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Specific features of sedimentation environment in waters of the Šventoji port, Lithuania

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The article presents results of water area investigations in the Šventoji port, Lithuania in June 2004. The data obtained showed changes of the sedimentation environment and bottom sediments in the Šventoji port in a different geographical situation. The goals of the investigations were to determine the main geographical factors responsible for the character of sedimentation processes, to distinguish sedimentogenetic zones, to reveal lithological composition patterns of the surface bottom sediments, and to find out whether the water indices are able to reflect changes in sedimentation conditions. The work includes analysis of a new river channel formatting and changing of the contour of the water basin. We have found that water indices reflect changes in sedimentation conditions. New bathymetric and lithological maps were compiled. Silty-clayey mud (26%) and muddy-sandy silt (16%) have been shown to be the most widespread surface bottom sediments in the Šventoji port.

Key words: accumulation, bottom sediments, composition, depth, particulate material, sedimentation, transparency, water colour, Lithuania

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INTRODUCTION

The first data on the reconstruction of the Šventoji River mouth aimed at improving navigation conditions go back to the 16th century. Since then the contours and depth of the river have been corrected many times and the mouth location has changed (Šimoliūnas, 1933). The most extensive construction of the port took place in the interwar period. The port was not then finished. Yet the changed channel of the Šventoji River, excavated basins and installed jetties (Fig. 1) are largely responsible for the present shape of the Šventoji port (56°01′N; 21°04′E). In the course of years, the former contours of the port waters have undergone considerable changes: the nearshore sand of the Baltic Sea filled up the outer basin and covered the jetties. A thick layer of alluvial deposits sheeted the inner basins. The greatest changes occurred in the closest to the sea part of the Šventoji port. The wide basin meeting the sea was converted into a narrow channel through which the water from the Šventoji River flows out into the sea. The reconstruction of the port for leisure navigation and for handling of the Būtingė terminal is included into the strategic plans of the Republic of Lithuania (Fig. 2). It is projected to change the outlines of some water areas and to remove the bottom sediments.

Preliminary studies of the Šventoji mouth and the composition of port sediments were carried out in June 1996 (Galkus, Stakėnienė, Jokšas, 1997). The first scheme of bottom sediments was mostly based on visual description. Because of the intensive dynamics of sedimentation conditions in the artificially transformed river channel (characterized by a heterogeneity and high variety of the lithological types of sediments), the composition of sediments is constantly changing. There is a necessity to carry out new investigations of bottom sediments based on granular composition analysis. Having in mind that the composition of sediments not only depends on the characteristics of the sedimentation environment but also reflects them in an integrated way, the authors attempted to analyse certain indices of the sedimentogenetic space and to compare the patterns of their spatial distribution with the distribution patterns of the lithological composition of bottom sediments. Notwithstanding the high diversity of description criteria applied to sedimentation environments, the depth always remains one of the major ones (Trimonis, 2002). Therefore, much attention was devoted to the studies of subaqeaous relief as they were lacking altogether in the last few decades.

The goals of the present article were to determine the main geographical factors responsible for the character of sedimentation processes, to distinguish sedimentogenetic zones, to reveal the patterns of lithological composition of the surface bottom sediments, and to find out whether the water indices are able to reflect changes in sedimentation conditions.

MATERIALS AND METHODS

The study of the Šventoji port waters (7.75 ha between the bridge across the Šventoji River and the Baltic Sea) included bathymetric analysis, measuring of water indices (transparency, colour, concentration of dregs), sampling of surface bottom sediments, and measuring of water and particulate drift yield in the Šventoji River, which were carried out in June 2004. The sampling sites (Fig. 3) and the limits of zones overgrown with water plants were fixed by measuring their distance (with the aid of a measuring tape) from the port jetties and other stable coast sectors plotted on maps. The depth for bathymetric survey was measured with a sea-gauge (the water level – 1.45 m below the eastern embankment encircling the Eastern basin and part of the Šventoji River). For water transparency value, the greatest depth of visibility of a white *Sekki* disk was measured. The water colour was determined using the standard colour scale (21 colours). The spectrum of colours ranged from blue to brown. As transparency and colour were measured in the surface water layer, water samples for comparative concentration of particulates matter were taken from the depth of 0.5 m (or from the surface horizon of shallow areas) in the centre of each profile studied. Two water samples were taken from the deepest and shallowest parts of long profiles with a complex relief (profiles 4, 5, 12, 22, 25, Fig. 3). The concentration of particulate material was determined by the standard filtration-weighing method. The river yield value was derived from stream velocities measured with a multifunctional sound (RCM 9 of AANDERAA Instruments, (Norway). Samples of the surface layer (0–5 cm) of bottom sediments were taken with a small dredger. The minutely described soil samples were preserved and later dried in a stationary laboratory. The percentages of the particles from <0.01 mm to >10 mm were determined in 16 fractions. Muddy sediments with a high amount of particles with a diameter <0.01 mm were analysed by the pipette method (Петелин, 1967; Folk, 1974). Microscopic examination of fine-grained (<0.063 mm) sediments and particulates was performed using the same method (Галкус, 1992).

