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Sea Ice Services in the Baltic Sea

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ABSTRACT: The Baltic winter navigation depended always very much on the ice conditions in the sea. The sea ice occurs different in form and amount, depending on the sea area and the winter season. As the maritime traffic on the Baltic Sea constitutes a substantial amount in the whole of the Baltic countries transport, Sea Ice Services (SISs) have come into being. They constituted the Baltic Sea Ice Meeting (BSIM) – a body, which assembles the parties, which are interested in warnings against bad ice conditions, and in protection of navigation in ice in the Baltic Sea. An indispensable co-operator to this body was always the company "Baltic Icebreakers". To-day within the BSIM operate by the SISs of Denmark, Sweden, Finland, Russia, Estonia, Latvia, Lithuania, Poland and Germany, Netherlands, Norway and the Baltic Icebreakers. The main statutory duties of the SISs is the acquisition, processing and dissemination of actual information on sea ice conditions and on obstructions to navigation due to sea ice. This is done by maintaining observing posts along the coast of those countries, in their ports and approaches to them, by gathering information from ships, from ice beakers, if possible – from reconnaissance flights or satellite images. Routine products of SISs are the ice reports, ice bulletins, ice charts, forecasts and warnings and other information broadcast by mass media, e.g. radio, internet, Navtex and on the national and Baltic SISs' web sites etc.

1 ICE CONDITIONS IN THE BALTIC SEA

Baltic Sea is a semi-closed, tide less and comparatively dismembered sea. Its low salinity varies from about 20 ‰ in the Belts waters to about 1‰ to 4‰ in the north-eastern basins. The differentiation of salinity, bathymetry, the latitudinal and continental (climatic) influences generates significant inhomogeneity of freezing conditions in different basins of the sea. Some of the basins freeze each winter, the other only rarely, during exceptionally severe winters. In order to be able to compare the winter conditions in different years or in different basins of the sea, some scales of winter severity are in use. According to one of them (sea ice severity index S_{reg}, after Sztobryn et al.,2008) three types of winters were distinguished (mild, normal and severe) and a classification of winters between 1955 and 2005 in the Baltic Sea was made, as in Table 1.

Highest values of sea ice index S_{reg} were characteristic for the Bay of Bothnia, where they oscillated between 9,32 in 1980/81 and 5,34 in 1991/92. The lowest values of S_{reg} were gained in the Western Baltic, with the minimum equal to 0,0, what occurred for eight times in the investigated 50 winter seasons, while the maximum value there was as high as S_{reg} = 5,72 in 1995/96. Quite close to the values representative for the Western Baltic were the extreme conditions in the Aland Sea and the Archipelago: maximum value of S_{reg} reached there 5,89 in 1969/70 and the minimum value was 0,0 (for four times).

The values of basic S_{reg} statistics, when compared, allowed to distinguish three groups of regions considered here, which were similar to each other with regard to the sea ice conditions.

Table 1. Number of winters of given severity in particular basins of the Baltic Sea in the winter seasons 1955/56 – 2004/05 (Sztobryn et.al.2008)

type of sea ice severity	Baltic	Western Baltic	Southern Baltic	Gulf of Finland	Aland & Arch	Sea of Bothnia	Norra Kvarken	Bay of Bothnia
mild	17	43	36	16	33	14	2	0
normal	17	1	8	11	9	11	4	0
severe	16	6	6	23	8	25	44	50

The first group, the “mild winters zone”, consisted of the Western Baltic Sea, Southern Baltic Sea and the Aland Sea; the second group, the “normal winters zone” made the western Gulf of Finland and the Sea of Bothnia. Into the third group, the “severe winters zone”, were included the Norra Kvarken and the Bay of Bothnia, where the statistical parameters of S_{reg} were positively higher, than in the remaining considered regions of the Baltic Sea. It must be stressed that though very characteristic, the above cited indices did not involve all areas of the Baltic Sea, as for instance, the south-eastern coasts of the central sea parts.

