http://data.csb.gov.lv/Dialog/varval.asp?ma=TR0220&ti=TRG22%2E+AR+J%DBRAS+TRANSPORTU+NOS%DBT%CETAS%2C+SA%D2EMTAS+KRAVAS+PA+KRAVU+VEIDIEM+%28t%FBkst%2E++tonnu%29&path=../DATABASE/transp/Ikgad%E7jie%20statistikas%20dati/Transports/&lang=16

[4] Available (accessed on 15.03.2012): http://data.csb.gov.lv/DATABASE/transp/Ikgad%C4%93jie%20statistikas%20dati/Transports/Transports.asp

At the beginning of the analyzed period just two equally important cargo groups accounted for almost 70 % of the turnover at Ventspils port, namely, oil products and crude oil (Table 4). However, within 10 years the situation changed dramatically. The upward trend in proportion of oil products was accompanied by gradual decrease in proportion of crude oil. In result, the latter plummeted and was nil in 2010. At the same time the proportion of other cargo either increased or remained almost the same (with the exception of potassium salt which after wild fluctuations and subsequent insignificant decrease leveled off at 10 % in 2010). The proportion of coal demonstrated the most considerable increase of 15 percent points. It was followed by roll-on, roll-off cargo (5 percent points). The conclusion can be drawn that unlike the concentration of cargo assortment which could be clearly observed at the port of Riga, the structure of cargo turnover has become more diversified at the port of Ventspils.

Table 4. Structure of cargo turnover at the port of Ventspils in 2000 – 2010, percent

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	Vσ
Oil products	37	36	44	52	53	56	52	54	53	60	54	16
Coal	1	4	5	6	14	15	14	13	16	20	15	53
Potassium salt	14	13	16	18	16	17	13	10	9	4	10	33
Roll-on, roll-off cargo	0	0	0	1	1	2	6	6	5	3	5	89
Liquefied gas	2	2	1	3	3	3	3	3	4	3	2	30
Grain and grain products	0	0	1	0	0	0	0	1	3	2	3	110
Woodchip	0	0	0	1	1	2	2	1	1	2	1	64
Crude oil	39	40	26	12	8	1	7	7	5	2	0	111
Other	6	5	7	7	4	3	4	4	5	4	11	39

Source: authors' calculations based on data obtained from Central Statistical Bureau of Latvia

In comparison with 2000 the structure of cargo turnover at small ports was more balanced in 2010 (Table 5). Although timber continued to dominate as the most important cargo its proportion was not so large as it used to be at the beginning of the century (91 % and 66 % accordingly). The gradual decrease in proportion of timber occurred at the expense of the rise in woodchip which formed almost a fifth of the cargo transported through small ports at the end of decade. Likewise, the proportion of construction materials climbed from 1 percent to 8 percent.

Table 5. Structure of cargo turnover at small ports in Latvia in 2000-2010, percent

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	Vσ
Timber	91	88	88	72	72	60	58	65	62	54	66	18
Woodchip	3	7	8	11	16	16	17	19	25	25	19	47
Construction materials	1	0	1	9	4	15	17	8	6	8	8	81
Peat	1	0	0	5	5	5	5	5	3	6	5	61
Other	5	4	3	3	3	3	2	2	5	6	3	35

Source: authors' calculations based on data obtained from Central Statistical Bureau of Latvia

The significance of changes in the structure of cargo turnover at Latvia's ports can be revealed in the result of special quantitative analysis and application of statistical technique. Nowadays several dissimilarity indexes have been proposed. [26] A dissimilarity coefficient is a function that measures the difference between two objects. [4] One of the most commonly used measures is the one (Formula 1) invented by Hungarian statistician Sandor Alexander Szalay (1912-1983), who did research on quality of life and spending of leisure time.

$$I_S = \sqrt{\frac{\sum_{i=1}^{n}\left(\frac{d_2 - d_1}{d_2 + d_1}\right)^2}{n}} \tag{1}$$

n - number of groups in comparable structures
d - proportion of a group in total amount

Initially the Szalay index was invented to analyze the difference in use of time budget among various groups of people [21]. At present it is vastly applied as an aggregated ratio for quantitative comparative analysis of different structures. Another one is an integral coefficient of structure changes which is known as K. Gatev coefficient (Formula 2) [27].

$$I_G = \sqrt{\frac{\sum (d_1 - d_2)^2}{\sum d_1^2 + \sum d_2^2}} \tag{2}$$

d – proportion of a group in total amount

The values of both Szalay index and Gatev coefficient lay in the interval from 0 to 1 where the lower bound represents dissimilarity and the upper bound complete identity. Gatev coefficient measures absolute and relative changes of structures in their mutual conjunction. It means that, unlike Szalay index, Gatev coefficient not only takes into account the intensity of changes in a group but also the proportion of that group in comparable periods.

The analysis revealed (Table 6) that changes in structure of cargo turnover at Latvia's ports were much more significant during the period from 2000 to 2005 than from 2005 to 2010. The degrees of dissimilarity assessed by both Szalay index and Gatev coefficient were almost equal with the exception of Ventspils port. At this port Szalay index indicated an extremely high degree of dissimilarity between structure of cargo turnover in 2005 and 2010 whereas according to Gatev coefficient the changes were moderate and did not exceed the similar level in other ports. According to Szalay index the structure of cargo transported though Latvia's ports underwent the most important changes at Ventspils port. However, Gatev coefficients pointed at the most considerable transformation which occurred at Riga port.

Table 6. Szalay index and Gatev coefficient of dissimilarity calculated for structure of cargo turnover at Latvia's ports

Years for comparison	Riga port		Liepaja port		Ventspils port		Small ports	
	Szalai index	Gatev coefficient	Szalai index	Gatev coefficient	Szalai index	Gatev coefficient	Szalai index	Gatev coefficient
2000 & 2005	0,4799	0,7429	0,4683	0,4258	0,6558	0,5460	0,5971	0,3290
2005 & 2010	0,2189	0,1866	0,2887	0,2790	0,5506	0,1396	0,1430	0,1026
2000 & 2010	0,4778	0,6932	0,5453	0,6062	0,7390	0,5647	0,5773	0,2690

Source: authors' calculations

Ports still keep their importance even from a national perspective as they generate stable tax flows and duties, providing direct positive effects on GDP, Balance of Payments and Balance of Trade. For example, according to provisional calculations operation of the port of Riga provides approximately 3 to 3.3 % of the GDP in Latvia. [13] Usually ports are significant growth poles for national industries (e.g. manufacturing, transport, logistics) and services, effective macro-economic tools for development of economically depressed areas as well as a channel to international markets and foreign investments. Port industry plays an irreplaceable role as central links in the logistic chains of the global economy.

Therefore it is vitally important to forecast the future changes in cargo turnover in total as well as at both Latvia's freeports and small ports. For this reason the trend estimation for cargo turnover (Table 7) was made using Microsoft Excel tools. Trend estimation for Klaipeda and Tallinn port was made just for the purpose of comparison. The criterion for the choice from the list of possible trends was the goodness of fit measured by the coefficient of determination R^2. Time series included data on cargo turnover at Latvia's ports from 1993 to 2010[5], at Klaipeda port from 1991 to 2010[6] and at Tallinn port from 1999 to 2011.[7]

[5] Available (accessed on 15.03.2012):
http://data.csb.gov.lv/DATABASE/transp/Ikgad%C4%93jie%20statistikas%20dati/Transports/Transports.asp

Table 7. Trend estimation for loaded and unloaded cargo at Latvia's ports, Klaipeda and Tallinn ports

Loaded cargo		
Total at all Latvia's ports	$y = 10908\ln(x) + 26285$	$R^2 = 0{,}952$
Riga	$y = 2{,}5509x^2 + 1512{,}5x + 733{,}3$ $y = 1561x + 571{,}75$	$R^2 = 0{,}975$ $R^2 = 0{,}9749$
Liepaja	$y = 509{,}45x^{0{,}7504}$	$R^2 = 0{,}9383$
Ventspils	$y = 21{,}153x^3 - 719{,}31x^2 + 6582x + 16898$	$R^2 = 0{,}7753$
Small ports	$y = -1{,}3164x^2 + 97{,}553x - 19{,}956$	$R^2 = 0{,}9329$
Klaipeda	$y = 38{,}529x^2 - 154{,}11x + 10985$	$R^2 = 0{,}9316$
Unloaded cargo		
Total at all Latvia's ports	$y = 21{,}158x^2 - 102{,}51x + 3045{,}6$	$R^2 = 0{,}848$
Riga	$y = 3{,}527x^2 - 8{,}4951x + 2139{,}9$	$R^2 = 0{,}5321$
Liepaja	$y = -3{,}6085x^2 + 102{,}94x - 71{,}387$	$R^2 = 0{,}882$
Ventspils	$y = 249{,}73e^{0{,}1158x}$	$R^2 = 0{,}7097$
Small ports	$y = -0{,}302x^3 + 7{,}6619x^2 - 44{,}842x + 98{,}718$	$R^2 = 0{,}8077$
Klaipeda	$y = 23{,}893x^2 - 264{,}33x + 4084{,}5$	$R^2 = 0{,}8558$
Total loaded and unloaded cargo		
Total at all Latvia's ports	$y = 12328\ln(x) + 27314$	$R^2 = 0{,}9608$
Klaipeda	$y = 61{,}889x^2 - 411{,}32x + 15051$	$R^2 = 0{,}9401$
Tallinn	$y = 50{,}91x^3 - 1210{,}1x^2 + 8163x + 21680$	$R^2 = 0{,}8736$

Source: authors' calculations

According to the coefficient of determination R^2 the equations for loaded cargoes at Latvia's ports (with exception of Ventspils port) demonstrate better goodness of fit compared to the ones for unloaded cargo. As initial data for total unloaded cargo at all Latvia's ports, unloaded cargo at Riga port and small ports did not allow calculating the trends of acceptable goodness of fit some additional processing was applied. Therefore the calculation of trend was based on a simple moving average of the period of four years. A moving average is a set of numbers, each of which is the average of the corresponding subset of a larger set of data points. It is commonly used with time series to smooth out short fluctuations and highlight long-term cycle. The application of this method resulted in trend equations with the coefficient of determination R^2 ranging from 0,5321 for unloaded cargo at Riga port to 0,882 for total unloaded cargo at all Latvia's ports. Similar method of simple moving average of the period of three years was applied to the calculation of trend for total cargo at Tallinn port.

Conclusions

Although the researchers are unanimous that ports contribute to the development of national economy, they have doubts about both their impact on regional economy and determinative factors of impact. It is argued that nowadays role of ports in regional development is often exaggerated. At the same time the importance of analysis of cargo volumes (annual throughput) transshipped by the port and changes in commodity mix are stressed. The analysis revealed that over the last 10 years the diametrically opposed processes took place in the ports of Riga and Ventspils. If at the former the concentration of cargo assortment occurred, at the latter the structure of cargo became more diversified. The structure of cargo turnover at small ports became more balanced in 2010 compared to 2000. However, timber still accounted for two thirds of total turnover. The results of the analysis of structure dissimilarity for cargo turnover at Latvia's ports demonstrated that it was much more significant during the period from 2000 to 2005 than from 2005 to 2010. According to Szalay index the structure of cargo transported though Latvia's ports underwent the most important changes at Ventspils port. Nevertheless, Gatev coefficients pointed at the most considerable transformation at Riga port. According to the coefficient of determination R^2 the equations for loaded cargoes at Latvia's ports (with exception of Ventspils port) demonstrated better goodness of fit compared to the ones for unloaded cargo.

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GLOBAL WARMING IMPACT ON THE TEMPERATURE AND SEA LEVEL AT THE LATVIAN COASTAL AREAS DURING LAST CENTURIES

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Abstract
This title scrutinizes dynamical changes of several hydrometeoroligal parameters in relation with notorious 'global warming' process, these changes in Latvian coastal areas within last centuries, namely, water temperature changes in Riga Bay (1963-2011), average air temperature changes in Riga and vicinity (1795-2011), as well as seawater level changes in Ventspils and Daugava river basin (1873-1968). The analysis of data reveals some trends and findings: 1) Air temperature and water temperature fluctuations and trends in Riga bay are mutually correlated, so, statistical data on changes of air temperature might be used for overall hydrometeorological analysis. 2) last centuries dynamic of the air temperature fluctuations is being expressed as the cyclic process, however, there is not considerable major temperature growth monitored. 3) The average tempo of water level growth in the area is considerably less than as compared with the records from last Glacial Era's final phase. The global warming process is being continuing after the end of last Glacial Era up to now, and there is no solid ground for assumption, that this process has been facilitated nowadays.
Keywords: *global warming, temperature, levels of water.*

Introduction

The attribution „global warming" usually is associated with atmospheric and lithospheric average temperature growth, this is a hot issue within last decades, and object of stipulations for scientists (researchers), politicians and public mass media. Quite frequently the process of global warming is attributed to be caused and intensified by human industrial activities and civilization. The perceived or real consequences of the global warming process could be described as follows:

1) Carbon dioxide (CO_2) content increase in the atmosphere, causing the growth of air and lithospheric temperature due to impact on Earth thermal balance, by ways of absorbing secondary terrestrial infrared emitting.

2) Carbon dioxide content augmentation causes as air, as water temperature growth at seas and oceans

3) Temperature growth causes and facilitates de-glaciation (glaciers melting) at continental, oceanic and mountainous regions,

4) Glaciers melting, in turn, cause water temperature growth in global oceans and seas, so the cycle is self-supporting process;

5) Also, global warming facilitates various climatic, hydrographical and other related phenomenon and processes, such as Ozone (O_3) layer depletion, rapid desertification advance, tropical cyclones and extreme weather phenomenon escalation etc.

The information and data about water levels changes and those causing factors are of extreme actuality, in order to derivate the forecasts for future. The data on water levels fluctuations could be very important for coastal construction and building industry, as well as for planning and designating the maritime coastal-traffic routes and hydrography works.

This research analyses some hydrometeorology parameters of Latvian coastal area in direct relation with the global warming; namely, temperature changes in Bay of Riga, air temperature changes in the City of Riga and in vicinity, as well as water levels alterations in the Ventspils and Daugavgriva (Daugava river basin).

Research's methodology and processed data

The fluctuation of sea water temperature in Riga bay at time period from 1963 to 1970 is being evaluated by statistical data from Latvian Hydrometeorology Administration [1]. More extended time period for such evaluation of Riga Bay temperature is covered by data from fishery department: registry from 1971 to 1991 is taken from BaltNIIRH (*Baltijskij Naučno Issledovateļskij Institut Ribnogo Hozjaistva*) records; 2004 thru 2010 data are derivate from Fish Recourses department (LZRA-*Latvijas Zivju resursu aģentūra*) records, as well as all data since 2011 are retrieved from Fishery Department's Marine laboratory (BIOR) sources.

Average water temperature in the Bay of Riga is being calculated using the observations, which are equalized in adherence to average seasonal calendar datum (February 10, May 10, August 10, October 25) and in pro-rata to layers volumes adhered to ice-cover thickness at particular winter season[2, 3].

Air temperature data series for the City of Riga are erratic due to changing methods of observations in the Riga and vicinity, as well as there are some time-gaps in observations. Since 1795 up to 1813 observations were conducted in the University of Riga; series are continued in years 1824 thru 1830; 1840; 1851 thru year 1950. In city of Jelgava air temperature observations have been conducted from 1831 thru 1876, from 1890 thru 1892, as well as from 1894 thru 1904; than from 1925 thru 1950; all these data are processed from literary sources [4].

At time period from 1942 to 1973, observations have been conducted in Riga Observatory. Riga Airport has executed air temperature observations since 1974 thru 2009 and all these data also processed from literary sources [5,6,7].

The period 1992- 2009 is covered by dynamic observation data from Website FOBOS, weather station at Riga Airport, http://www.gismeteo.ru/catalog/latvia/; further observations after 2009 have been extracted from Webiste WINDGURU, from location in Riga (Kisezers DA), Web: http://www.windguru.cz/.

This research implements data from Riga Airport as the basic source of air temperature records (hereinafter-Riga), and all other air temperature observations are adhered to these by means of conversion factor by particular months, in cases when there are correlated by time observations (see Table 1). Observations without time correlating are being assumed to be substituted by other ones from different locations.

Table 1. Monthly air temperature conversion factor for the City of Riga (°C)

Convertions (ºC)	Month											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Jelgava - Riga	0.1	-0.1	-0.2	-0.6	-0.5	-0.5	-0.3	0	0.2	0	0	0.1
Riga Univesity -Riga	0.1	-0.2	-0.1	-0.5	-0.7	-0.8	-0.9	-0.5	-0.1	-0.1	-0.1	0.1

Observations on the water levels alterations in Ventspils and Daugava river basin at time period from 1873 up to nearly 1978 are retrieved from the publications of Latvian Hydrometeorology Administration [8].

This research implements calculations and parameters-related average indicators and values in the profile of perennial dynamic. The changes of the parameters per 100 years have been calculated; for instance, temperature changes ºC/100 years, or water level changes cm/100 years.

In some cases the analysis is being conducted by deploying correlation factors between, for instance, air temperature in Riga and average water temperature in Riga bay.