The content of organic matter in bottom sediments was determined by combustion (Nelson, Sommers, 1996). The type of sediments was determined according to the dominant fraction and median diameter, using the decimal classification system. The median diameter (D_{50}) and the sorting coefficient (So) of sediments were calculated according to the method of Trask (1930).

Comparative analysis of the spatial distribution of indices is was chosen as a method of investigation. Authors attempted to identify sediment trends associated with sediment transport pathways (McLaren, Bowles, 1985).

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RESULTS

Bathymetric analysis

Any study of water basin is impossible without knowledge of the bottom relief. The authors carried out individual bathymetric investigations of the Šventoji port waters, because recent literary sources contained no such information. The results have revealed that today the Šventoji port is unfit for navigation due to permanent accumulation of sediments. Shoals occupy 15.5% (<0.5 m) and 38.5% (<1 m) of the water area. The most widespread depth is 1–2 m (35.5%). The depth exceeds 3 m only in three small areas. The greatest depth (6.2 m) was measured in the Šventoji River near the northern boundary of the studied water area (Fig. 3). The configuration of port waters predetermining the direction of the main flow of the Šventoji River towards the Eastern winter basin and an abundant sedimentation of alluvium in this direction. South of the deepest area the eastern part of the river channel sharply becomes shallow. The shallow area (0.5 m) composed of alluvial sedimentary material and overgrown with bulrushes extends from north to south. The depth (1–1.5 m) of the branch becomes even smaller (0.5–0.7 m) when it reaches the Eastern basin of the port. The depth in the greater part of the Eastern basin ranges within 1–1.5 m and within 1.5–1.9 m in the southern part of the basin.

The depth of the navigation channel of the Šventoji River locally increases (up to 3.2 m) in the channel bend to the west. Its depth in front of the Western basin is 2.5–2.9 m. A large shoal extends from east to west-north of the navigation channel. In the two bulrush 'islands' in its centre the depth reduces to 0.1–0.3 m or to 0.3–0.5 m (Fig. 3). The depth of the Western basin (2.5–3 m) is about twice as large as the depth of the Eastern basin. The deepest depression of the basin (>3 m) is situated in its southern part (Fig. 3).

The 1.5 m deep navigation channel extending towards the Šventoji mouth ends by a 0.5 m deep shoal