There exists a high proportionality between the values of the indices S_{reg} and the number of icebreaker assistances, requested by all kind of vessels plying between the coasts of the Baltic Sea. The icebreakers are ready to assist any ship on the ice obstructed routes of the Baltic Sea, from the Belts to the farthest ends of the Bothnia Bay or the Gulf of Finland. Varied ice conditions in the Baltic Sea cause much greater navigational difficulties in the northern and eastern parts of the sea. One of the indicators of those difficulties is the number of cases, in which the assistance of icebreakers is indispensable. For instance, in the 50 years considered here, the number of assistances of only the Swedish and Finnish icebreakers varied from 121 in the winter season 1991/92 to as many as 4107 during the winter 1986/87 (Grafstrom & Kiggren, 2007). The relationship between the ice severity (by the severity indices for Baltic Sea and Aland Sea) and icebreakers activities (number of cases, in which the Swedish and Finnish icebreakers assisted the ships) is presented by the comparison, of how these two winter features varied during the 50 winters of 1956 – 2005 (Figure 1).

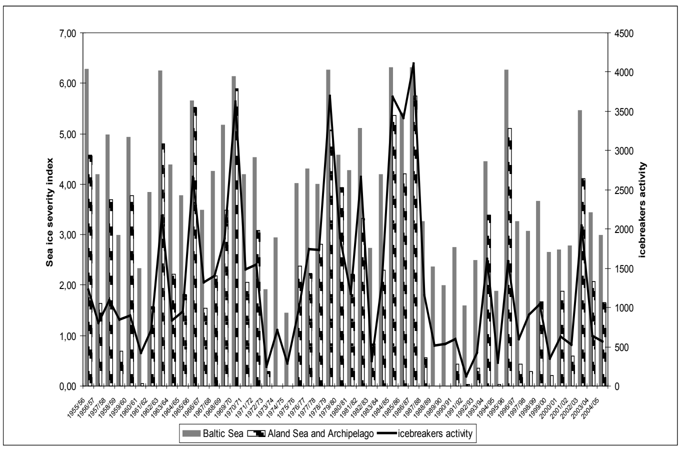

Figure 1. Long term icebreakers activity variation (in annual number of assistance cases) compared to winter severity (represented by the sea ice severity indices) during the winters 1955/56 – 2004/2005.

The seasonal sea ice severity is presented by the ice severity index S averaged over the whole Baltic Sea and regional, and the ice breakers activity is shown in number of cases, in which icebreakers assisted the ships. It must be stressed here that the BSIS are always supported by both the icebreakers and the ship masters in gaining actual information on ice conditions on their sea routes.

2 THE SCOPE OF ACTIVITIES AND ORGANISATION OF THE BALTIC SEA ICE SERVICES

The Baltic winter navigation depended always very much on the ice conditions in the sea. The sea ice occurs different in form and amount, depending on the sea area and the winter season. As the maritime traffic on the Baltic Sea constitutes a substantial amount in the whole of the Baltic countries transport, Sea Ice Services (SISs) have come into being. They constituted the Baltic Sea Ice Meeting (BSIM) – a body, which assembles the parties, which are interested in warnings against bad ice conditions, and in protection of navigation in ice in the Baltic Sea. An indispensable co-operator to this body was always the company “Baltic Icebreakers”. To-day within the BSIM operate by the SISs of Denmark, Sweden, Finland, Russia, Estonia, Latvia, Lithuania, Poland and Germany, Netherlands, Norway and the Baltic Icebreakers (Fig.2). The main statutory duties of the SISs is the acquisition, processing and dissemination of actual information on sea ice conditions and on obstructions to navigation due to sea ice. The existence of BSIM and cooperation between SISs guarantees the use of standardised ice messages, codes, graphic symbols, formats, etc in the ice data exchange not only between all these countries but also for navigators.

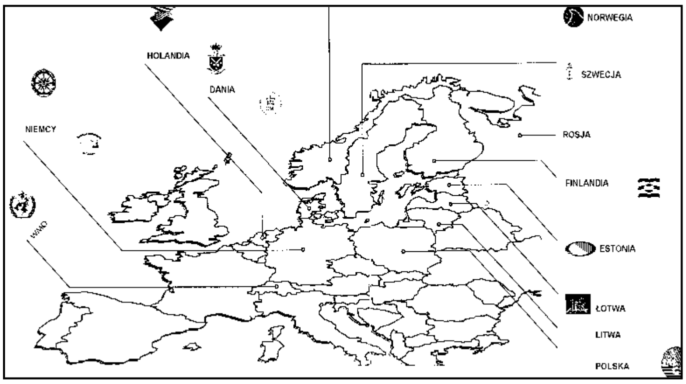

Figure 2. Sea Ice Services in the Baltic Sea Ice Meeting.