Air and sea water temperature dynamic at time period 1963-2011

The analysis of water and air temperature data for time period from 1963 to 2011 delivers impression, that Global Warming process is ultimately in force, because average air temperature has grown up by 4.1 ºC/100 years, and, accordingly, water temperature by 2.3 ºC/100 year. The correlation factor between these two parameters is 0.8, meaning tight mutual alignment of data (Figure 1).

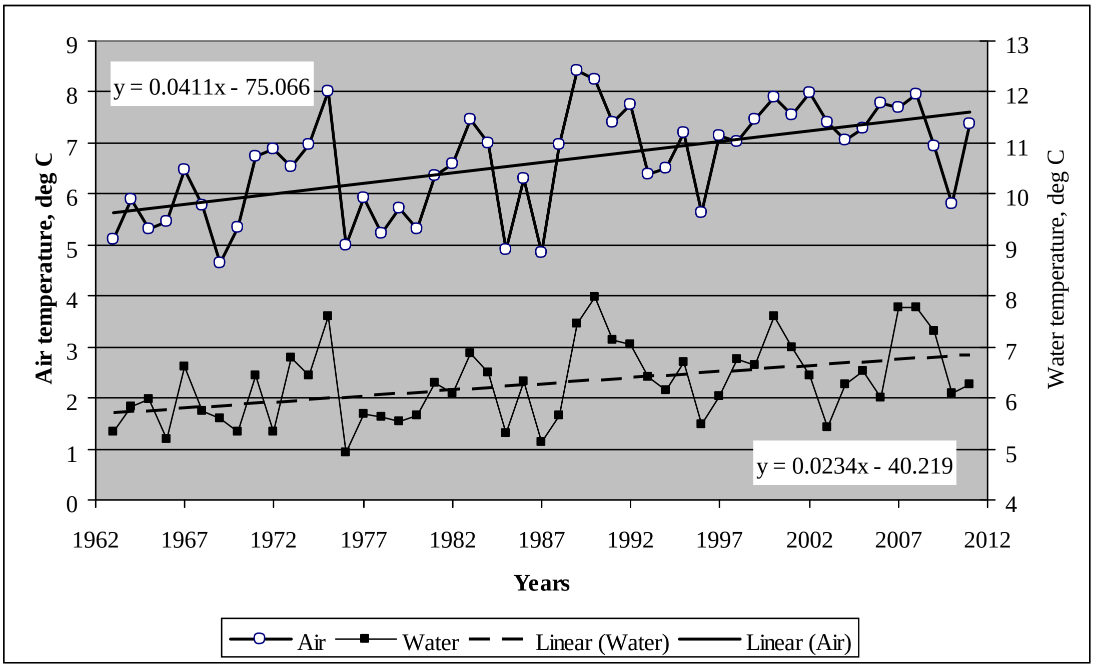

Figure 1. Annual average air temperature measurements in Riga and water temperature in Bay of Riga at time period 1963-2011

Air temperature dynamic at time period 1795-2011

Using above mentioned revealing on tight mutual correlation of air and water temperature indicators, we can analyse the temperature fluctuation dynamic within more extended time period, approximately for two centuries. Looking at air temperature changes within this time span, we can derivate several distinctive features as follows:

1) Temperature grows at rate 0.31 ºC/100 years at time span two hundred years, however this growth is at least 13 times less compared with the data for last 50 years (see Figure 2)

2) Widening up Extending the calculation time period demonstrates, that average air temperature growth rate consequently decreases (see Table 2).

3) At time period 1795 thru 1960 air temperature decreases with the rate -0.22 ºC/100 years , and this rate is more profound for time period 1795-1910, achieving -0.62 ºC/100 years (see Figure 3 and Table 2).

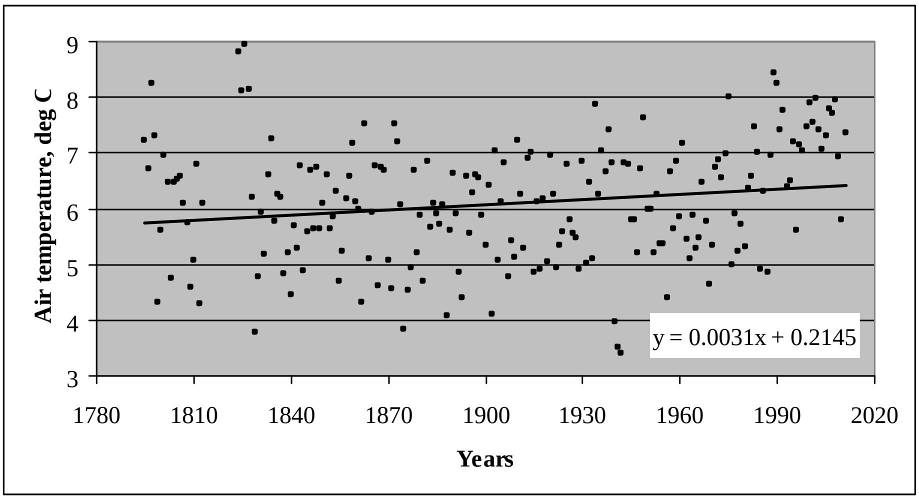

Figure 2. Average air temperature changes in Riga at time period from 1795 to 2011

Table 2. The general tendency of air temperature changes in Riga, at value of ^{o}C/100 years for different periods

Time period years	1963 - 2011	1900 - 2011	1840 - 2011	1795 - 2011	1795 - 1960	1795 - 1910
Tendency of air temperature changes, ^{o}C/100 years	4.11	1.37	0.69	0.31	-0.22	-0.62

In general, the purpose of current research is to estimate air and water temperatures, as well as water levels fluctuations and tendencies; however, the major analysis reveals the cyclic (or periodical) dynamic of parameters changes. For instance, the estimation of air temperature changes within last centuries delivers at least two temperature maximums-at the end of 18th century and at the beginning of 19th century, as well as at the end of 20th century and currently and, consequently at the initial time period of 21th century. Also several time periods, where decreased air temperature is observable (see Figure 2).

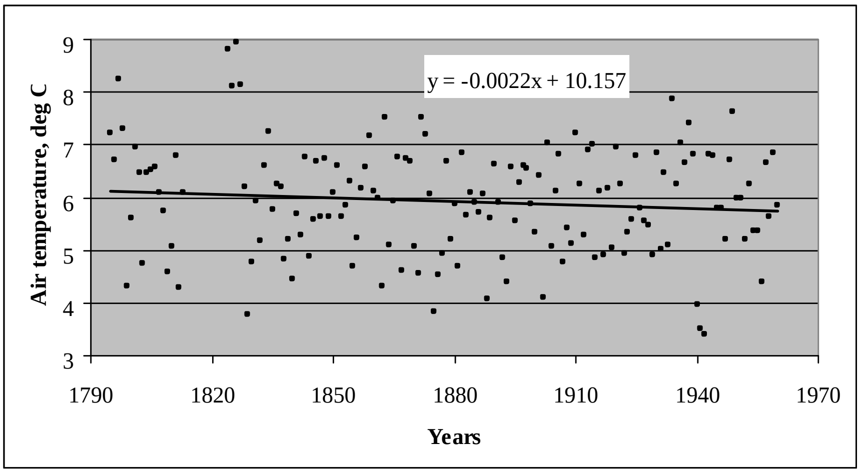

Figure 3. Average annual air temperature changes in Riga at time period from 1795 to 1960

The dynamic and fluctuations of water levels changes at time period from 1873 to 1968

Levels of water are being influenced by astronomical conditions, fresh water balance, uneven atmospheric pressure, and wind /water density mutual rates. Water level changes in Baltic Sea are being under direct impact from endogenous fresh water flow fluctuations, changes of atmospheric pressure and winds; there are some direct relations of such changes with melting of ice cover and Earth crust's vertical shifts.

This title covers annual average changes of the levels of water in Ventspils and Daugavgriva at time period from 1873 to 1968. Both locations are characterized by clear tendency of water level growth – in the Daugava river the level of water has grown by 20.5 cm per 100 years, in Ventspils water level growth rate is 4.45 cm/100 years. Therefore, water level growth in Daugavgrivas basin is at least 4 times more than in Ventspils (see Figure 4).

The interest sparking finding is that the average speed (rate) of water level growth in both locations is quite different. This difference could be explained by Earth crust's lithospheric vertical shifts in Baltic region. There are no significant vertical lithospheric shifts in Daugavgriva, but average vertical lithospheric movement rate in Ventspils is about 0.6-1.0 mm/year , providing water level augmentation at rate 6-10 cm/100 years [9]. The assumption is, that water level fluctuations in Daugavgriva are in direct relation with the common trends of Ocean water level; in turn, Ventspils parameters are under impact from Earth crust's lithospheric vertical shifts, being more significant in Northern areas of Baltic region (see Figure 5).

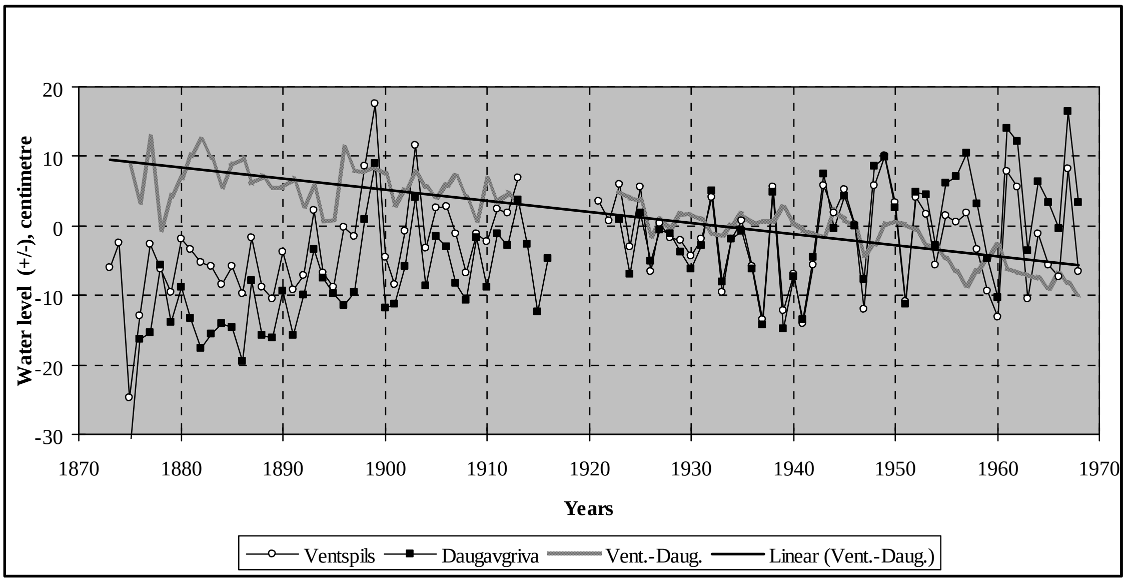

Figure 4. The changes of water level in Ventspils (sea) and Daugavgriva (river basin) at centenary time period

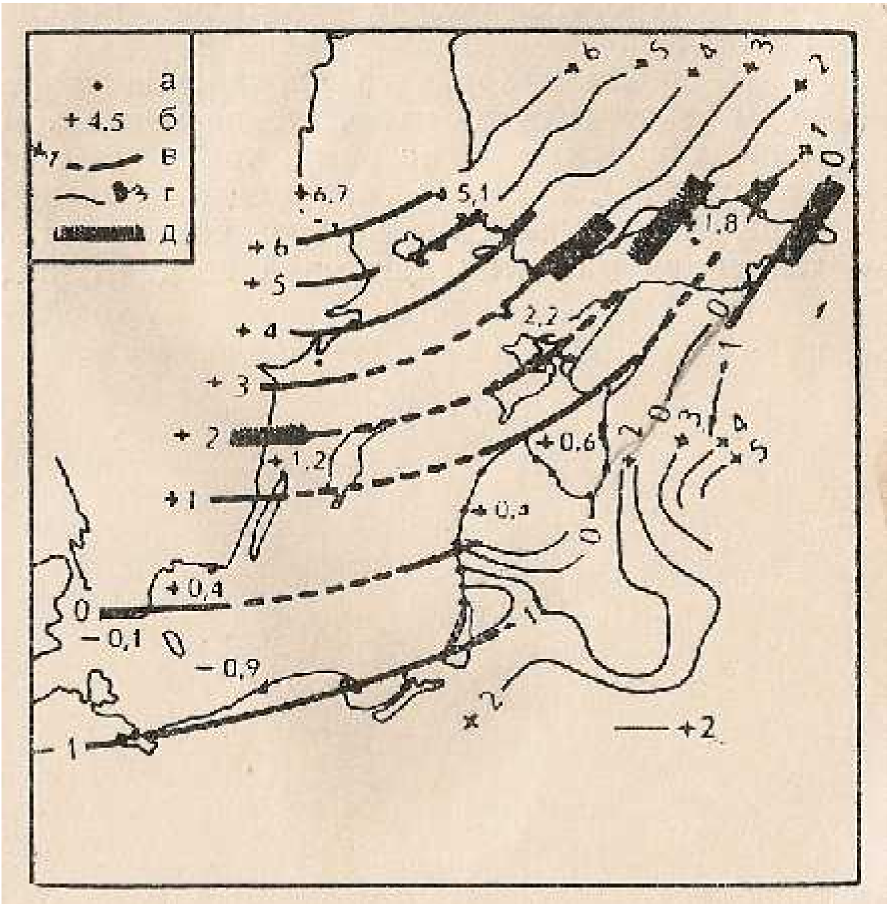

Figure 5. The intensity of current Earth crust's lithospheric vertical shifts in Baltic Sea area: **а** – locations of water level monitoring spots, **б** – intensity of vertical shifts, mm/year, **в** – isobases of vertical shifts as derivate from water levels measurements, **г** – isobases of vertical shifts as derivate from geodetic field-levelling, **д** – areas of most consistent measurements [9, pp. 93].

Discussion

The analysis of air and water temperatures statistical data reveals common trend of last 50 years, when assumption about global warming caused by human industrial activities is quite plausible. The tendencies of air and water temperatures growth directly lead to such an assumption. The analysis of air temperature fluctuations at time period approximately of two centuries: those are being profoundly correlated with water temperature fluctuations, reveals quite doubtful systematic and incremental temperature growth, at least in Baltic Sea region, because there are as temperature increasing as temperature decreasing time periods [10, 11].

The analysis of available data from publications and literary works on common trends within much more extended time periods (approximately 12 000 years) reveals, that fluctuations and changes are being profoundly expressed in broader time-continuum. For instance, the book by Ojars Aboltins about natural environmental processes in Baltic sea region at time period since the last Glacial era up to modern times, ostensibly concludes the occurrence of cyclic temperature changes: there were five temperature ‘’troughs’’(including final stage of Glacial era) and at least four temperature ‘’peaks” [12, p. 96].

The graphs provided by Aboltins indicate the occurrence of so called ‘’climatic optimum” 6500 years ago, when average temperature was approximately by 2.4^{o}C higher than nowadays. Elevated meanings of temperature was 4100 and 1800 years ago, being, accordingly, 2.1 ºC and 1.2 ºC higher than nowadays. Lower temperature indications could be found 5300, 2800 and 300 years ago, when it was 0.4 ºC, 1.3 ºC and 1.2 ºC less than modern meanings accordingly.

The above mentioned temperature data quite apparently demonstrate, that assumption about global warming and its direct correlation with human industrial activities is quite dubious. The elaborated data analysis just leads to conclusion, that natural processes are associated with shorter or longer cycles of climatic changes with all related consequences. The features of climatic changes since last glacial era are obviously supported by modern paleontological researches of fossil farina and spore, when thermophile or psychrophilic plants-breed distribution across the geographical areas and epochs obviously amplifies the data on average temperature meanings.

Cyclic changes of climate with all related factors are also backed up by various researches: dendrology researches (tree-ring chronology of temperature), investigations of deep ice-sample drilling in Greenland and Antarctica with revealing of carbon dioxide (CO2) specific content, as well as ‘’light’’ and ‘’heavy’’ oxygen particular content rates. All these biological and naturalistic researches allow to derivate conclusions about average temperature dynamic in historical perspective [12].

The climate impacting factors and their cyclic changes are thoroughly described in fundaments book by Monin and Šiskov about the history of the Earth climate since the existence of our planer. The book stipulates in a detailed way all the basic climate changes upon the last glacial era and nowadays, with the geographical coverage of Europe and, particularly Baltic Sea region. There are attributed tectonic, glaciological, geomorphological, biological, paleontological, dendrology and other nature and environmental changing-in-dynamic parameters for different time periods and centennial profiles. For instance, the aforementioned book states, that within so called ‘’climatic optimum’’ time period between 5000 thru 7000 B.C., the air temperature in Europe was being at least by 2 ºC higher compared with nowadays, whereas the summer seasonal air temperature in Siberia was being ~ 4 ºC higher than now. There are not mentioned 8 thru 11. Century so called ‘’Viking era” air temperature dynamic, however, considering glaciers and trees-breeds penetration geography, supported by other data, there are indications of air temperature to be higher than at modern times. So called ‘’Minor Glacial Era”, which has covered time period between 17 to 19 centuries, the average air temperatures was by 1-2 ºC lower, than nowadays [13].