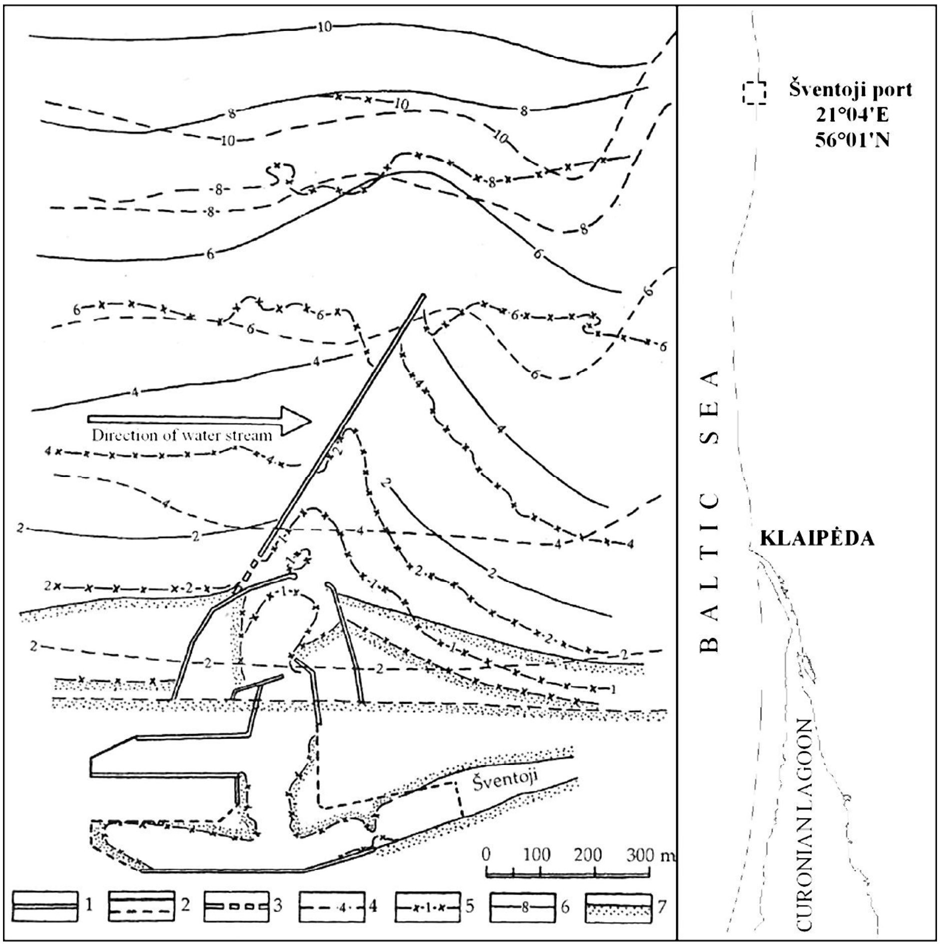
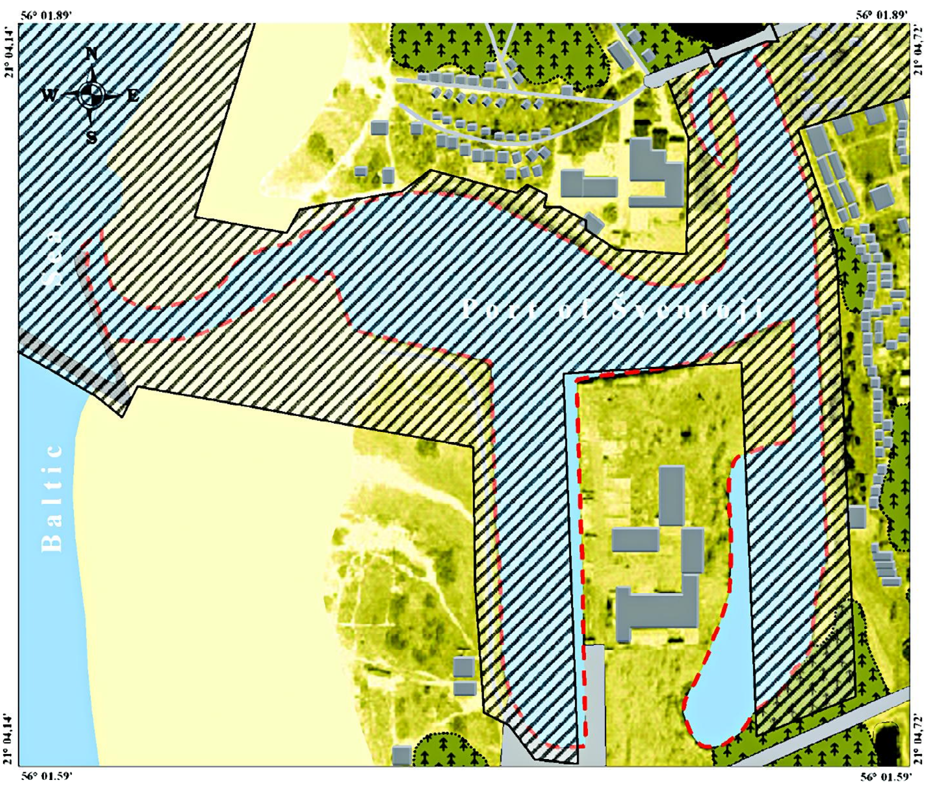


Fig. 1. Depth and coastline variations in the Šventoji port water basin and in surrounding waters (Žaromskis, 1998): *1* – finished hydrotechnical constructions; *2* – unfinished hydrotechnical constructions; *3* – gap left in the southern jetty; *4* – isobaths before the port construction (1924); *5* – isobaths in 1943; *6* – isobaths in 1965; *7* – coastline

1 pav. Jūros gylio ir kranto linijos kaita Šventosios uoste bei jį supančioje akvatorijoje (Žaromskis, 1998): *1* – pastatyti hidrotechniniai įtvarai; *2* – nebaigti statyti hidrotechniniai įtvarai; *3* – statybos metu pietiniame mole palikta anga; *4* – prieš uosto statybą 1924 m. buvusios izobatų linijos; *5* – izobatų linijos 1943 m.; *6* – izobatų linijos 1965 m.; *7* – kranto linija



– Boundary of the study water area / tyrimų rajono riba

– Prospective basins of Šventoji port / perspektyviniai Šventosios uosto baseinai

Fig. 2. Prospective basins of the Šventoji port

2 pav. Planuojami įrengti Šventosios uosto baseinai

Fig. 3. Bathymetric scheme, study profiles and stations in the Šventoji port water basin
3 pav. Šventosios uosto akvatorijos batimetrinė schema, tyrimų pjūviai ir stotys

which is an obstruction not only to navigation but also to the natural circulation of sediments.

Analysis of water indices

The distribution pattern of water indices (transparency and colour, and concentration of particular material) in the Šventoji port is an indirect indicator of water circulation, bioproduction and sedimentation peculiarities. Of course, the absolute values of water indices have a seasonal character, but only the spatial dynamics of water indices is important for this work.