BSIM as well as SISs is working on two levels – the national one and the international.

The national level involves :

– network of coastal observing posts,
– data collecting centre,
– Sea Ice Service National Centre

The Sea Ice Service National Centre is responsible for :

– acquisition of all possible ice information (from beyond the routine ice observing network data) as icebreaker data, satellite data, air reconnaissance data etc,
– data control and interpretation,
– edition and dissemination of ice information in form of ice reports, ice bulletins, ice charts etc,
– forecasts of ice conditions development,
– exchange of ice information - locally, and in the region - internationally,
– co-operation with icebreakers.

The international level demands for:

– daily routine exchange of ice information products between the Sea Ice Services,
– international co-operation with Ice Breaker Service,
– participation in BSIM conferences in order to asses the activities of the National Sea Ice Services, to implement the developing technologies into these activities and to adapt these activities to changing economic and political conditions,
– co-operation with the WMO, JCCOM as well as with International Ice Charting Working Group (IICWG).

Between the BSIM conferences, the activities of the Sea Ice Services are co-ordinated by the representatives of the National SISs, under the leadership of the acting BSIM Chairman.

3 SHORT HISTORY OF THE BALTIC SEA ICE SERVICES

Importance of the winter navigation in the Baltic Sea on one side and on the other – serious sea-ice borne difficulties, forced in the regions of severe winters regular sea ice observations already in the middle of 19-th century. This, however, was initiated by individual countries (the economy of which mostly depended on sea traffic, also in winter). Therefore the first observations were carried out only in those countries, with no integration on larger scale.

The tragedy of “Titanic” powered to create the first in the world, a completely organised, world wide sea ice service (International Ice Patrol). In this time Europe began also to develop the protection of winter traffic in sea ice conditions. However the World War 1 and the following formation of new political systems on the continent did not allow to meet the Baltic ice experts earlier than in 1925 (Strubing 2003). That ensemble of experts on protection against sea ice discussed the in that time available instruments of information exchange; among others they proposed the use of the Baltic Sea Ice Code (BSIC). Already in 1926, on the 1st Conference of the Baltic Hydrographers (CBO) in Riga the frames of data exchange standardisation had been settled, and one year later, on the 2nd CBO, the first BSIC was accepted. The recommendations of this Conference were implemented very soon, and already in the severe winter 1928/29 the majority of information, among them the ice charts, was used according to the uniform BSIC rules. In the year 1936, on the 5th CBO in Helsinki the status quo of the SISs was discussed, including reports on their organisation and activities. Also the sea ice terminology was completed and accepted, together with the multilingual terminology of the BSIC.

The World War 2 interrupted the co-operation within the BSIM. The National SISs, however, resumed their ice information exchange by the same rules as before, straight away after the war ended. Not earlier, however, than in the year 1954 the ice experts of Denmark, Finland, Federal Republic of Germany, the Netherlands and Sweden activated the BSIM to compile the International Sea Ice Terminology and to actualise the BSIC by enriching its content. Short after 1956 also the former German Democratic Republic, Poland and the former USSR sent their representatives to resume the co-operation within the BSIM. Further meetings of this body consisted in improving the information exchange technologies, in the revision and actualisation of BSIC and ice chart (among them the Sea Ice Egg Code), in completing the multilingual vocabulary of sea ice terminology, digitalisation of ice charts by introducing the SIGRID code and last, but not least, in implementing the mathematical prognostic models of ice conditions development into the operational routine. Successive years brought enormous development in both observation technologies (remote sensing, aircraft reconnaissance, radar and satellite imagery) and in data transmission (internet, Navtex, other mass etc). Successive BSIMs had to cope with that abundance of potentiality to be implemented into the Sea Ice Service observing practices, into data transmission and forecasting. Sea ice codes had to be repeatedly revised and completed, also due to political changes in the last decade of the 20th century. In the year 2005, on 21st BSIM in Riga the Memorandum of Understanding of the Sea Ice Services has been signed by the majority of the national services.