All the aforementioned findings and many other researches just prove the facts, that in matters of climate changes, a time period after last glacial era could be described as the cyclic process of climatic parameters changes (especially air and water temperatures fluctuations), where some spikes and troughs could be observed. Therefore, quite intensive temperature growth, being observed at the last centennial timing profile, as well as being generally attributed to human industrial activities, could be, in reality, to be just a segment of on-going global climatic natural process on the ascending phase, whereas human industrial influence and impact on the process are quite doubtful.

Summarizing all above mentioned available researches data, we can conclude, that there is no clear and profound ground for predication on intensive and incremental temperature growth. Such a growth is being observed just within the time period of several centennials.

The level of world ocean was by 60 meters lower than nowadays approximately 12000 years before, and average water level growth rate is at least 50 centimetres per 100 years nowadays [12, 14]. The comparison of water level growth rates within last centuries with the average same indicators of the last glacial era's final stage, reveals the fact, that modern water level growth rate is at least three times slower; it means, that ice-melting overall process is much slower either, so there is none any solid ground for predication on intensive water level growth during last centennials. However, water level growth is very considerable, and this process can impact the construction and building industry in coastal area (dumbs, wave -breakers, piers and quays, as well as hydrography installations) in matters of projecting, design and building works.

Conclusions

The research and analysis of air and water temperatures, as well as water levels fluctuations in Latvian coastal areas during time periods of last centennials, supported by other related researches on parameters deducted shortly thereafter the last Glacial era, draw the conclusions as follows:

1) The growth of temperature within time period of the last 50 years might be the sort of confirmation about global warming process caused by human industrial activities.

2) The dynamic of temperature fluctuations at time period within last two centennials is not changing substantially.

3) The dynamic of temperature fluctuations at time period since the final stage of last Glacial era demonstrates average decrease of the temperature, at least within last 6500 years, and there are shorter or longer cycles of climatic changes.

4) The water level growth rate at time period within last centennials is at least three times slower than it was at time just after last glacial era's final stage.

In general we can draw a conclusion, that so called ''Global Warming" process has commenced thereafter last glacial era; it is in active phase up to nowadays, however associated with some parameters' fluctuations, and there are no any solid ground for a statement, that this process has become more intensive during last centennials.

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EXPERIMENTAL PROPELLER SHAFT CONVEYED POWER METERING

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Abstract

A method of experimentally exterminating the propeller transferred power of the shore moored vessel, using non-contact adapters and without using any dismantling operations is described in this work. The method of the power measurement results the indirect of the confidence interval calculation using only directly measured parameters of the partial errors is determinate in this paper. The vessel's propeller transferred power, the experiment data and processing results, including the error estimates are treated using an example vessel. It is shown how to make the rational calculations in order to narrow the confidence interval by analyzing the experimental data. Certain calculating methodology is proposed for the capacity limits of applicability to the given permissible relative errors, as well as adapters and signal recording equipment parameters.

Keywords: *impulse signal, torsion moment, absolute and relative error, credibility range.*

Introduction

In many cases, the small vessels performance is determined not only with the engine's power. Not always characteristics of the propeller are fully consistent with the engine described speed. In this case, at the very "light" propeller, engine power is not fully used, but at too "heavy" - the engine can not reach nominal revolutions and, therefore, develop the full power. The performance of direct propeller transferred power more objectively is being characterized. This power can be calculated using the vessels theory, found in the relationship (e.g., work [1]). However, the obtained results will not accentuate with the high precision by means of calculation, a series of rates in formulas are derived empirically, and any failure to comply with the propeller and engine condition, which during operating time can vary widely. Therefore, it is target experimentally to measure propeller's transferred power at different engine revolutions directly to the moored vessels.

The power could be determined directly on ship board with the power measuring method, which is protected by the Latvian Patent Nr.14004 [2]. However, the difficulties caused by the fact that in many cases it is difficult to tare the equipment without load, because usually there is no such shaft stage between the propeller and the engine, which could be disconnected from the propeller without dismantling work. On the other hand the moment of rotation of the propeller impedance in the water, even at the minimum revolutions of the main engine is too large to be ignored. The method to circumvent these difficulties is described in this paper.

The description of the method

The proposed methodology includes the following. Marks 1 and 2 are glued at the shaft (Fig. 1) and opposite the adapters 3 and 4 are fixed. At intervals t_1 (from 1st mark, moving along the sensor end till 2nd mark moving along the sensor end) and t_2 (from 2nd mark, moving along the sensor end till 1st mark moving along the sensor end) optical sensor generated pulse type signals are recorded and stored in the database (Fig 2).

To determine transmitted power of the shaft, the ship is moored at the pier and measurements were made at two different propeller revolutions speed ω_1 and ω_2, where $\omega_2 > \omega_1$. At $\omega = \omega_1$ optical sensor generated pulse type signals in a time span t_1 is marked as i_1, but the amount of time t_2 - as i_2. And at $\omega = \omega_2$ are marked with the number of pulses j_1 and j_2. The mark 1 nearest to the engine, turning angle φ growth anent to marks 2 turning angle angular velocity increasing from ω_1 to ω_2 can be calculated as

$$\varphi = 2\pi \left(\frac{j_1}{j_\Sigma} - \frac{i_1}{i_\Sigma} \right) \text{, where } j_\Sigma = j_1 + j_2 \text{ , } i_\Sigma = i_1 + i_2 \qquad (1)$$

The increment of this turning angle is proportional to the increment of torque M

$$M = \varphi \cdot c \text{ ,}$$

where c - shaft spinning rigidity between the marks 1 and 2.

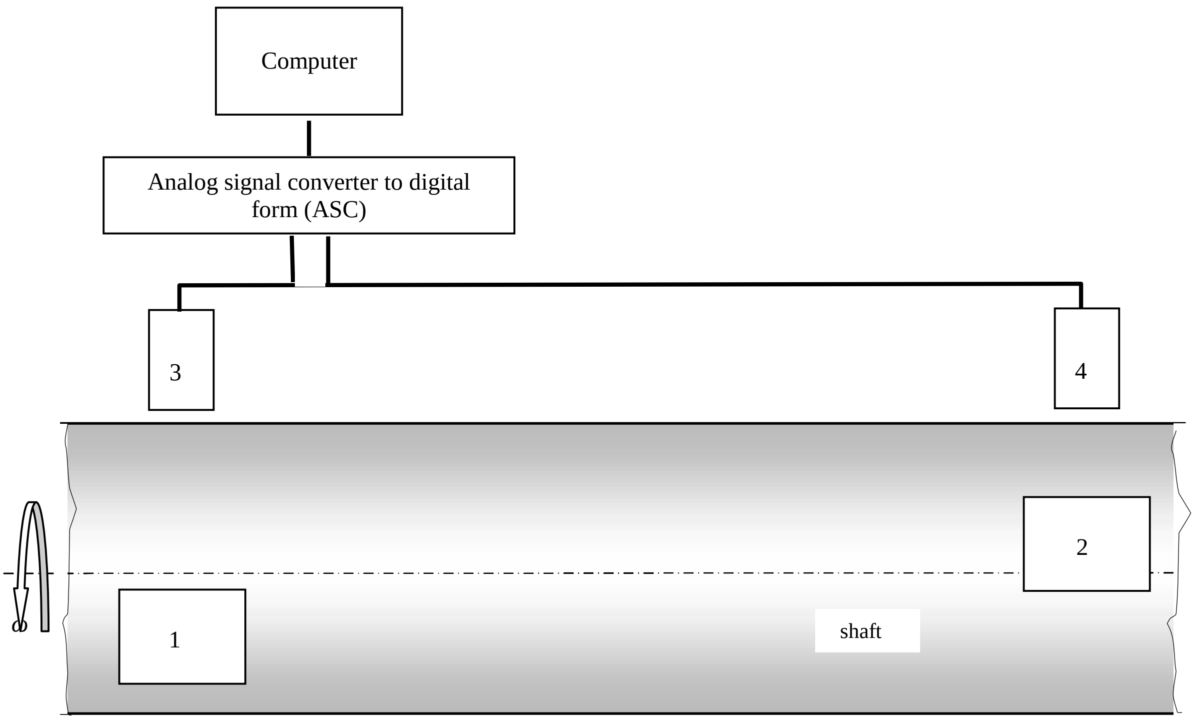

Figure.1 The scheme of the shaft transferred power measurement equipment

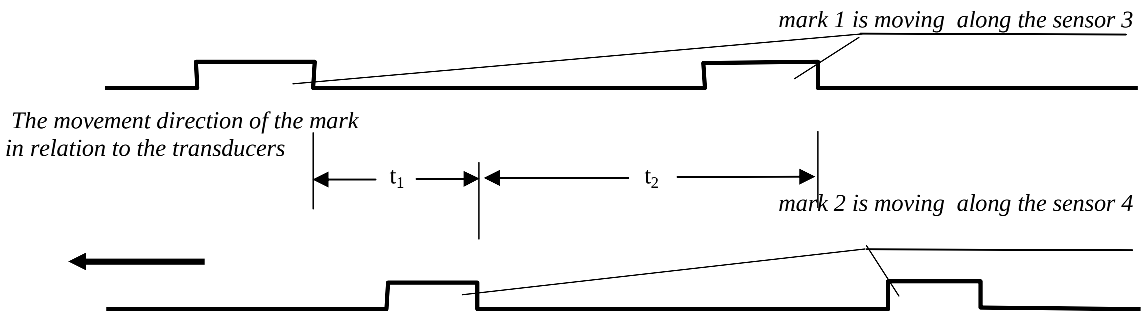

Figure 2. Optical sensor generated signals

From ships theory it is known (e.g., [1]) that for the propeller turning, torque proportional to the square of the speed rotation is required.

Then

$$\frac{M_2}{M_1} = \left(\frac{\omega_2}{\omega_1}\right)^2 = \left(\frac{i_\Sigma}{j_\Sigma}\right)^2 \qquad (2)$$

Here M_1 , M_2 - torque at ω_1 and ω_2: $M_2 = M_1 + M$ (3)

From the expressions (2) and (3) we find

$$M_1 = \frac{M}{k^2 - 1} \quad , \quad M_2 = \frac{k^2 \cdot M}{k^2 - 1} \qquad (4)$$

Here the rotational speed ratio is indicated with k:

$$k = \frac{\omega_2}{\omega_1} = \frac{i_\Sigma}{j_\Sigma}$$

Angular velocity and rotary frequency (revolutions / minute), are calculated with the formulas:

$$\omega_1 = \frac{2\pi \cdot f}{i_\Sigma}, \quad n_1 = \frac{60 \cdot f}{i_\Sigma} \quad \omega_2 = \frac{2\pi \cdot f}{j_\Sigma} \quad , \quad \frac{60 \cdot f}{j_\Sigma} \quad n_2 =$$

(5)

where f – the frequency of sensor generated pulse signal .

Knowing the torque, engine power P_1 and P_2 at the angular rotation of ω_1 and ω_2 is calculated with the formulas:

$$P_1 = M_1 \cdot \omega_1 = \frac{2\pi \cdot \varphi \cdot c \cdot f}{i_\Sigma \cdot (k^2 - 1)}$$

$$P_2 = M_2 \cdot \omega_2 = \frac{2\pi \cdot \varphi \cdot c \cdot f \cdot k^2}{j_\Sigma \cdot (k^2 - 1)} \qquad (6)$$

Estimate of the accuracy of the results obtained

In formulas (1) - (6) the values of i_1 , i_2 , j_1 , j_2 , f and c parameters are not known with the absolute precision. Registered number of impulsive signals i_1 , i_2 , j_1 and j_2 in each shaft revolution fluctuates an average value - this can be explained by the reading error, as well as the angular velocity fluctuations Experimental studies have shown that recording the number of pulse counts over 100 during the shaft rotation, the average relative error of values of $i_{1\Sigma}$, j_Σ , k , i_1/ i_Σ and j_1/ j_Σ does not exceed a few hundredths of a percentage.

Signal generation frequency f depends on the AC mains frequency, which may vary during the experiment within 0.5%. Shaft torsion rigidity c depends on the shaft material shear modulus, which can be found in the literature with only a 5% precision for a steel shafts and 15% precision for cast iron shafts. Therefore, the reduction of the deviation from the calculated average values of the results, is better to be measured stiffness spinning of the shaft between marks 1 and 2 directly on-board static loading of an existing stationary shaft with known torsional moments and directly measuring the torsion angles.

Equating function and argument mistakes to differentials:

1) by the formula (1) the error $\Delta\varphi$ of the calculated φ angle is determined by the formula:

$$\Delta\varphi = 2\pi \sqrt{(\Delta(j_1/j_\Sigma))^2 + (\Delta(i_1/i_\Sigma))^2} \quad , \qquad (7)$$

where $\Delta(j_1/j_\Sigma)$ and $\Delta(i_1/i_\Sigma)$ is $\frac{j_1}{j_\Sigma}$, $\frac{i_1}{i_\Sigma}$ ratio and average value of the error.

2) the rotational speed ratio squared k^2 relative error δk^2 :

$$\delta k^2 = 2\sqrt{(\delta i_\Sigma)^2 + (\delta j_\Sigma)^2}\,, \qquad (8)$$

where δi_Σ and δj_Σ are i_Σ and j_Σ are average relative errors.

3) the calculated power P_1 andP_2 relative errors are δP_1 and δP_2 :

$$\delta P_1 = \sqrt{(\delta c)^2 + (\delta\varphi)^2 + (\delta f)^2 + (\delta i_\Sigma)^2 + (\delta k^2)^2}\,, \quad \delta P_2 = \sqrt{(\delta c)^2 + (\delta\varphi)^2 + (\delta f)^2 + (\delta j_\Sigma)^2 + 2(\delta k^2)^2}\,, \qquad (9)$$

where δc , $\delta\varphi$, δf are c , φ and f are average values relative errors.

The example of the method application

The proposed methodology is approbated by carrying out the measurements on the ship PIRITA engine propeller power. The ship propulsion plants scheme is shown in Figure 3.

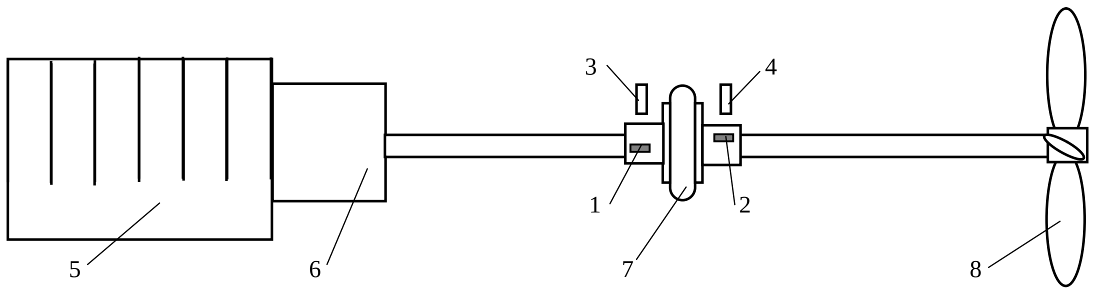

Figure 3. Propulsion plant on board ship PIRITA
1, 2 – marks, 3, 4 – optical sensors, 5 – engine, 6 – gearbox, 7 – flexible rubber clutch, 8 – propeller

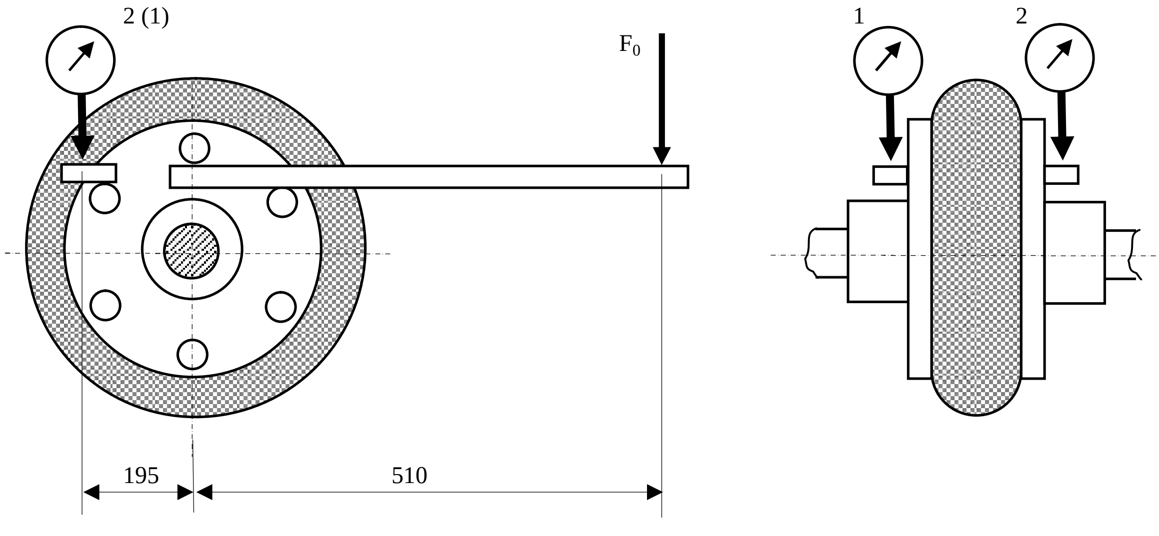

Figure 4. Clutch torsional stiffness measurement scheme
1, 2 - indicators

For determining propeller's drive shaft transferred power the marks 1 and 2 were glued at clutch hubs on both sides of the elastic element, because clutch torsional stiffness is approximately 15 times lesser as shaft spinning rigidity between clutch and propeller, but decrease of stiffness increase precision of metering as sensitiveness of measuring instrument is limited.