At the time of investigation, the water yield measured in the Šventoji River was 1.2 m^3/s and the yield of particulates 1.1 t/day. The concentration of particulates in the Šventoji River ranged from 5–9 mg/l in the water surface to 11–12 mg/l at a depth of 1–2 m and 20 mg/l in the near-bottom layer (approximately 2.5 m) of the navigation channel.

The concentrations of particulates in the navigation channel of the port range from 4.5 mg/l (profile 11, Fig. 3) to 6.7 mg/l (profile 12). The prevailing concentration is close to 5 mg/l. In the shoal of the river mouth the concentration of particulate material increases to 8 mg/l. The concentrations in the shallow zone obstructing the Eastern basin are higher than in the navigation channel; reaching 7.2 mg/l in profile 13, 8 mg/l in profile 14 and 7.1 mg/l in profile 15. In the Eastern basin, the concentration of particulates is slightly lower (5.8–6.7 mg/l). It is similar in the greater part of the Western basin (5.9–7 mg/l). The values increase to 8 mg/l near the embankments of the Western basin and in the rearmost part of the basin.

Generalization of water transparency data revealed a bifurcating zone of relatively most transparent water in the navigation channel of the Šventoji River (up to 1.3 m) (Fig. 4). One of the branches turns to the Western basin of the port. Water transparency values are highest in its southern part (1.5 m). The other branch extends up to the river mouth. In shallow areas of the mouth front the water transparency values slightly reduce (1–1.1 m) and again increase further towards the sea (1.3 m). Water transparency values were considerably lower at the shoal slopes, especially in their backwater parts. The lowest water transparency values (0.7 m) were obtained in front of the Eastern basin on the way of the Šventoji sediment drift. In the greater part of the Eastern basin, the water is transparent down to the bottom (>1.1 m) and in the southern part to 1.1 m.

The water colour of the port basin varies from yellowish green (No XII of the scale) to brownish yellow (No XVII). Most greenish tones are characteristic of the water coming from the Šventoji mouth (Nos. XII–XIII), Eastern basin and shoals overgrown by water plants (No XIII) and Šventoji River (No XIV) (Fig. 5). The water gathers brownish tones in the areas where the water stream ‘rests against’ shoals and closed water basins: the littoral zone of the river overgrown by macrophytes (profiles 9 and 11), a branch to the Eastern basin, the eastern slope of the wide shoal in front of the Western basin (profile 6), and the rearmost part of the Western basin. In the rearmost part of the Eastern basin the water remains greenish yellowish, because the

Fig. 4. Water transparency in the Šventoji port
4 pav. Šventosios uosto akvatorijos vandens skaidrumas

Fig. 5. Water colour in the Šventoji port
5 pav. Šventosios uosto akvatorijos vandens spalva

water stream heading towards this basin is blocked earlier (in the sector where water is brownish).

Bottom sediments

The lithological composition of bottom sediments not only depends on but also is an integrated reflection of the specific features of the sedimentation environment. The composition of bottom sediments of the Šventoji port is predetermined by the Šventoji drift, sand migration in the offshore and on the coast, and biological material produced by plankton and water macrophytes. The composition of sediments in a basin of sophisticated configuration also depends on concrete areas of sedimentation.

Taking into account the variegated composition of heterogeneous bottom sediments and the principles of generalization and classification of bottom sediments during previous investigations (Galkus, Stakėnienė, Jokšas, 1997) and following the Lithuanian standards of classification (Gaigalas, 1995) the following types of bottom sediments were distinguished: gravel (10–1 mm), sand with gravel (>10 mm – 0–5%, 10–1 mm – 25–50%, <1 mm – 50–75%), coarse-grained sand (1–0.5 mm), medium-grained sand (0.5–0.25 mm), muddy medium-grained sand (0.5–0.25 mm, organic matter >3%), fine-grained sand (0.25–0.1 mm), silty sand (1–0.1 mm – 70–90%, 0.1–0.01 mm – 5–25%, <0.01 mm – 0–5%), muddy fine-grained sand (0.25–0.1 mm, organic matter >3%), silty clayey mud (<0.1 mm, organic matter >5%).

In general, the established spatial dynamics patterns of bottom sediments are the same as in previous investigations (Galkus, Stakėnienė, Jokšas, 1997). As the preesent study was based on a denser network of stations and another classification of sediments, changes of sediment composition during the time between the investigations were not analysed.

The sediments covering the bottom of the study water basin extending furthermost into the Šventoji River are very heterogeneous. They are formed by coarse-grained material from the channel slopes and bottom and fine-grained river drift. The granular composition of silt sediments varies from gravel and sand with gravel in the navigation channel to muddy sandy silt (Fig. 6). The average value of the sorting coefficient is 1.6 and the range of variation is very wide: 0.8–2.4.