4 BALTIC SEA ICE CODE

This code is a set of conventional numeral symbols used in transmitting messages on ice conditions and obstruction to navigation due to sea ice in particular areas of the Baltic Sea, in ports and approaches to them and on other sea router (about 500 observational posts). After having collected all the ice messages from its region of responsibility, each individual SISs prepares national ice report/ice bulletins (Fig.3) and transmits it to be broadcast by the Global Telecommunication System (GTS). The first edition (used as national code from 1920/21) of Baltic Sea Ice Code (from 1928/29) contained only two groups, specified as “j” and “k”. Under “j” described were the ice conditions, under “k” – the obstruction to navigation due to the ice. The second BSIC established in 1954/55 (used in Poland from1963) and revised in 1969, was modified by adding another group on ice development. Now by “i” were meant the ice conditions, by “j” – ice development, and by “k” – impact on navigation by ice. The third BSIC has been introduced in 1981 and is till to-day in use. It described the ice conditions in ports, fairways and significant navigation channels. BSIC (in ice bulletins and reports) with ice charts give the detailed information for ships’ officers of actual ice and navigation conditions. The sea and navigation areas of each country are designated by capital letters AA, BB, CC ets. Each area is subdivided into parts numbered from1 to 9. Baltic Sea Ice Code (Figure 3) consists of four groups:

A_B – amount and arrangements of sea ice,

S_B – stage of ice development,

T_B – topography or form of ice,

K_B – navigation conditions in ice

STPL42 SOWR 120758
POLISH ICE REPORT 120201
AA 10//0 24200 36241 44211 55312 65312
BB 11100 23000 31100 44320 57260 62000 77260
CC 18353 25213 35313 43213 55123

Figure 3. An example of Polish Sea Ice Report from 12 of Feb.2001

where CC18353 after decoding:

CC “1” = observational post; here Swinoujscie, Pomerania Bay,

“8” – fast ice,

“3”- grey-white ice,

”5”-rafted ice,

”3”-navigation without icebreaker assistance possible only highpowered vessels of strong construction and suitable for navigation in ice.

The receivers of the ice reports from the whole sea region use them, after having decoded them, to compile their routine products: ice bulletins, ice charts and other information, e.g. the forecasts. Ice report/ ice bulletin is edited daily or weekly, depending on the severity of sea ice situation. Also ice bulletins, which give detailed ice situation in the whole Baltic Sea area are issued routinely, in national languages and additionally in English. Bulletins can be mailed in paper form or e-mailed to the users.

5 ICE CHARTS

Ice charts were one of the oldest methods to distribute the information on sea ice conditions and on the obstructions, which the ice could be to navigation. The first ice charts, which now are stored in archived form, were drawn already in the end of 19th century. As a routine product of the SISs, however, they were issued not earlier than about the nineteen thirties. The main aim of an Ice Chart is to project on a map the actual ice conditions in the given sea basin or route.