Since the clutch catalogues torsional stiffness is defined with an accuracy of ± 20% and it can vary during operating time , the first, given clutch torsional stiffness c is measured experimentally.
The coupling torsional stiffness coefficient of the average value c = 129,6 kN·m/rad was experimentally obtained, with a confidence interval of ± Δc = 1,0 kN·m/rad (relative error δc= 0.0080).

The number of recorded optical sensors pulses was fixed at as slow shaft rotation (138 rpm) and at full shaft rotation speed (541 rpm). Pulse generation frequency f = 10 000± 50 pulses/s (relative error δf = 0.005). 100 measurements were recorded at slow rotation, but at the full speed rotation - 139 measurements.

It was accepted, that both angular velocities of shaft are constant during metering (roughly 1 minute). Tables 1 and 2 show, that such concession was justified – slow revolutions range from 136 to 139, but fast revolutions range from 539 to 541.

The registered number of pulses for each revolution is given in Table 1 and Table 2.

Table 1. Slow revolutions of the shaft

i_2	i_1	i_Σ			i_2	i_1	i_Σ			i_2	i_1	i_Σ			i_2	i_1	i_Σ		
1288	3100	4388	136	APGRM	1287	3099	4386	136	APGRM	1289	3093	4382	136	APGRM	1288	3097	4385	136	APGRM
1294	3094	4388	136	APGRM	1282	3096	4378	137	APGRM	1282	3097	4379	137	APGRM	1284	3093	4377	137	APGRM
1284	3106	4390	136	APGRM	1285	3087	4372	137	APGRM	1288	3095	4383	136	APGRM	1283	3099	4382	136	APGRM
1288	3088	4376	137	APGRM	1276	3078	4354	137	APGRM	1273	3075	4348	137	APGRM	1282	3085	4367	137	APGRM
1272	3099	4371	137	APGRM	1289	3075	4364	137	APGRM	1279	3076	4355	137	APGRM	1283	3089	4372	137	APGRM
1279	3091	4370	137	APGRM	1281	3092	4373	137	APGRM	1282	3085	4367	137	APGRM	1280	3095	4375	137	APGRM
1281	3097	4378	137	APGRM	1279	3083	4362	137	APGRM	1277	3097	4374	137	APGRM	1284	3078	4362	137	APGRM
1269	3089	4358	137	APGRM	1285	3096	4381	136	APGRM	1271	3085	4356	137	APGRM	1285	3099	4384	136	APGRM
1272	3065	4337	138	APGRM															
1273	3074	4347	138	APGRM	1272	3077	4349	137	APGRM	1270	3056	4326	138	APGRM	1257	3071	4328	138	APGRM
1274	3052	4326	138	APGRM	1266	3063	4329	138	APGRM	1279	3073	4352	137	APGRM	1271	3055	4326	138	APGRM
1266	3060	4326	138	APGRM	1268	3053	4321	138	APGRM	1266	3071	4337	138	APGRM	1276	3059	4335	138	APGRM
1260	3042	4302	139	APGRM	1274	3078	4352	137	APGRM	1274	3051	4325	138	APGRM	1265	3055	4320	138	APGRM
1269	3056	4325	138	APGRM	1267	3058	4325	138	APGRM	1267	3066	4333	138	APGRM	1272	3063	4335	138	APGRM
1269	3049	4318	138	APGRM	1267	3051	4318	138	APGRM	1274	3074	4348	137	APGRM	1269	3060	4329	138	APGRM
1274	3054	4328	138	APGRM	1269	3061	4330	138	APGRM	1263	3047	4310	139	APGRM	1263	3063	4326	138	APGRM
1269	3065	4334	138	APGRM	1262	3037	4299	139	APGRM	1266	3068	4334	138	APGRM	1274	3057	4331	138	APGRM
1263	3054	4317	138	APGRM															
1271	3040	4311	139	APGRM	1265	3061	4326	138	APGRM	1270	3043	4313	139	APGRM	1267	3064	4331	138	APGRM
1256	3042	4298	139	APGRM	1270	3052	4322	138	APGRM	1269	3055	4324	138	APGRM	1266	3045	4311	139	APGRM
1262	3037	4299	139	APGRM	1265	3052	4317	138	APGRM	1266	3049	4315	139	APGRM	1267	3059	4326	138	APGRM
1262	3055	4317	138	APGRM	1266	3048	4314	139	APGRM	1265	3058	4323	138	APGRM	1259	3033	4292	139	APGRM
1259	3032	4291	139	APGRM	1269	3052	4321	138	APGRM	1263	3043	4306	139	APGRM	1263	3047	4310	139	APGRM
1260	3036	4296	139	APGRM	1267	3039	4306	139	APGRM	1271	3065	4336	138	APGRM	1257	3048	4305	139	APGRM
1256	3036	4292	139	APGRM	1262	3045	4307	139	APGRM	1265	3060	4325	138	APGRM	1257	3053	4310	139	APGRM
1257	3036	4293	139	APGRM	1264	3051	4315	139	APGRM	1267	3051	4318	138	APGRM	1267	3052	4319	138	APGRM
1253	3035	4288	139	APGRM	1266	3043	4309	139	APGRM										

The obtained data is being mathematically processing is found:

$i_\Sigma = 4337 \pm 3$, $\delta i_\Sigma = 0{,}00069$, $j_\Sigma = 1109{,}6 \pm 0{,}1$, $\delta j_\Sigma = 0{,}00009$,

$\dfrac{i_1}{i_\Sigma} = 0{,}70685 \pm 0{,}00008$, $\delta(i_1/i_\Sigma) = 0{,}00011$, $\dfrac{j_1}{j_\Sigma} = 0{,}71108 \pm 0{,}00006$, $\delta(j_1/j_\Sigma) = 0{,}00009$.

Then

$$\varphi = 2\pi\left(\frac{j_1}{j_\Sigma} - \frac{i_1}{i_\Sigma}\right) = 2\pi\,(0{,}71108 - 0{,}70685) = 0{,}0266 \text{ rad} ,$$

$$\Delta\varphi = 2\pi\sqrt{(\Delta(j_1/j_\Sigma))^2 + (\Delta(i_1/i_\Sigma))^2} = 2\pi\sqrt{0{,}00006^2 + 0{,}00008^2} = 0{,}00063 ,$$

$$\delta\varphi = \frac{\Delta\varphi}{\varphi} = \frac{0{,}00063}{0{,}0266} = 0{,}024 .$$

$$k^2 = \left[\frac{i_{\Sigma...}}{j_\Sigma}\right]^2 = \left[\frac{1337}{1109,6}\right]^2 = 15,28 \; ,$$

$$\delta k^2 = 2\sqrt{(\delta i_\Sigma)^2 + (\delta j_\Sigma)^2} = 2\sqrt{0,00069^2 + 0,00009^2} = 0,0014 \; .$$

Power at full shaft speed rotations

$$P_2 = \frac{2\pi \cdot \varphi \cdot c \cdot f \cdot k^2}{j_\Sigma \cdot (k^2 - 1)} = \frac{2\pi \cdot 0,0266 \cdot 129,6 \cdot 10000 \cdot 15,28}{1109,6 \cdot (15,28 - 1)} = 209 \text{ kW}$$

$$\delta P_2 = \sqrt{(\delta c)^2 + (\delta\varphi)^2 + (\delta f)^2 + (\delta j_\Sigma)^2 + 2(\delta k^2)^2} =$$

$$= \sqrt{0,0080^2 + 0,024^2 + 0,005^2 + 0,00009^2 + 2 \cdot 0,0014^2} = 0,026 \; ,$$

$$\Delta P_2 = P_2 \cdot \delta P_2 = 209 \cdot 0,026 = 6 \text{ kW} \; .$$

This determinates, that the propeller transferred power at full engine speed is 209 ± 6 kW.

Table 2. Fast revolutions of the shaft

j_2	j_1	j_Σ			j_2	j_1	j_Σ			j_2	j_1	j_Σ			j_2	j_1	j_Σ		
320	790	1110	540	APGRM	322	789	1111	540	APGRM	320	788	1108	541	APGRM	321	789	1110	540	APGRM
319	791	1110	540	APGRM	319	789	1108	541	APGRM	321	789	1110	540	APGRM	321	787	1108	541	APGRM
321	789	1110	540	APGRM	320	790	1110	540	APGRM	321	789	1110	540	APGRM	320	790	1110	540	APGRM
319	789	1108	541	APGRM	321	789	1110	540	APGRM	322	787	1109	541	APGRM	322	789	1111	540	APGRM
321	787	1108	541	APGRM	320	789	1109	541	APGRM	320	789	1109	541	APGRM	319	790	1109	541	APGRM
320	790	1110	540	APGRM	321	789	1110	540	APGRM	321	789	1110	540	APGRM	320	789	1109	541	APGRM
321	789	1110	540	APGRM	320	789	1109	541	APGRM	320	789	1109	541	APGRM	320	790	1110	540	APGRM
321	789	1110	540	APGRM	322	790	1112	539	APGRM	321	789	1110	540	APGRM	323	789	1112	539	APGRM
322	789	1111	540	APGRM	321	789	1110	540	APGRM	320	789	1109	541	APGRM	322	790	1112	539	APGRM
320	792	1112	539	APGRM	320	791	1111	540	APGRM	320	791	1111	540	APGRM	321	788	1109	541	APGRM
322	789	1111	540	APGRM	322	789	1111	540	APGRM	320	790	1110	540	APGRM	321	790	1111	540	APGRM
321	790	1111	540	APGRM	321	790	1111	540	APGRM	321	790	1111	540	APGRM	321	788	1109	541	APGRM
321	791	1112	539	APGRM	320	790	1110	540	APGRM	320	791	1111	540	APGRM	320	791	1111	540	APGRM
321	790	1111	540	APGRM	320	790	1110	540	APGRM	322	789	1111	540	APGRM	320	790	1110	540	APGRM
321	788	1109	541	APGRM	320	789	1109	541	APGRM	321	790	1111	540	APGRM	321	789	1110	540	APGRM
319	791	1110	540	APGRM	320	789	1109	541	APGRM	322	790	1112	539	APGRM	321	790	1111	540	APGRM
322	787	1109	541	APGRM	321	789	1110	540	APGRM	320	789	1109	541	APGRM	320	790	1110	540	APGRM
321	790	1111	540	APGRM	319	791	1110	540	APGRM	321	789	1110	540	APGRM	321	790	1111	540	APGRM
320	790	1110	540	APGRM	322	790	1112	539	APGRM	319	790	1109	541	APGRM	321	788	1109	541	APGRM
321	789	1110	540	APGRM	322	789	1111	540	APGRM	321	790	1111	540	APGRM	322	788	1110	540	APGRM
321	789	1110	540	APGRM	320	788	1108	541	APGRM	320	789	1109	541	APGRM	319	790	1109	541	APGRM
319	791	1110	540	APGRM	320	788	1108	541	APGRM	323	788	1111	540	APGRM	321	788	1109	541	APGRM
322	788	1110	540	APGRM	321	788	1109	541	APGRM	320	791	1111	540	APGRM	320	790	1110	540	APGRM
320	790	1110	540	APGRM	320	789	1109	541	APGRM	321	790	1111	540	APGRM	320	789	1109	541	APGRM
320	791	1111	540	APGRM	321	790	1111	540	APGRM	320	791	1111	540	APGRM	320	790	1110	540	APGRM
322	789	1111	540	APGRM	321	792	1113	539	APGRM	321	790	1111	540	APGRM	321	790	1111	540	APGRM
321	790	1111	540	APGRM	319	791	1110	540	APGRM	320	790	1110	540	APGRM	320	790	1110	540	APGRM
320	790	1110	540	APGRM	321	791	1112	539	APGRM	321	789	1110	540	APGRM	321	790	1111	540	APGRM
322	790	1112	539	APGRM	321	790	1111	540	APGRM	320	790	1110	540	APGRM	320	791	1111	540	APGRM
321	791	1112	539	APGRM	322	790	1112	539	APGRM	320	790	1110	540	APGRM	321	790	1111	540	APGRM
320	790	1110	540	APGRM	320	792	1112	539	APGRM	319	791	1110	540	APGRM	321	791	1112	539	APGRM
320	790	1110	540	APGRM	322	788	1110	540	APGRM	322	790	1112	539	APGRM	321	790	1111	540	APGRM
320	790	1110	540	APGRM	322	790	1112	539	APGRM	320	791	1111	540	APGRM	320	792	1112	539	APGRM
320	790	1110	540	APGRM	321	791	1112	539	APGRM	321	789	1110	540	APGRM	322	789	1111	540	APGRM
323	789	1112	539	APGRM	320	791	1111	540	APGRM	319	791	1110	540	APGRM					

The limits of the method applicability

The proposed method of transferred power measuring is targeted to be used only if the relative error of obtained results is sufficiently small. From formulas (9) error is calculated and it shows that in any case, the estimated power relative error will be greater than the greatest relative errors in the square root. At sufficiently large number of measurements errors δj_Σ and δk^2 do not exceed a few tenths of a percentage, δf less than 0.5%.

Torsional stiffness relative error which is experimentally determined does not exceed one percent. Thus, applicability of the proposed method boundaries are defined only by torsion angle detection error $\delta\varphi$.

To reduce the torsion angle calculation error it is target to calculate the torsion angle φ by the formula (1) and the rotational speed ratio k using rather separately calculated average values of i_1, i_2, j_1 and j_2, but each revolution-calculated average values i_Σ and j_Σ, as well as i_1/i_Σ and j_1/j_Σ. There by reducing the rotational

speed fluctuations of any errors. The above mentioned is illustrated on board ship PIRITA obtained data in power measurements , using only separately calculated i_1, i_2, j_1 and j_2 average values:

$i_1 = 3066 \pm 2$, $\delta i_1 = 0{,}00064$, $i_2 = 1271 \pm 1$, $\delta i_2 = 0{,}0007$,

$j_1 = 789{,}0 \pm 0{,}1$, $\delta j_1 = 0{,}00010$, $j_2 = 320{,}6 \pm 0{,}1$, $\delta j_2 = 0{,}0002$,

Then

$$\Delta i_\Sigma = \sqrt{(\Delta i_1)^2 + (\Delta i_2)^2} = \sqrt{2^2 + 1^2} = 2{,}24 , \quad \delta i_\Sigma = \frac{\Delta i_\Sigma}{i_\Sigma} = \frac{2{,}24}{4337} = 0{,}00052$$

$$\Delta j_\Sigma = \sqrt{(\Delta j_1)^2 + (\Delta j_2)^2} = \sqrt{0{,}1^2 + 0{,}1^2} = 0{,}141 , \quad \delta j_\Sigma = \frac{\Delta j_\Sigma}{j_\Sigma} = \frac{0{,}141}{1109{,}6} = 0{,}00012$$

$$\delta(i_1/i_\Sigma) = \sqrt{(\delta i_1)^2 + (\delta i_\Sigma)^2} = \sqrt{0{,}00064^2 + 0{,}00052^2} = 0{,}00082$$

$$\delta(j_1/j_\Sigma) = \sqrt{(\delta j_1)^2 + (\delta j_\Sigma)^2} = \sqrt{0{,}00010^2 + 0{,}00012^2} = 0{,}00016$$

$$\Delta\varphi = 2\pi \sqrt{(\Delta(j_1/j_\Sigma))^2 + (\Delta(i_1/i_\Sigma))^2} = 2\pi \sqrt{0{,}00016^2 + 0{,}00082^2} = 0{,}0052 ,$$

$$\delta\varphi = \frac{\Delta\varphi}{\varphi} = \frac{0{,}00522}{0{,}0266} = 0{,}196 .$$

$$\delta k^2 = 2\sqrt{(\delta i_\Sigma)^2 + (\delta j_\Sigma)^2} = 2\sqrt{0{,}00052^2 + 0{,}00012^2} = 0{,}00106 .$$

$$\delta P_2 = \sqrt{(\delta c)^2 + (\delta\varphi)^2 + (\delta f)^2 + (\delta j_\Sigma)^2 + 2(\delta k^2)^2} =$$

$$= \sqrt{0{,}0080^2 + 0{,}196^2 + 0{,}005^2 + 0{,}00012^2 + 2 \cdot 0{,}00106^2} = 0{,}197 ,$$

$$\Delta P_2 = P_2 \cdot \delta P_2 = 209 \cdot 0{,}197 = 41 \text{ kW} .$$

Example of calculation this error shows that the irrational error calculation on the same output data, the apparent error increases significantly – about 7 times at the given example.