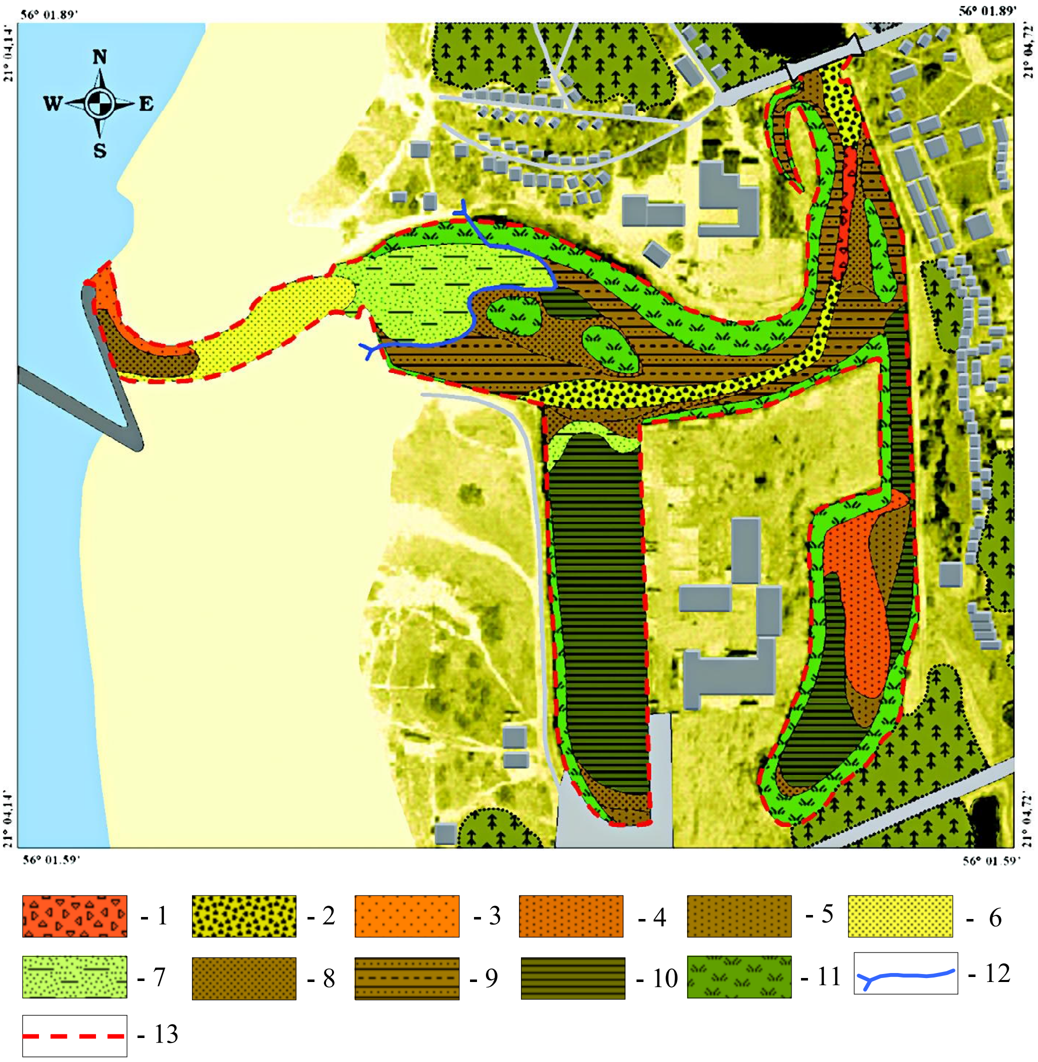


Fig. 6. Surface bottom sediments (0–5 cm) in the Šventoji port:
1 – gravel, *2* – sand with gravel; *3* – coarse-grained sand, *4* – medium-grained sand, *5* – muddy medium-grained sand, *6* – fine-grained sand, *7* – silty sand, *8* – muddy fine-grained sand, *9* – muddy sandy silt, *10* – silty-clayey mud, *11* – bulrush and reed overgrowths, *12* – the boundary from which the zone of marine sand sedimentation extends westwards, *13* – boundaries of the study area
6 pav. Šventosios uosto akvatorijos paviršinės (0–5 cm) dugno nuosėdos:
1 – žvirgždas, *2* – žvirgždinis smėlis, *3* – stambiagrūdis smėlis, *4* – vidutingrūdis smėlis, *5* – dumblingas vidutingrūdis smėlis, *6* – smulkiagrūdis smėlis, *7* – aleuritingas smėlis, *8* – dumblingas smulkiagrūdis smėlis, *9* – dumblingas smėlinis aleuritas, *10* – aleuritinis-pelitinis dumblas, *11* – plotai, apaugę meldų-nendrių sąžalynais, *12* – riba, nuo kurios į vakarus plyti jūrinio smėlio sedimentacijos zona, *13* – tyrimų rajono riba

In the first silt shoal (Fig. 3) formed after an abrupt artificial diversion of the river stream to the west (before the port construction the river channel extended across the present Eastern and further on across the Western basins), gravel and sand with gravel underlie the surface layer of sediments (from a few to a dozen centimetres in thickness) composed of muddy fine-grained sand and muddy sandy silt. In the branch to the Eastern basin, coarse-grained silty sediments are covered by silty clayey mud. The same type of mud is deposited in the nearshore of the Eastern basin and in a wide area in the southern part of the basin. The mud of the Eastern basin contains a great amount of diatomic algae remains which sometimes account for up to 20% of fine-grained (<0.063 mm) sedimentary material. The northern and central parts of the basin are covered by medium-grained sand (Fig. 6). The whole bottom of the Eastern basin is thickly overgrown by underwater plants which successfully play the role of the biological clearer of the water. The water colour in this closed basin is the same as that of the river water closest to the sea (Fig. 5).

The belt of sand with gravel in the navigation channel of the river extends to the mouth of the Western basin. North of it, there is a zone of mass sedimentation of silty material which failed to settle down earlier. Silty fine-grained sand covers the surface of the central part of a wide shoal composed of this material (Fig. 3), and sandy silt and silty sand are found in the peripheries (Fig. 6).

The Western basin, which used to be part of the river channel, is now a peripheral basin accumulating only thin-dispersed mineral material (fraction <0.063 mm accounts for >70%) which together with planktogenic detritus form loose silt sediments. The bottom is almost entirely covered by silty clayey mud. Areas of muddy coarser sediments (sandy silt, fine-grained and medium-grained sands) can be distinguished only in the mouth and rearmost part of the basin. Silty clayey mud is the most widespread type of surface bottom sediments in the Šventoji port water basin (26% of the bottom). Gravel and coarse-grained sand are the least widespread (1% each).

The content of organic matter in the bottom sediments of the Šventoji port is rather variable. In sandy soils it does not reach 1%, whereas in silty clayey mud it increases about ten-fold. The values of organic matter are especially variable in the soils of the Eastern basin.

In the small Šventoji River mouth sector, accumulation dominates among the coastal processes (in contrast to the neighbouring sectors) (Kirlys, Janukonis, 1993; Gaigalas, Kairytė, Gulbinskas, 1999). Sand of the Baltic Sea coast plays the principal role in the formation of bottom sediments between the second silt shoal and the Šventoji mouth. It has filled up the whole former outer port basin and the NW periphery of the inner basin (Figs. 1 and 6). The sand coming with setup waters and blown from the dunes periodically replenish the bottom sediments of the inner basin of the port. Mixed with the finer river drift material, it forms a field of silty sand sediments (Fig. 6).

Moving from dunes to the sea, the sand becomes coarser and its sorting coefficient reduces. The preserved jetties and sand cape near the river mouth are responsible for the differences of sand accumulation on both sides of the mouth: fine-grained sand accumulates in its southern part and medium-grained in the northern part. Differences of the gradedness coefficients of these sands are small (Jarmalavičius, Žilinskas, 1996). The medium-grained sand ($D_{50} \cong 0.28$ mm) in the northern slope of the river channel is washed out even more, making this sector the only one containing coarse-grained sand (Fig. 6). Beaches in the other river sectors are composed of fine-grained sand. Its grain diameter D_{50} ranges from 0.1 to 0.19. Sand of comparable composition covers the channel bottom near the mouth. Mud accumulates near the former Southern jetty of the port gates and together with the local sand forms muddy medium-grained sand sediments.

Bottom sediments, composed mainly of coast sands, differ from the sediments of deeper zones of the port waters in a smaller range of S_o variations. Though the average value of S_o of coastal sand reduces but little (1.4), its variation range (1.3–1.5) is considerably smaller than that of silt sediments (0.8–2.4).

The bottom of the Šventoji port waters is almost entirely covered by water plants (except the mouth sector and the deepest areas of the Western basin covered by mud). Macrophytes form bulrush-reed overgrowths towering above the water surface even in 22% of the basin area. They not only extend along the shores but somewhere form plant islands on shoals (Fig. 6).

CONCLUSIONS

The new bathymetric map of the Šventoji port water basin reveals a very complicated bottom relief (Fig. 3). The map of surface bottom sediments, based on an amended granulometric classification (Fig. 6), is an integrated reflection of a multifactorial environmental impact on sedimentation processes. Analysis of the maps of water transparency and colour (Figs. 4 and 5) allows stating that variations of water indices reflect the changes of sedimentation conditions.

The present study provides a basis for the following conclusions:

1. The following main geographical factors are responsible for the character of sedimentation processes in the Šventoji port: 1) the port is situated in a reconstructed river channel; 2) the water area of the port crosses a lithodynamically active zone of the sea coast.