As calculations shows, the resulting accuracy is mainly determined by the torsion angle φ calculation error. In order to obtain results with acceptable levels of relative error $[\delta\varphi]$, the torsion angle satisfy the inequality

$$\varphi > \frac{\Delta\varphi}{[\delta\varphi]} , \text{ where } \varphi = \frac{M}{c}$$

At a sufficiently large number of measurements that are made with the authors used equipment, it is not difficult to ensure $\Delta\varphi$, which does not exceed 0.1%. So, if $[\delta\varphi] = 5\%$,

$$c < 50 \cdot M \approx \frac{500\ P}{n} \qquad (10)$$

where the rotational frequency n is expressed in revolutions per minute.
If the marks 1 and 2 (Fig. 1). are glued at cylindrical shaft section with diameter d and length L, then

$$c = \frac{G J_p}{L} \qquad (11)$$

where G - shaft material shear modulus,

$J_p = \dfrac{\pi d^4}{32}$ – inertial polar moment of the shaft cross-sectional area.

Shaft spinning provision is $$\frac{16\,M}{\pi\, d^3} \le [\tau] \quad , \qquad (12)$$

where [τ] - shaft material allowable tangential stress.

When you insert in disparities (10) c expression (11) and from inequalities (12)'s torque M expression, after truncation we find

$$\frac{L}{d} > \frac{G}{100\,[\tau]}$$

Since the steel shaft $G \approx 8 \cdot 10^4$ MPa and $[\tau] \approx 40$ MPa then we conclude that the distance L between the marks 1 and 2 (Figure 1) must be at least 20 d. If the full strength of the shaft is not used, the distance should be greater between the marks.

Summary

The authors developed and tested propeller shaft transferred power measuring method allows to:

• determine propeller shaft transferred power with a sufficient accuracy at various propeller speeds on pier moored vessel without labour-intensive experiments to;

• to determine the confidence interval of the obtained results;

• assess compliance propeller with the engine.

As the proposed method results are recognized in the Latvian Maritime Administration, the method opens wide opportunities to be used for performance testing at small vessels. Results of these tests may be eligible for a variety of relief in operation and the EU quotas.

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THE METHOD OF STARTING AIR SYSTEM ROUGH CALCULATION

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Abstract
The paper deals with diesel compressed air starting system calculation method based on the comparison between the compressed air efficient work and the work consumed by the air compression in the engine cylinder during the compression stroke. Approximate engine starting time duration depending on pressure in starting air receiver correlations were found, as well as compressed air consumption. The approximate correlations for calculating pressure drop in receivers depending on the receiver volume and the volume of air consumption at engine starting were given. The calculation of starting process using found out correlations was made for six cylinder slow speed engine as an example.
Keywords: *starting system, efficient work, air receiver*.

Introduction

Over the past 20 years, the design of ships main engine has undergone radical changes. The notable change of cylinder thermodynamic work cycle parameters (air compression pressure and combustion pressure) are observed. An increase of these parameters is associated with the need to increase the relative power and the cylinder indicated power efficiency.

Significantly increasing the engine stroke to diameter ratio from *1.7* to *2.2 - 2.5* have increased thermal and mechanical loads.

In the calculation on the basis of LPG tanker's "Kurzeme" [4] main engine MAN B & W 6S50 MC parameters, it is evident that the ratio p_z / p_c , or so-called pressure increase ratio (Lambda), at significant increase in the parameters has been reduced to *1.1 – 1.3* instead of previous *1.4-1.5*. The compressed air pressure in cylinder is equal to *9.8-10.0 MPa* and the maximum combustion pressure reaches *13.0 MPa*. Such changes in construction and parameters are making a significant impact on engine starting and reversing processes. These processes are significant for main engines coupled directly to the ship's propeller nevertheless they are operated shortly. Although the changes in parameters have been made the pressure in starting air vessel remains the same - maximum *3.0 MPa*.

It is necessary to perform calculations to determine the possibility to ensure engine starting and reversing processes in future due to p_z and p_c parameters continue to grow.

Starting duration and rotation speed of crankshaft at the end of starting

First, let's look at two-stroke engines, in which the compressed air is supplied to all cylinders during starting.

The work made by air during one revolution of crankshaft at starting of engine

$$W_1 = W_1^{*} + W_1^{**} \ , \qquad (1)$$

where W_1^{*} – the work made by compressed air during the air supply
W_1^{**} – the work made by compressed air after the air supply suspension [7]

$$W_1^* = A \cdot p_g \cdot s_2 \ ; \quad W_1^{**} = \frac{p_g \cdot V_2}{n_1 - 1}\left\{1 - \left(\frac{V_2}{V_3}\right)^{n_1 - 1}\right\}$$

where A – the area of cylinder,

p_g – the pressure of compressed air in the system,

s_2 – piston displacement from TDC to the point at which compressed air supply suspended

n_1 – the polytropic index

V_2 – the volume of cylinder when air supply is suspended,

V_3 – the volume of cylinder when exhaust is commenced

The work consumed during the compression W_2 is calculated as follows [7]:

$$W_2 = \frac{p_a \cdot V_4 - p_c \cdot V_c}{n_1 - 1} \qquad (2)$$

where

p_a – atmospheric pressure, V_4 – the volume of cylinder when exhaust is commenced,

p_c , V_c – the air pressure and the volume of cylinder at TDC

Assuming that the water resistance force to the rotation is proportional to the propeller's angular velocity squared [3]

$$M_{prop} = k \cdot µ^2$$

and friction losses taken into account the efficiency at engine starting ¦ , the efficient work W achieved by engine with z cylinders during one revolution of the crankshaft could be approximately determined as follows:

$$W = z(¦ \cdot W_1 + W_2) - 2® \cdot k \cdot µ^2 . \qquad (3)$$

According to the theorem of kinetic energy change, crankshaft angular speed of one revolution in the engine at starting to be determined from the relationship:

$$0{,}5\ J_{red} \cdot \omega^2 = W$$

or, taking in account expression, $$0{,}5\ J_{red} \cdot \omega^2 = z(¦ \cdot W_1 + W_2) - 2® \cdot k \cdot µ^2 ,$$

where J_{red} - simplified moment of inertia of the crankshaft with the pistons, connecting rods, flywheels, shaft and propeller.

After N revolutions:

$$0{,}5\ J_{red} \cdot \omega^2 = N\,[\, z(¦ \cdot W_1 + W_2) - 2® \cdot k \cdot µ^2 \,] ,$$

Whence we find:

$$N = \frac{0{,}5\ J_{red} \cdot \omega^2}{z(¦ \cdot W_1 + W_2) - 2® \cdot k \cdot µ^2} \qquad (4)$$

Assuming that the crankshaft moves steadily accelerated at engine starting, starting time t determined from the relationship:

$$t = \frac{4\,\pi \cdot N}{\omega} \qquad (5)$$

The calculation of work amount in four-stroke engines, in which the compressed air is supplied to all cylinders during starting, is made by equations (1) and (2). The work is done per 2 revolutions of the crankshaft and whole volume of cylinder is V_3 and V_4. So the work per revolution is calculated by the formula

$$W = 0{,}5\, z\cdot(¦\cdot W_1 + W_2) – 2®\cdot k \cdot µ^2 \qquad (6)$$

and number of the crankshaft revolutions till angular velocity achieve µ

$$N = \frac{J_{red} \cdot \omega^2}{z\cdot(¦\cdot W_1 + W_2) – 4®\cdot k \cdot µ^2} \qquad (7)$$

For engines, in which during the starting period the air is supplied only to half of cylinders, z should be replaced with z/2 in formulas (3), (4), (6) and (7).

The consumption of compressed air and necessary volume of starting air receiver

The consumption of compressed air for one cylinder during one revolution of the crankshaft is slightly less than V_2 . So during *N* revolutions total air consumption is:

$$Q < N \cdot z\cdot V_2 \; .$$

As the compressed air receivers must run at least *n* times, the total air consumption will be:

$$Q_{\Sigma} = z\cdot V_2 \cdot \sum_{i=1}^{n} N_i \; , \qquad (8)$$

where N_i – number of revolutions of the crankshaft at *i*-starting time

Based on the Clapeyron equation, the pressure drop Δp_i in starting air receiver at *i* starting time calculated as follows:

$$\Delta p_i = p_{oi} – p_i = p_{oi} \; \frac{Q_i}{V_{rec}} \; , \qquad (9)$$

where p_{oi} , p_i – the pressure in starting air receiver at *i*-starting time beginning and the end

Q_i – the consumption of the air at *i*-starting time, V_{rec} – the volume of the starting air receiver.

For four-stroke engines, in which during the starting period the air is supplied only to half of cylinders, *z* should be replaced with *z/4* in formula (8) and for two-stroke engines z should be replaced by *z/2*

Example of calculation

By way of example let's look at 12-cylinder two-stroke engine with a nominal power of *9880 kW* at the rotation frequency of *114 RPM*. Cylinder diameter of *424 mm*, stroke - *1944 mm*, crank length to connecting rod length ratio - *0,5*. Crankshaft with piston group, a flywheel, the propeller drive shaft and propeller simplified moment of inertia is $224000\ kg{\cdot}m^2$. Resistance moment of the propeller rotation $M_{prop} = 5800 \cdot µ^2 \;\; N{\cdot}m$.

The exhaust commences at the angle of *120 degree* of crankshaft rotation $\varphi_3 = 120^o$ in relation to TDC. The exhaust valve closes at the angle of *240 degree* of crankshaft rotation $\varphi_3 = 240^o$ in relation to TDC. Compressed air pressure at the first starting time is $p_g = 3.0\ MPa$. The polytropic index is taken as $n_1 = 1{,}35$ and mechanical efficiency during engine starting $\eta = 0{,}8$.

The angular speed of the crankshaft µ and consumption of air after *N* number of crankshaft revolution is calculated. Also the time of revolutions at different interruptions of air supply to cylinders which is determined by the angle ¨$_2$ is calculated. In the case when compressed air is supplied to all cylinders, the result of the calculation is graphically shown in Figure 1. In the case when compressed air is supplied only to half of all cylinders, the result of the calculation is graphically shown in Figure 2.

From the diagrams it is possible to obtain that in the case, when the air is supplied to all cylinders - the lowest consumption of the air at one starting time is then angle φ_2 , which is approximately 60^o. But in the case when air is supplied only to half of cylinders angle φ_2 is approximately 90^o.

The consumption of the air during one starting time and starting time duration at optimal φ_2 values when the air pressure in system is reduced are calculated and the results are diagrammatically shown in Figure 3. From this diagram it is obtained that the consumption of the air and duration of the start is slightly increased. The summary of air consumptions and the remaining air pressure in the air receiver depending on the number of starts and different volumes of starting air receivers are calculated by formulas (8) and (9). The results are diagrammatically shown in Figure 4.

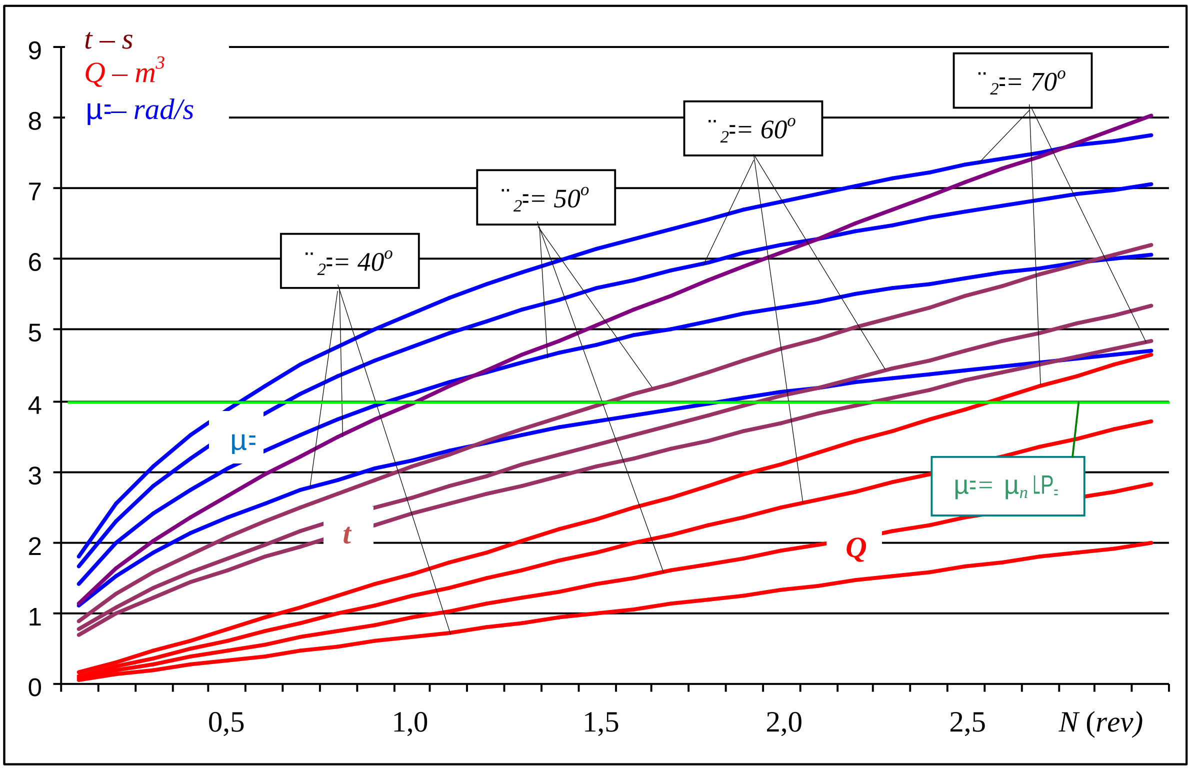

Figure 1. The angular speed of the crankshaft µ and consumption of air after *N* number of crankshaft revolution, when air is supplied to all cylinders

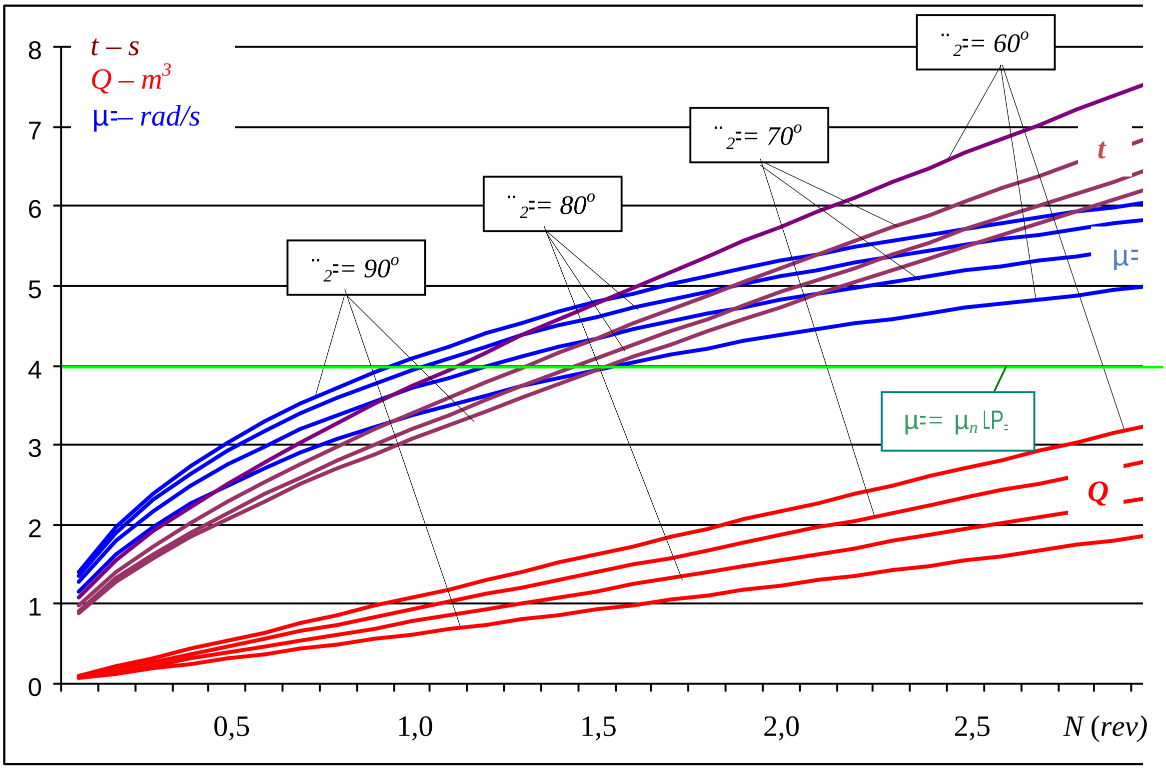

Figure 2. The angular speed of the crankshaft µ and consumption of air after *N* number of crankshaft revolution, when air is supplied to half of all cylinders.