2. Formation of a new river channel in the artificially formed water basin of complicated configuration, changes of the contour of the basin and bottom relief as well as permanent accumulation of sediments make the port water basin ever more shallow and unfit for navigation. Depths of <1 m occupy 38.5% and bulrush-reed overgrowths 22% of the basin area. The ever deteriorating conditions of water and sediment transit contribute to intensification of sedimentation.

3. Water indices do reflect the changes of sedimentation conditions:

- the most transparent water is overlying the deepest zones of the water basin, where the sediment transport conditions are best and resuspension of bottom sediments is minimal;
- the higher turbidity values in the areas of most intensive sedimentation (especially in the “shadow” parts of shoals) imply a permanent wash out of thindispersed sedimentary matter from the swelling elevations of the bottom relief;
- the colour of the port water, varying from yellowish green to brownish yellow, obtains the greenish tones in the sedimentation zone of marine sands and brownish where the water stream “props” against bars and closed water areas.

4. The following sedimentary materials play the leading role in the formation of the Šventoji port sediments: 1) marine sand in the sector closest to the sea (Fig. 6); 2) particulate fine-grained mineral material and plankton detritus in the Western basin and the southern part of the Eastern basin; 3) inequigranular silt material – the Šventoji drift and products of channel slope and bottom erosion in the rest of the basin.

5. Silty-clayey mud (26%) and muddy sandy silt (16%) are the most widespread, whereas coarse-grained

sand and gravel (1% each) are the least widespread surface bottom sediments of the Šventoji port.

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ŠVENTOSIOS UOSTO (LIETUVA) AKVATORIJOS SEDIMENTACINĖS APLINKOS YPATUMAI

S a n t r a u k a

XX a. I pusėje vykę Šventosios uosto statybos darbai, kurių metu buvo iškasti baseinai ir pastatyti molai, daugiausia nulemia šiandieninį Šventosios uosto vaizdą. Metams bėgant uosto akvatorijos kontūrai smarkiai keitėsi: Baltijos jūros priekrantės smėlis užpildė uosto išorinį baseiną, užklojo molus. Storas aliuvinių nuogulų sluoksnis padengė uosto vidinius baseinus. Labiausiai pakito arčiausiai jūros buvusi Šventosios uosto dalis. Šiuo metu yra numatyta atstatyti Šventosios uostą: pakeisti senųjų baseinų kontūrus, išgabenti susikaupusias dugno nuosėdas.

Šventosios upės žiočių ir uosto akvatorijos dugno nuosėdų sudėties pirmuosius apžvalginius tyrimus šio straipsnio autoriai atliko 1996 m. birželį. Vis dėlto pačių akvatorijų kontūrų ir dugno morfologijos pokyčiai bei Šventosios upės ir uosto baseinų vandens rodikliai iki šiol nebuvo tyrinėti. Siekiant užpildyti šią pažinimo spragą, 2004 m. birželį atlikti nauji Šventosios uosto akvatorijos tyrimai, kurių rezultatai apibendrinami šiame straipsnyje. Straipsnio tikslas – įvertinant pasikeitusią geografinę aplinką ir atsižvelgiant į vandens storymės rodiklių erdvinę dinamiką, atskleisti Šventosios uosto akvatorijos sedimentacinės aplinkos ypatumus.

Patikslinus akvatorijos kontūrų kartografinį vaizdą ir atlikus batimetrinius tyrimus, vandens rodiklių (skaidrumo, spalvos, drumzlių koncentracijos) matavimus, paviršinių dugno nuosėdų ėminių medžiaginės sudėties ir granuliometrinę analizę, sudarytos Šventosios uosto akvatorijos batimetrinė, paviršinių dugno nuosėdų, vandens skaidrumo ir spalvos schemos. Rodiklių lyginamąja analize nustatyta, kad tirtų vandens rodiklių kaita rodo sedimentacinių sąlygų pokyčius:

- skaidriausias vanduo plyti virš giliausių vandens baseino zonų, kuriose nešmenų transportavimo sąlygos yra geriausios, o dugno nuosėdų resuspendacija minimali;
- padidėjęs vandens drumstumas intensyviausio nuosėdų kaupimosi arealuose, ypač – „šešėlinėse“ upės vandens srauto atžvilgiu seklumų pusėse, rodo nuolatinį smulkiadispersinės nuosėdinės medžiagos išplovimą iš augančių dugno reljefo pakilumų;
- uosto akvatorijoje nuo gelsvai žalios iki rusvai geltonos kintanti vandens spalva daugiausia žalsvų tonų įgyja jūrinių smėlių sedimentacijos zonoje, rusvų – ten, kur vandens tėkmė „atsiremia“ į seklumas ar uždaras akvatorijas.

Šventosios uosto sedimentacinių procesų pobūdį nulemia šie svarbiausi geografiniai veiksniai: 1) uostas įsikūręs pertvarkytoje upės vagoje; 2) uosto akvatorija kerta litodinamiškai aktyvią jūros kranto zoną. Sudėtingos konfigūracijos dirbtinai suformuotame vandens baseine upės tėkmei naujai formuojant vagą, keičiantis akvatorijos kontūrams ir dugno reljefui bei nuolat kaupantis sąnašoms, uosto akvatorija intensyviai seklėja ir šio metu visiškai netinka laivybai. < 1 m gyliai užima 38,5%, makrofitų sąžalynai – 22% akvatorijos ploto. Nuolat blogėjančios vandens ir nešmenų tranzito sąlygos skatina tolesnį sedimentacijos intensyvėjimą.

Formuojantis Šventosios uosto akvatorijos dugno nuosėdoms didžiausią vaidmenį vaidina ši nuosėdinė medžiaga: 1) arčiausiai jūros esančioje atkarpoje – jūrinis smėlis; 2) vakariniame baseine ir rytinio baseino pietinėje dalyje – suspensijų pavidalu atkeliaujančios smulkios mineralinės dalelės ir planktono detritas; 3) likusioje akvatorijos dalyje – įvairiagrūdė aliuvinė medžiaga: Šventosios nešmenys ir šlaitų bei dugno erozijos produktai. Didžiausius Šventosios uosto akvatorijos paviršinių dugno nuosėdų plotus užima aleuritinis-pelitinis dumblas (26%) ir dumblingas smėlinis aleuritas (16%), mažiausius – stambiagrūdis smėlis ir žvirgždas (po 1%).

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ОСОБЕННОСТИ СРЕДЫ ОСАДКОНАКОПЛЕНИЯ В АКВАТОРИИ ПОРТА ШВЯНТОЙИ, ЛИТВА

Р е з ю м е

Еще в первой половине XX в. построенные пирсы и бассейны определяют основные контуры нынешнего порта

Швянтойи. Со временем акватория порта претерпела и значительные изменения: морские пески полностью занесли внешний бассейн порта, частично похоронили молы. Мощный слой аллювиальных осадков покрыл внутренние бассейны порта. В настоящее время планируется реконструировать порт, значительно расширить бассейны и вывезти большое количество накопившегося в них осадочного материала.

Донные осадки акватории порта Швянтойи авторами статьи впервые были исследованы в июне 1996 г. Однако за десятилетия сильно изменившиеся условия среды осадконакопления и происходящие при этом процессы долгое время оставались неизученными. В июне 2004 г. были проведены новые исследования акватории порта, результаты которых представлены в настоящей работе. Цель статьи – с учетом изменившихся географических условий и на основе анализа пространственной динамики показателей водной среды выявить особенности среды осадконакопления в акватории порта Швянтойи.

После картирования изменившихся границ акватории порта, батиметрических исследований, промеров показателей водной среды (прозрачности, цвета воды, концентрации взвеси), гранулометрического анализа проб донных осадков были составлены картосхемы: батиметрическая, состава донных осадков, цвета и прозрачности воды. Путем сравнительного анализа установлено, что:

– вода наиболее прозрачной становится в самых глубоких зонах бассейна с благоприятными условиями для переноса осадочного материала и минимальной ресуспендацией донных осадков;

– увеличение мутности воды в ареалах наиболее интенсивного накопления осадочного материала, особенно – в „теневых“ зонах (по отношению к водному потоку) мелководных участков, указывает на постоянный вынос вещества с поверхности подводных возвышенностей;

– в акватории порта цвет воды изменяется с желто-зеленого до коричнево-желтого: зеленый оттенок преобладает в зонах седиментации морских песков, коричневый – там, где поток воды достигает мелководья или упирается в закрытое пространство.

Характер процессов осадконакопления в порту Швянтойи определяется следующими наиболее важными географическими факторами: 1) порт находится в искусственно измененном русле реки; 2) акватория порта пересекает особенно активную литодинамически зону морского берега. В искусственно созданной акватории сложной конфигурации речная вода формирует новое русло, меняя контуры и рельеф дна водного бассейна. Непрерывно накапливающиеся наносы постепенно заполняют акваторию порта. В настоящее время порт стал совершенно непригодным для судоходства. Глубины менее 1 м занимают 38,5%, возвышающиеся над водой макрофиты – 22% акватории порта. Постоянно ухудшающиеся условия транзитного переноса воды и наносов в акватории способствуют все более интенсивному осадконакоплению.

При формировании донных осадков порта Швянтойи главную роль играют: 1) на наиболее приближенном к морю участке – морские пески; 2) в западном бассейне и южной части восточного – приносимые в виде взвеси мелкие минеральные частицы и планктоногенный детрит; 3) в других частях акватории порта – разнозернистый аллювий. Наиболее распространенные виды донных осадков порта – алеврито-пелитовый ил (26%) и илисто-песчаный алеврит (16%). Наименее распространены крупнозернистый песок и гравий (по 1%).