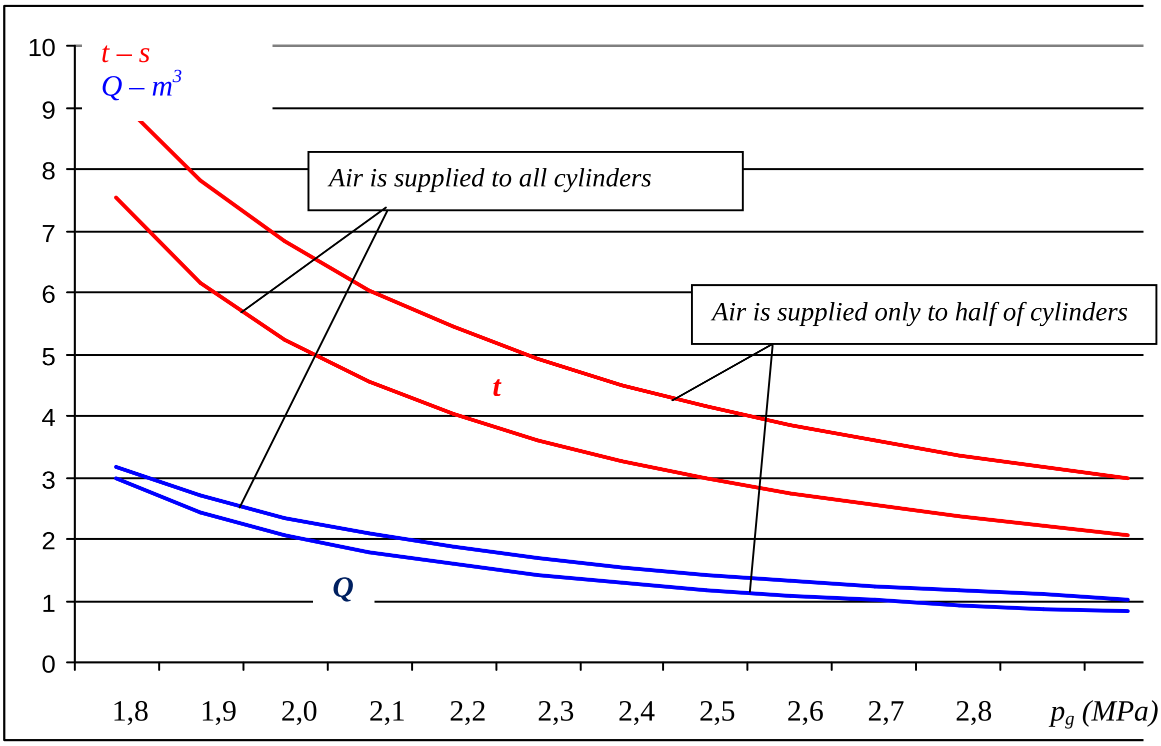

Figure 3. Compressed air consumption and starting time duration depending on the pressure in staring system.

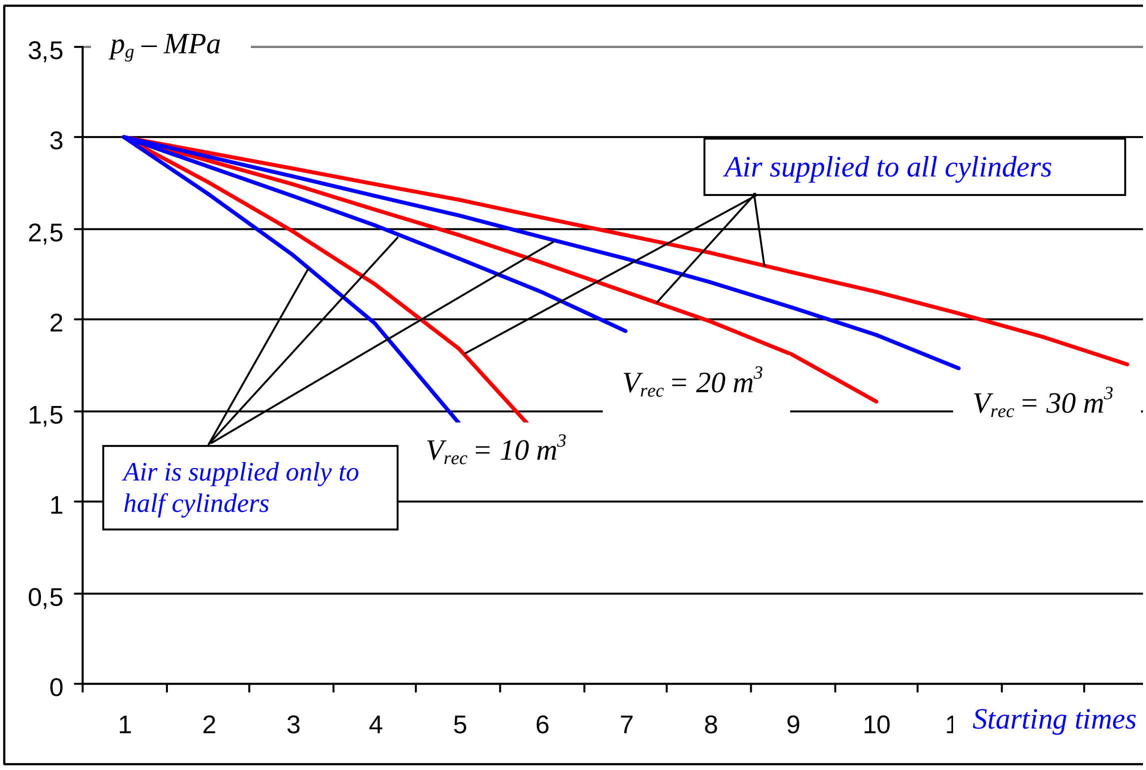

Figure 4. The air pressure in the air receiver before each starting time.

Conclusions

The paper offers a simplified calculation method of starting and reversing processes.

Knowing the compression pressure in cylinder, air pressure in starting air system and engine propulsion arrangement's parameters this method allows, without complex calculations, to determine the key starting and reversing parameters of engine - the engine starting time duration, necessary number of crankshaft revolutions and air supply suspension angle, starting air receiver's volume and air consumption during engine starting.

The method can be useful for marine engineers, also for ship designers for evaluation in designing new or redesigning existing propulsion systems.

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CLUSTER BASED APPROACH AS TOOL FOR INCREASING COMPETITIVENESS OF FREEPORT OF RIGA

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Abstract
The cluster-based approach offers a new way of dividing and understanding an economy and competitiveness. Cluster environment stimulates competitiveness and competition inside the cluster and the industry. Some explanation of the current problems of Latvia's competitiveness deals with the level of co-operation and business integration of business entities into the national economy of Latvia and Freeport of Riga in particular. Companies are isolated into their approaches to increase their competitiveness and enter the global market. In many cases it is too hard a task for a single company. The co-operation and integration of business entities co-operation is a gateway to integrated development and higher competitiveness in the global markets. Cluster environment is stimulating integrated development of all the business entities within the cluster. The main objective of the presented paper is to find out the industrial cluster influence on business competitiveness and integrated development of the Freeport of Riga.
Keywords: *cluster, competitiveness, co-operation, development, Freeport.*

Introduction

Rapid integration with the global economy, sustained growth (8-10% of GDP per annum) in Latvia over years 2004-2007 was not only a good example of successful transition economies, but has also made the country more vulnerable to contagion during the economic crisis that is now having dramatic consequences in Latvia (shrinking of GDP about 25% in 2008-2010 and following growth rate 5.5% in 2011). Government, companies and economic experts are trying to analyze mistakes of the past and find the way out of economic recession and build the fundament for competitive national economy by managing conservative fiscal policy and planned joining to euro area in 2014, and it's sustainable development in the future.

The term "competitiveness" and "integration" are used more and more in the context of economy's performance. These concepts may be discussed on different levels: countries, regions, industries and companies. In general country's level of competitiveness can be measured by Global competitiveness index - Latvia has only 64th place between 142 other countries in the year 2011-2012. The index is significantly lower comparing to majority of other European Union countries, including our neighbor countries – Lithuania (44) and Estonia (33) [27]. There are many factors to be analyzed but the one which indicates integrated development tendency and co-operation is *state of cluster development* index, which measures how prevalent are well-developed and deep clusters. Unfortunately this is one of the weakest points of the country – we are far behind to more advanced countries.

A cluster initiative offers a comprehensive assessment of a cluster's markets, products, linkages, externalities, and synergies to help identify regulatory and business constraints, find new and wider market opportunities. Strategic initiatives may vary by different cases, but often focus on improving market information, workforce development, supply chain improvements, common quality standards, branding, integration and process improvements. Cluster initiative around the world show the crucial element of initiative development is the creation of a platform for meaningful dialogue within the cluster, to develop business strategies, and with the public sector, to discuss policy changes and possibly financial support. [10] "Co-operation" and "competition" are the key words to describe cluster environment. [18]

The Freeport of Riga is a significant part of global and regional cargo supply chains and passenger traffic network in the Baltic Sea region, providing safe and reliable services. An integral part of the city, the Freeport recognizes its social and environmental responsibilities and makes a strong contribution to the growth of Latvia's economy.

Unfortunately, because of the lack of positive historical experience, the level of integration and co-operation among companies in Latvia is underdeveloped and in many cases term "competitor" is similar to "enemy", which you must weaken and destroy. This is by no means a good environment for collaboration and development. Companies are isolated in their approaches to enter into new markets and in many cases these approaches could be more successful if proper strategy would be selected. It is particularly important to take in to account the specific feature of the national economy of Latvia – all the companies are small or medium sized according to the global market standards. It is essential for the companies to co-operate and integrate to be competitive, increase their export potential and be successful in the global markets.

The hypothesis of the paper is: Cluster environment in Freeport of Riga may enlarge the level of co-operation between different enterprises and induces integrated development of enterprises in diverse industries. The aim of the paper is to find out how cluster environment in Freeport of Riga can stimulate companies' integrated development and competitiveness.

There are several tasks to be solved to achieve the aim:

- to describe the most important aspects of ports' cluster environment and integration,
- to identify the linkage among cluster environment, integration and competitiveness,
- to describe the Freeport of Riga business and institutional situation,
- to develop cluster approach proposals to increase port's competitiveness.

The methods applied are as follows: monographic method, method of logical analysis and synthesis, analysis of statistical information, expert method.

Facts and Figures about the Freeport of Riga

An integral part of the city, the Free port of Riga recognizes its social and environmental responsibilities and makes a strong contribution to the growth of Latvia's economy. Due to economic crises in former years, and according to provisional calculations operation of the Freeport of Riga provides approximately 3.5 % from the gross domestic product in 2011. The port is not just a ''spender" of tax payers' money, but it is the major tax payer: the Freeport Authority together with port enterprises pay state taxes in the amount of 350-420 million euro per year. Operation of the port has a multiple influence and currently income on average is 14 euro for each reloaded ton of cargo. Share of the Baltic countries biggest ports in 2011 were following: Riga -9.4%, Klaipeda -9.9%, Tallin -9.9%, Ventspils -7.7%, and Liepaja -1.1% from the total sea bound cargo volume 361 million tons of the Baltic see East-North region [28]

Freeport of Riga lies on the both banks of the River Daugava covering 15 kilometres in length, land of the port 1 962 ha, port water area 4 386 ha, total length of berths, maximum permissible vessel draft by the berth 12.2 meters. The Port is open for navigation all year round. Loading capacity (assessed) at the terminals of the Freeport of Riga accounts for 45 million tons per annum. In 2011 the volume of the transhipped cargoes has reached 34.07 million tons – it was the highest index during all the 805 years of Riga port activities. Having transshipped 9.48 million tons of cargos or 25% of the total amount of cargos transshipped in this region in the first quarter of this year, the Port of Riga has with certainty become the leader among ports of the Baltic States. It should be noted that per the amount of handled cargos the Port of Riga is also the third among the fourteen ports on the eastern shore of the Baltic Sea.

Main types of cargo handled at the Freeport are coal, containers, mineral fertilizers, timber, petrol and food products. 32 stevedore companies and 35 shipping agents successfully operate at the Freeport of Riga. The Law on the Freeport of Riga defines general principles of the Freeport of Riga activities and a procedure of the free zone regime application: fulfilling certain requirements business companies can conclude an agreement on activities under free economic zone regime. Licensed business companies have the opportunity to apply direct tax relief for the investment in their fixed assets that are used at least five years. [14] Increase of activity of the Port of Riga can be explained with improvement of infrastructure and deepening of ship passes which allows bigger vessels to enter the Port of Riga and notably improve competitiveness of the Port of Riga. The number of vessels with capacity above 40 000 GT that have entered the port approve the fact. This year such vessels form one third part of all ships that have entered the port, while last year there were only 3 vessels of such capacity in the accordant period of the last year. 928 traders have entered the Freeport of Riga in the first three months of 2012. The number of vessels in the period of account has increased by 6%, and simultaneously total GT of vessels has also increased by

9%. Approximately 81% of all cargos transshipped in the first quarter of 2012 were transit cargos. 8.4 million tons were forwarded with vessels from the port, but 1.1 million tons of cargos were received. [29]

Vision of the Freeport of Riga development is to stay as a leading port of the Baltic States and a source of real prosperity for Latvia.

There is a very weak tendency to co-operate between Freeport of Riga and other big ports in Latvia – Ventspils, Liepaja and small ports. Co-operation between different ports in Latvia may increase competitiveness in the global market and therefore compete more successfully with other ports in the Baltic Sea Region. Further sustainable development and competitiveness increasing are the key questions for Freeport of Riga and requires new methods to reach it. One of them is the cluster based approach.

Cluster based approach – opportunity for port development and competitiveness

Macro-economic tendencies show that Freeport of Riga is located in a region of dynamically growing countries. On the one hand, it opens good perspectives for increase of cargo volume, on the other hand – high competitiveness and unstable political climate exists in the region. Just like in the rest of the world, decrease of growth speed can be observed in this region along the economic recession. In the present global crisis it is facing a particularly steep decline for a number of reasons and the current recession is expected to significantly impact the economy growth also for the coming years. There is a very week tendency to co-operate between the Freeport of Riga and other ports in Latvia – Ventspils, Liepaja and other ports. Co-operation between different ports in Latvia may increase competitiveness in the global market and therefore compete more successfully with other ports in the Baltic Sea Region. Further sustainable development and competitiveness increasing are the key questions for the Freeport of Riga and requires new methods to reach it. One of them is the cluster based approach.

The significance of cluster approach is although emphasized by the European Union (EU). Council of the European Union has set forming of clusters as one of the top priorities to support innovations and competitiveness. [10] Latvia has followed EU initiatives and cluster development is included in the national level economy strategy. The cluster support program was developed involving government support and EU funds but unfortunately due to budget shortage it was canceled.

Haezendonck is the first scholar who uses the term 'port cluster' and draws from cluster theories. She defines a port cluster as 'the set of interdependent firms engaged in port related activities, located within the same port region and possibly with similar strategies leading to competitive advantage and characterized by a joint competitive position vis-à-vis the environment external to the cluster'. [16] Haezendonck analyzes the performance of a port cluster with an adapted version of Porter's diamond framework [21]. She identifies 14 factors that influence the competitiveness of seaports, including internal competition, internal cooperation, client relationships in the cluster, the presence of related and supporting industries and the behaviour of (different levels of) the government.

The cluster approach recently has been used to analyze ports. Good example of port cluster case study is Antwerp's port cluster, which is annually reported by Bank of Belgium. In this study, a *cluster population* of about 1000 firms, including logistics and industrial firms, is identified. The development of the value added of this cluster is calculated. Hamburg port cluster management good practise shows another possibility to solve complicated competitiveness problems in active business area.

The first step to construct a cluster is to identify the economic specialization of the cluster. In the case of seaports the core specialization is *the arrival of goods and ships*. All activities related to the arrival of goods and ships are included in the port cluster. The importance of favourable geographical conditions, such as the presence of a navigable river and deepwater shelters and the structure of the seabed, combined with economies of scale of port facilities, explain the concentration of the arrival of ships and goods in a limited number of ports (instead of a 'scattered' distribution of terminals along the coast). All economic activities that are required to enable the loading and unloading of cargo and ships are included in the port cluster. These activities include terminal handling, cargo storage, pilot and towage. The arrival of ships and goods attracts related economic activities and therefore ports may be as drivers of agglomeration in cities.

Following on from the vision and mission and to increase the competitiveness of Freeport of Riga statement strategic objectives and strategic initiatives should be defined. The SWOT (Strength, Weaknesses, Opportunities, Threats) Matrix is the outcome from the analysis of Freeport's competitiveness in its overall business context, including geographical, regulatory, financial, environmental, reputation and other aspects. Essential competitiveness determinants as location, tariff policy, financial management, general management issues, infrastructure development, navigation safety, development of port terminals, part safety and security, environmental protection, port as socially responsible entity, marketing strategy are the main topics for port's strengths and weaknesses valuation. Opportunities and threats valuation cover the following topics: infrastructure development, navigation safety, development of port terminals, port safety and security, environment protection, port as socially responsible entity and marketing strategy.

The SWOT Matrix identifies factors, internal and external, which have or may have a positive or negative impact on the realization of its strategic targets. Internal aspects include advantages and strengths and weaknesses arising from the port's internal resources. External aspects cover the opportunities and threats emerging from the outside environment. A successful strategy builds upon a thorough SWOT analysis and aims at:

- Making use of the strengths to exploit opportunities;
- Overcoming weaknesses by using the advantages of the opportunities offered;
- Using the strengths to overcome or avoid the threats;
- Making efforts to minimize the weaknesses and threats.

In consideration of the vision and mission statement and the SWOT analysis of the Freeport of Riga for each of previous mentioned areas strategic objectives have been defined and targets have been set against which permanent improvement can be monitored.

The port cluster consists of *all economic activities related to the arrival of goods and ships*. Five broad groups of port cluster activities are identified: *cargo handling* activities, *transport* activities, *logistics* activities, *manufacturing* activities and *trading* activities. Transport activities are part of a port cluster, since a port is a part in a transport chain. Most cargo is transported further by means of inland modes, such as road, rail, and inland waterway. During the last months in Freeport of Riga many complicated problems are solved to develop transport chain seaport – airport, by handling cargo of economic and political importance.

All current Latvian transport corridors are included into TEN-T Nordic Axis network and are located in the close vicinity of the Central Axis with the nearest largest logistic centre in Moscow, easing freight transportation between the northern part of Europe to the Central Europe and further on to Central Asia and Caucasus regions. Motorways of the Sea connect Riga with all TEN-T network ports. Distances by sea from the biggest ports of the Central Europe – Rotterdam, Antwerp, Hamburg – to the ports of the eastern part of the Baltic Sea coastline are the shortest, providing advantage with regards to transportation costs and transit time. In terms of distance, routes through Riga are the shortest providing the possibility of transport cost reduction on rail and road from the Eastern Baltic Sea coast to the biggest cities of the Russian Federation, Belarus, Ukraine and other former Soviet Union countries that are developing as important and growing consumer markets. Riga is integrated into the uniform transport network of the EU, making Riga one of the most advantageous and efficient hub ports in regards to freight transhipment in the Baltic Sea region.

Thus, (branches of) transport firms are located in ports and are so strongly related to the arrival of goods and services that they are included in the port cluster. This applies to all firms involved in freight transport.

Logistics activities, such as storage, re-packing and assembling are included in a port cluster, because goods are stored in ports. This necessity of storage is a reason for locating logistics activities (such as blending and re-packing) in seaports. A second reason is that by locating in a port transport costs can be reduced. Both reasons explain the presence of logistics activities in ports and show that these activities are strongly related to the arrival of goods and ships in seaports. Thus, all logistics activities are included in the port cluster. Within the frameworks of the Freeport of Riga development program new infrastructure projects are being implemented that promote performance of business activities. The Freeport of Riga has a plan to extend borderline of the territory and build new logistic centre.

Specific kind of manufacturing firms are strongly related to the arrival of goods and ships in seaports: those firms get their raw materials from the port and are located in the port in order to reduce transport and logistics costs. A specific set of trading activities could although be included in the port cluster as well. Trading and storage (in a port) are closely linked. Commodity trade is, for some commodities, still related to storage and cargo handling.

Conclusions

Summarizing the cluster environment influence to the integrated development and competitiveness level of the companies, some conclusions can be drawn to understand how collaboration within the cluster may be promoted.

1. The cluster environment increases competitiveness of companies within the cluster by stimulating collaboration, interaction, competition, innovation and increasing efficiency. Favorable conditions for the companies' integrated development are created within the cluster and examples of companies' horizontal and vertical integration can be found in the cluster models. Integrated co-operation among leading enterprises, related enterprises and support enterprises, deepening value chains to produce more value added production are the key factors to be competitive in the global markets. The economic power of the company can increase in the cluster environment.

2. Clusters can create tangible economic benefits:

- Companies can operate with a higher level of efficiency, drawing on more specialized assets and suppliers with shorter reaction times than they would be able to in isolation.
- Companies and research institutions can achieve higher levels of innovation. Close interaction with customers and other companies create more new ideas and create pressure to innovate while the cluster environment lowers the cost of experimenting.
- The level of business formation tends to be higher in clusters. Level of trust is increasing within the cluster at same time reducing the costs of failure, as entrepreneurs can fall back on local employment opportunities in the many other companies in the same field.

3. Structure, activities and development level of Freeport of Riga are the main evidence for implementation cluster approach to increase their international competitiveness. The cluster environment increase competitiveness of companies within the cluster by stimulating collaboration, interaction, competition, innovation and increasing efficiency. The economic power of the company can increase in the cluster environment, and it is an evidence for developing cluster in the Freeport of Riga.

4. Successful implementation clusters approach in the Freeport of Riga can create tangible economic benefits:

- Companies can operate with a higher level of efficiency;
- Companies in co-operation with research institutions can achieve higher levels of innovation;
- Level of trust is increasing within the cluster at same time reducing the costs of failure.

5. As theoretical conception and good experience in foreign countries show it is useful to implement clusters' approach to successfully realize such ambitious development programmes as those worked out in the Freeport of Riga. Taking into account the Freeport's mission and vision of development and giving a full appraisal of its existent internal and external problems it is recommended to create three level clusters in certain time scale:

- Industrial business cluster inside the Freeport of Riga;
- Territorial cluster for Riga region, where the Freeport is included as one of the most important members;
- Transport cluster (national or may be international regional), where Freeport of Riga is included as member.

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MARITIME DELIMITATION OF LATVIAN WATERS, HISTORY AND FUTURE PROSPECTS

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Abstract
Maritime delimitation of Latvian waters was one of the important issues since Latvia has gained independence from USSR in 1991. The United Nations Law of the Sea convention, 1982 was not yet in force by that time, nevertheless the basic provisions of this convention have been applied when negotiating the sea borders with the Estonia and Lithuania. These negotiations resulted in Agreement with Estonia in 1996 and Agreement with the Lithuania in 1999. The letter Agreement still has been applied on preliminary base as not ratified by Latvian Parliament – Saeima. As to Latvian and Swedish waters delimitation, bilateral agreement of delimitation the Exclusive Economic Zone (EEZ) and Continental Shelf (CSh) is still pending, Tripartite agreement on common point between Estonia, Sweden and Latvia has been signed in 1997. Solution of this uncertain situation of delimitation of Latvian EEZ and CSh between Lithuania and Sweden is still an urgent task for Latvia.
Keywords: *delimitation, equitable solution, equidistance.*

Introduction

Delimitation principles for maritime zones have been prescribed by the United Nations Law of the Sea convention, 1982 (UNCLOS 1982).This convention now is in force in Latvia and also in our neighbouring States. In Article 15 of this convention in regard to territorial sea reference is made to the "method of the median line every point of which is equidistant from the nearest points on the baselines from which the breadth of the territorial seas of each of the two States is measured" and *„The above provision does not apply, however, where it is necessary by reason of historic title or other special circumstances to delimit the territorial seas of the two States in a way which is at variance therewith".*

As to delimitation of the Exclusive Economic Zone (EEZ) between States with opposite or adjacent coasts the provisions of Article 74 of UNCLOS 82 prescribe*:*

„1. The delimitation of the exclusive economic zone between States with opposite or adjacent coasts shall be effected by agreement on the basis of international law, as referred to in Article 38 of the Statute of the International Court of Justice, in order to achieve an equitable solution.

2. If no agreement can be reached within a reasonable period of time, the States concerned shall resort to the procedures provided for in Part XV.

3. Pending agreement as provided for in paragraph 1, the States concerned, in a spirit of understanding and cooperation, shall make every effort to enter into provisional arrangements of a practical nature and, during this transitional period, not to jeopardize or hamper the reaching of the final agreement. Such arrangements shall be without prejudice to the final delimitation."

All these UNCLOS 1982 provisions have been applied when negotiating with Estonia and Lithuania, partly also with Sweden. When considering term *„equitable solution"* we may look at the Oxfords Dictionary, were *„equitable"* is – fair, just, reasonable, and *"Equity"* – fairness, right judgement, principles of justice outside common law or Statute law, used to correct laws when these would apply unfairly in special circumstances. These principles of "justice outside common law" have been applied in many cases and vast experience gained internationally based on many decisions of International Court of Justice. [5]

Maritime delimitation with Estonia

Negotiations between delegations of Estonia and Latvia on Maritime delimitation have been started since 1991. Most of the difficulties to reach mutually acceptable agreement on delimitation were in connection with fishery interests. In spring 1995 differences of positions of both countries escalated even so that navy patrol boats were involved in the control of disputed area. Nevertheless negotiations were not terminated and in 1996 they resulted in „Agreement between the Republic of Estonia and the Republic of Latvia on the Maritime Delimitation in the Gulf of Riga, the Strait of Irbe and the Baltic Sea, 12 July

1996” which soon was ratified by both countries. Details of these negotiations are described in Vol. IV, American Society of International Law, International Maritime Boundaries, 2002. [6] This Agreement confirmed 15 points of delimitation and from point 15 also a straight geodetic line in the azimuth of 289°19.35' up to the boundary of the exclusive economic zone and the continental shelf of the Kingdom of Sweden. [1]

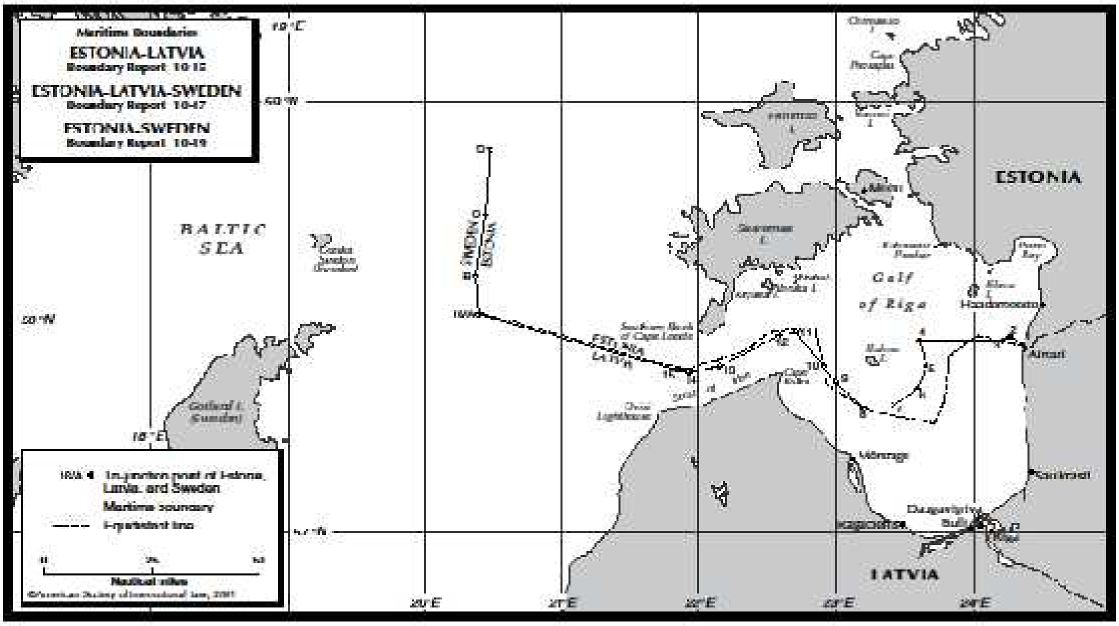

Figure 1. Delimitation map when negotiating Agreement between the Republic of Estonia and the Republic of Latvia on the Maritime Delimitation in the Gulf of Riga, the Strait of Irbe and the Baltic Sea, 12 July 1996. [6]

In April 1997 the Agreement between the Government of the Republic of Estonia, the Government of the Republic of Latvia and the Government of the Kingdom of Sweden on the Common Maritime boundary Point in the Baltic Sea was signed confirming this important common point in position 58° 01.440’N, 20°23.775’E. [2]

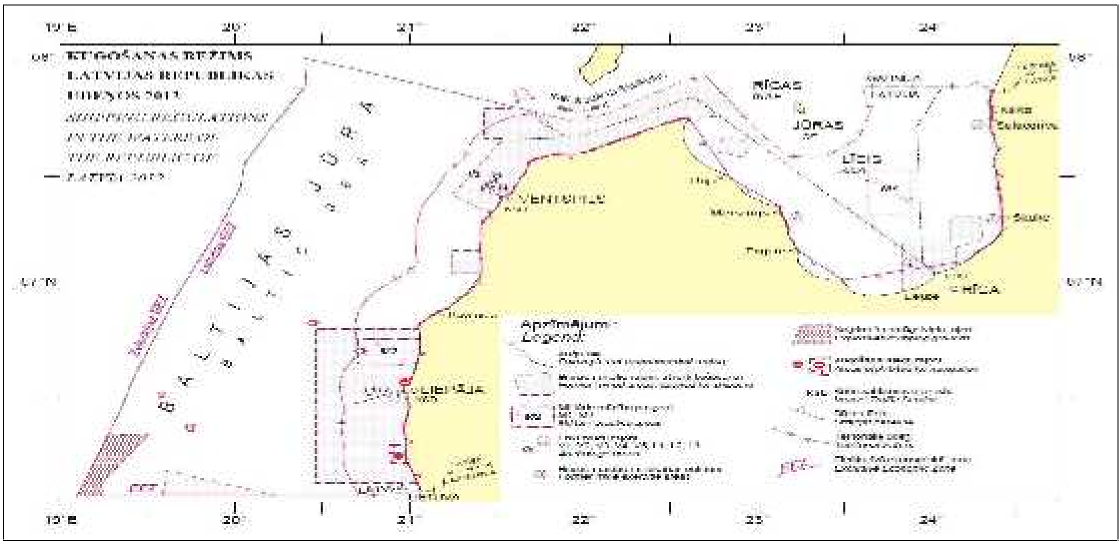

Figure 2. Delimitation of Latvian waters as published in the Notices to Mariners of Maritime Administration of Latvia [11]

These two Agreements, of 12 July 1996 (with Estonia) and of April 1997 (on tri-point with Estonia and Sweden) are giving solid base for good neighbourhood relations with Estonia and also for further spatial planning of relevant maritime area. At the same time some specific situation in connection with

Latvian national legislation, i.e., the Law “On the State Border of the Republic of Latvia” it should be noted in regard to territorial sea outer limit in the Gulf of Rīga area. This issue is discussed more in detail in part 4 of this paper.

Maritime delimitation with Lithuania

Negotiations between Latvia and Lithuania on maritime delimitation have been commenced since late 1993. Drastic differences in proposals of delimitation were noted from both countries from very beginning of these negotiations. In relation to territorial sea Latvia proposed prolongation of land border direction at sea, so applying historical method. That was declined by Lithuanian delegation. Then Latvian delegation gave in and proposed delimitation of territorial sea by equidistance from the relevant coast method. That proposal also was declined by Lithuanian side.

As to delimitation of EEZ and Continental Shelf (CSh) very different views have been presented. Latvia proposed application of equidistance method but Lithuania insisted on 270° azimuth (parallel) from last point of land border up to EEZ and CSh of Sweden. Basic obstacle to reach equitable solution was economic interests as there are substantial oil fields in disputed area. (Figure 3)

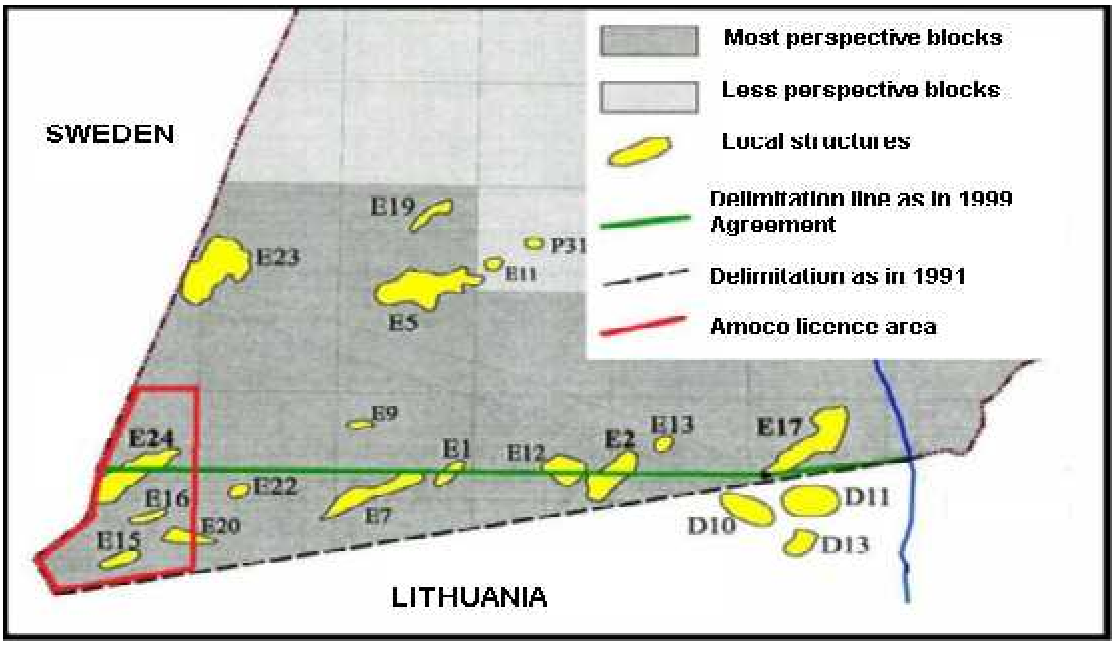

Figure 3. Oil fields on the Lithuanian – Latvian sea border [12]

Negotiations with Lithuanian delegation passed many unsuccessful stages. This situation was influenced also by Latvia concluding and ratifying in Saeima agreement with AMOCO Oil Company in October 1995. Licence for this company was extended up to outer end of disputed EEZ/ CSh area.

Some compromise solutions have been reached on later stages of negotiations on delimitation of territorial sea, but Lithuanian delegation was obstinate and persisted on parallel method on EEZ/ CSh delimitation.

In 1999 negotiations were activated in response to political pressure from Latvian ruling parties and President to conclude maritime delimitation agreement with Lithuania without delay, so demonstrating European Union that Latvia has no border conflicts with neighbouring countries.

In May 1999 in Palanga both delegations signed the “Agreement between the Republic of Latvia and the Republic of Lithuania on the delimitation of the territorial sea, exclusive economic zone and continental shelf in the Baltic Sea”. [3] This Agreement on 9th July 1999 was signed also by Prime Ministers of both countries. Then Latvian–Lithuanian Maritime Delimitation agreement was sent to Latvian Parliament – Saeima for ratification, but passed only 1st reading, while Lithuanian Parliament – Seimas ratified it in October 1999 by almost unanimous vote.

Numerous attempts to resume the ratification process of 1999 Agreement in Latvia further failed. This was also because of Latvian Fishermen Association (LFA) activities, as LFA was strongly against such delimitation and even thretend to initiate blockage of major Latvian ports with their fishing ships in case the ratification law is passed.

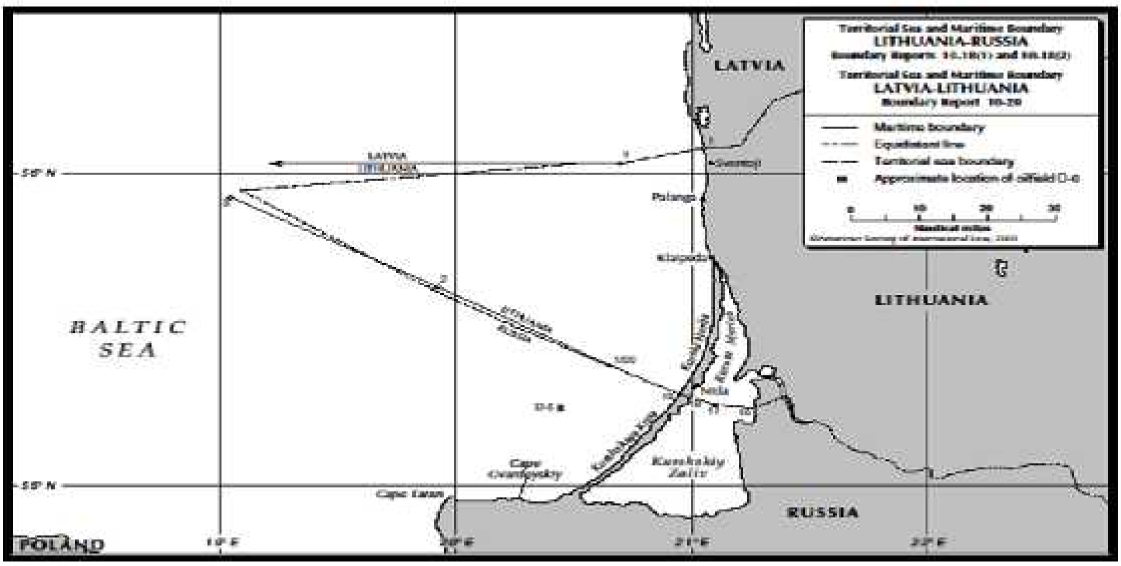

Figure 4. Equidistance method (LV) versus 270° azimuth (parallel) (LT) [6]

The 1999 Agreement was used since for practical application for cartography, for search and rescue purposes and for fishing. This delimitation was unilaterally also confirmed by Lithuanian national legislation [14] but not by Latvian national legislation.

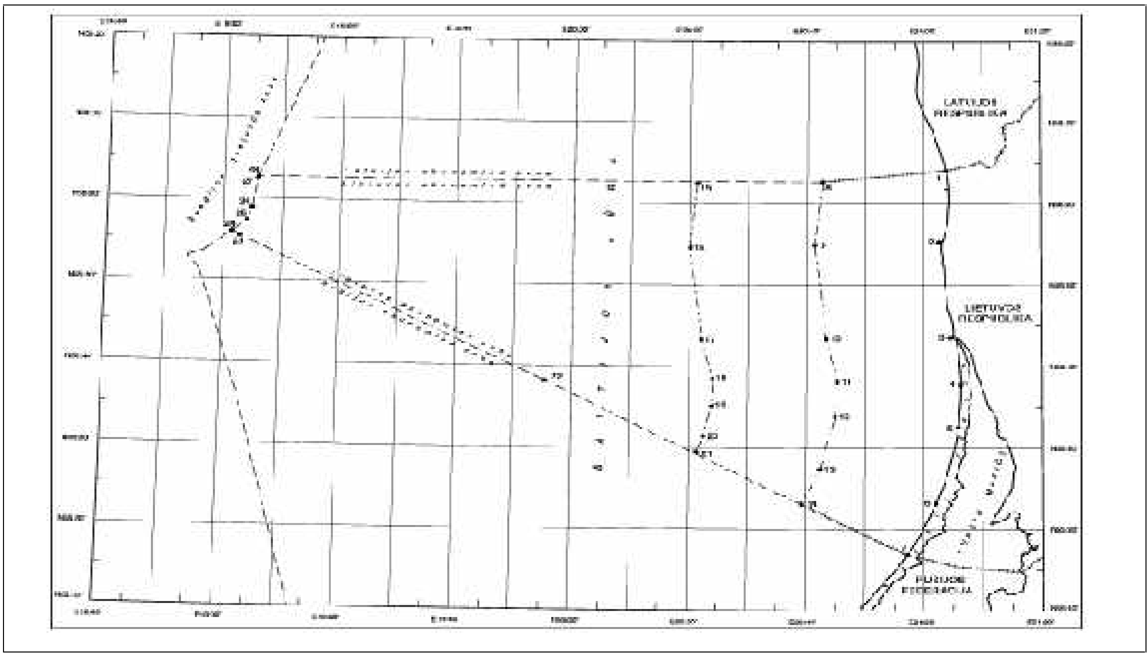

Figure 5. Delimitation of maritime waters of Lithuania as according to UN Division for Ocean Affairs and the Law of the Sea, Law of the Sea Bulletin, No.61 [14]

It is apparent that delimitation of EEZ as in 1999 Latvia – Lithuania Agreement is not complying nether with the principle of equidistance nor equity. This Agreement was driven by political motives of that time rather than following basic provisions of UNCLOS 82, which shall be applied now as this convention is ratified by both countries. 1999 Latvia–Lithuania maritime delimitation Agreement is not in national interests of Latvia, therefor need to be denounced and the case submitted for International Court of Justice (ICJ) hearing. Such proposal of legal expert was recently published in Latvian Journal

“JuristaVārds”, where Liene Eglaja, M.Sc., has presented excellent analysis of history of this Agreement and proposal for future actions to rectify the situation. [9]

There are many ICJ Judgments where the three stage method of testing of delimitation is applied. On the first stage the preliminary equidistance line was drawn. Then this delimitation line may be adjusted to take into account the specific circumstances for reaching equitable solution. During the third stage the proportionality test may be applied if necessary to confirm the equity of delimitation.

Such method was used in ICJ Judgment for Maritime Delimitation in the Black Sea, Romania v. Ukraine case of 3rd February 2009. On the first stage in this Romania–Ukraine case the preliminary equidistance line was drawn, then the relevant coast and relevant marine area was examined and disproportionality test of relevant coast and relevant marine area was made. The final Judgement in fact confirmed the delimitation of the first stage, i.e., based on equidistance method. [8] This ICJ Judgment resolved which country has the right to exploit oil and natural gas deposits in disputed area, which may total about 100 billion cubic meters of natural gas and 100 million metric tons of crude oil.

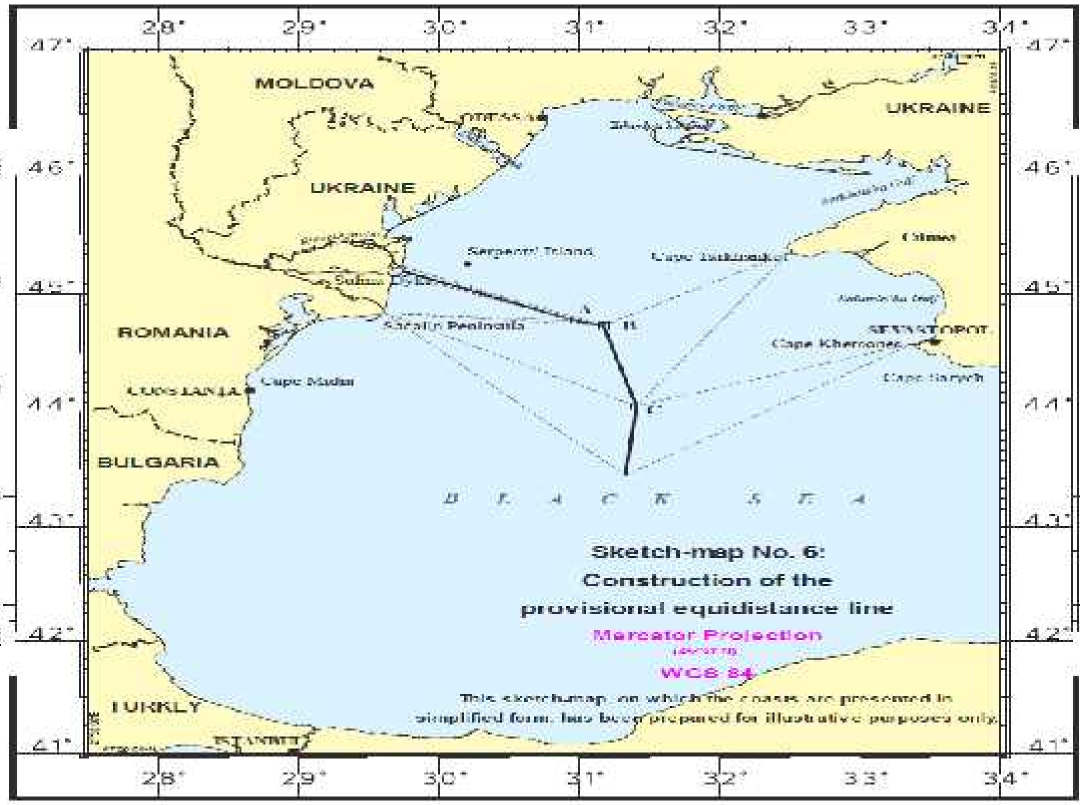

Figure 6. Map of maritime delimitation in the Black Sea, Romania v. Ukraine case as in the International Court of Justice judgement of 3rd February 2009. [8]

This ICJ Judgment case is a good example for Latvia and confirming the necessity of more pro-active proposals and not to be afraid of submission Latvia – Lithuania delimitation case for independent judgment of International body.

Maritime delimitation with Sweden

Sweden was the first of two countries who unilaterally established EEZ / CSh delimitation applicable to Baltic Sates. This was also in regard to Latvia – Sweden EEZ / CSh delimitation. In 1992 Swedish Government adopted the Ordinance on Sweden's Exclusive Economic Zone, 3 December 1992, were in paragraph 6. the Central and Northern Baltic Sea straight lines (loxodromes) between the 17 points were confirmed. [13]

The delimitation line in regard to Baltic States apparently has been taken from 1988 USSR–Sweden delimitation Agreement, where the principles of disputed area delimitation was agreed as 75% in favour of Sweden in exchange of fishing quotas 75% in favour of USSR. [4]

Should Latvia inherit USSR-Sweden delimitation of EEZ / CSh the opinions are different. Sweden naturally was positive on that opinion; same internationally recognized legal experts (viz. Erik Frankx) also support this delimitation principle. [7]

This is not in line with general rule adopted by Latvian Parliament in 1991 saying that agreements signed by USSR are not binding for Latvia. There were no maritime delimitation negotiations in early 1990 between Sweden and Latvia (at least to the knowledge of author) when theoretically new delimitation could be negotiated. Now that possibility is lost, especially because in 2005 Latvia submitted to UN Law of the Sea commission very similar delimitation points as in Sweden Government 1992 Ordinances. It was confirmed by Latvia submission to UN Law of the Sea Commission that "points A4-A14 are according with the Agreement between the USSR and Sweden, 1988 which is *de facto* observed". [10]

Even in case this 2005 submission from Latvia would not be made, the 20 year period for fishing quotas revision as in USSR - Sweden Agreement have expired in 2008 and is not applicable any more as now all fishing activities are under European Union ruling. All this make delimitation line with Sweden clearly established and leave no chance to new negotiations. At the same time official bi-partial Agreement with Sweden need to be concluded but first the common point with Lithuania and Sweden be established.

Maritime Delimitation in the Gulf of Riga

Delimitation in the Gulf of Riga in regard to Estonia is clear since 1996 Agreement was in force. Some small problem rose because some Irbe fairway boys are installed in Estonian waters, but this matter has been settled. We may notice some problems of compliance of Latvian National legislation with UNCLOS 82 provisions in regard to State border and territorial sea outer limit in Gulf of Rīga area.

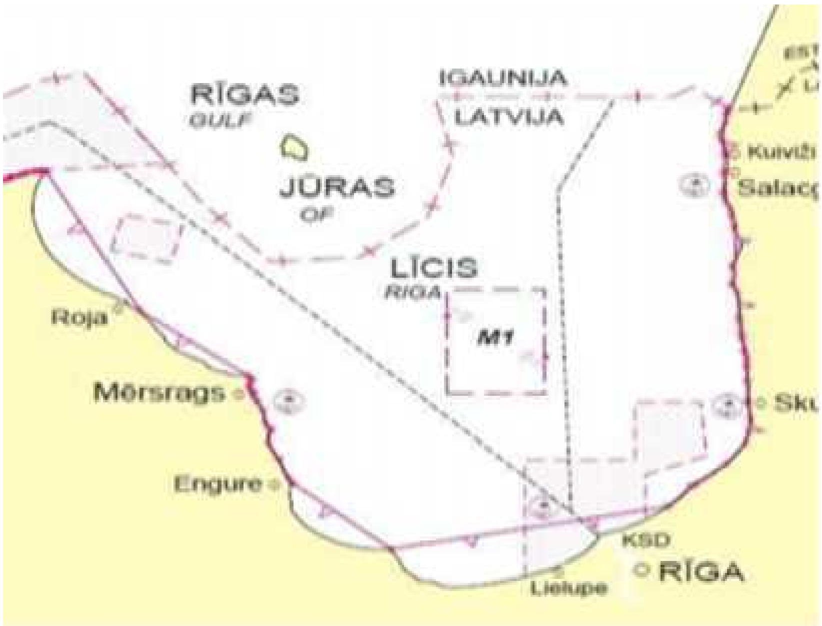

Figure 7. Delimitation in the Gulf of Riga according to Notices of Mariners No.1, 2012 [11]

In Latvian Law "On the State Border of the Republic of Latvia", Section 1 is a provision, that:

"9) territorial sea of the Republic of Latvia (hereinafter – territorial sea):

a) the waters of the Baltic Sea in width of 12 nautical miles, counting from the base line if it has not been otherwise specified by international agreements,

b) waters of the Gulf of Riga of the Baltic Sea from the base line to the State border which is determined in accordance with the agreement of 12 July 1996 between the Republic of Latvia and the Republic of Estonia regarding determination of the sea border in the Gulf of Riga, the Irbe Strait and the Baltic Sea;"

Looking on the map published by the Maritime Administration of Latvia in the Notices of Mariners No.1, 2012 of the Latvian Hydrographical Service (Figure 7) [11], we may notice the Latvian State border is the delimitation line as agreed with Estonia in 1996 Agreement. Nothing wrong with Latvia- Estonia maritime border line, but according to UNCLOS 82 Article 3 territorial sea shall not exceed 12 nautical miles:"*Every State has the right to establish the breadth of its territorial sea up to a limit not exceeding 12 nautical miles, measured from baselines determined in accordance with this Convention."*

When examining baseline situation as on the map (Figure 7) in the Gulf of Riga we may notice four straight baselines drawn which are not in compliance with Articles 6 and 10 of UNCLOS 82.

These two non-compliances of Latvian legislation (Latvian Law "On the State Border of the Republic of Latvia"), with UNCLOS 82 may be discussed more in detail, possibly this is deliberately adopted for strategic purposes.

Conclusions

1. There are no delimitation problems with Estonia, the 1996 Agreement is serving the purpose properly.

2. Agreement of 1999 with Lithuania is serving as preliminary, but need to be denounced following the procedures of UNCLOS 82.

3. Submission to International Court of Justice or to International Tribunal for the Law of the Sea should be initiated seeking for independent judgement on Latvia-Lithuania maritime delimitation.

4. Maritime delimitation Agreement with Sweden should be negotiated to confirm the *de facto* situation, but first tri-point to be agreed with Lithuania and Sweden.

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