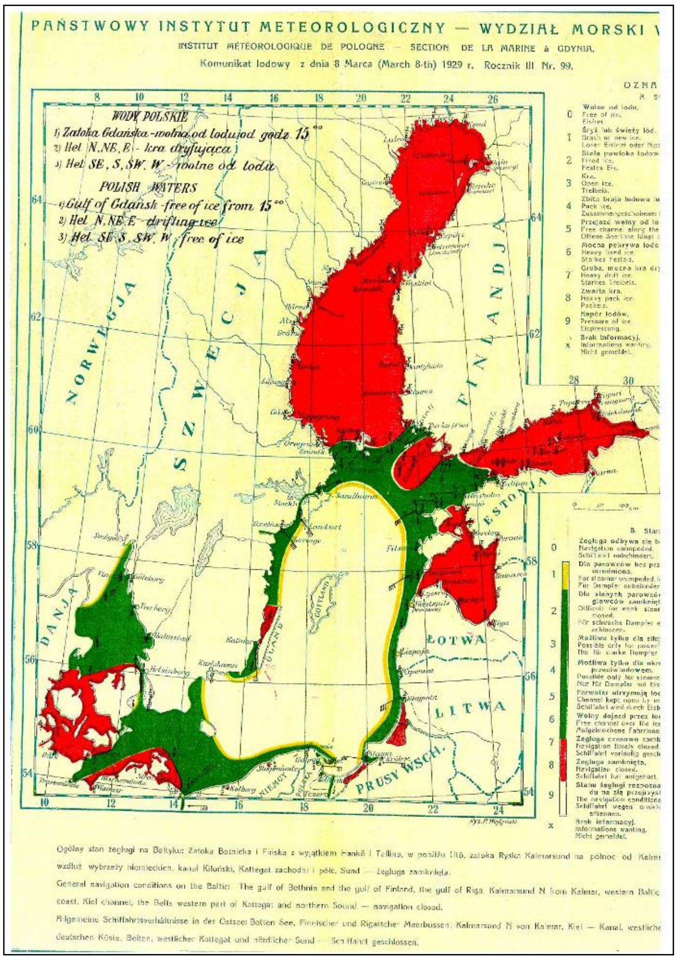

Figure 4. Polish Ice Chart from 8 of March 1929, issued by the Maritime Branch of the Państwowy Instytut Meteorologiczny in Gdynia.

Thus, an ice chart is a graphic supplement of the ice information contained in the Ice Report/Ice Bulletin and is issued daily, when ice conditions are severe, or twice a week, when the winter is calm.

The form, in which the ice conditions were presented on the ice charts, depended on the contemporarily available presentation technologies and on the accepted graphic symbols. Important also were the ways by means of which the maps were distributed to the users, especially ship masters, icebreakers, port officers.

The oldest Polish archived Ice Chart is dated on winter 1929 and is reproduced in Figure 4.

The chart was issued by the Wydział Morski in Gdynia of the contemporary Państwowy Instytut Meteorologiczny (Polish National Meteorological Institute). Ice conditions were presented by numbers of code in due chart places and the degree of obstructed navigation – by different colours. Beside of the graphic presentation a general description of ice conditions was given in plain language in Polish, English and German. Additionally, a more detailed description of ice situation in the Polish waters was given, including information on air temperature and wind. This, however, was a hand-made chart, delivered by messengers or mailed.

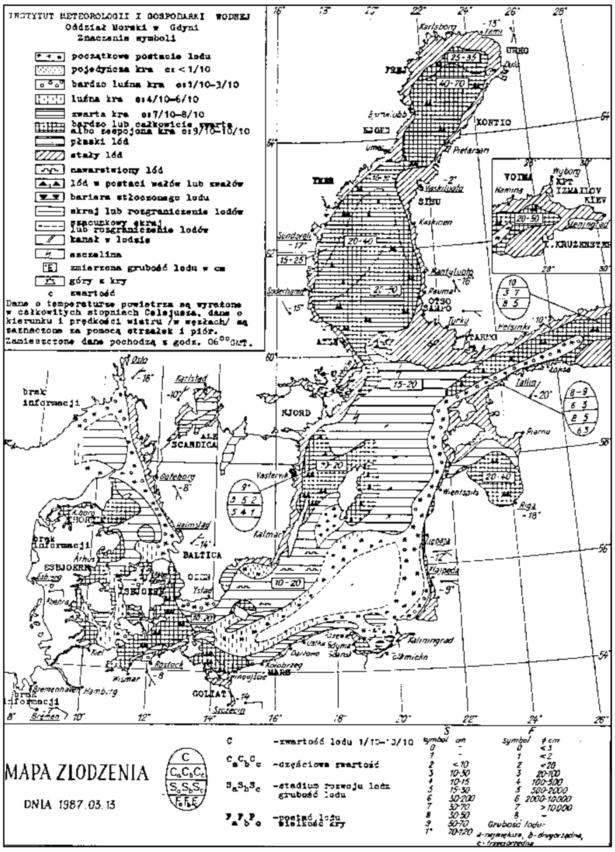

Figure 5. Polish Ice Chart from 13 of March 1987, edited by Oddział Morski IMGW in Gdynia (Marine Branch of the Institute of Meteorology and Water Management).

In the post-war decades, along with the telecommunication and other technical means development, the appearance of ice charts changed. When the facsimile transmission got possible, ready ice charts, in order to be transmitted to the addressees, had to be monochrome. Therefore, since 1981, new principles of one-colour drawing of ice charts were set. The Polish Ice chart had a conform conic projection and covered the area of the whole Baltic Sea, including Kattegat. Further, it gave all indispensable information on the ice conditions in the sea, the bays and lagoons.

Additionally, thickness of ice was added and names of icebreakers operating in particular sea areas could be inserted. However, preparation of an ice chart in that way was laborious enough (Fig.5).

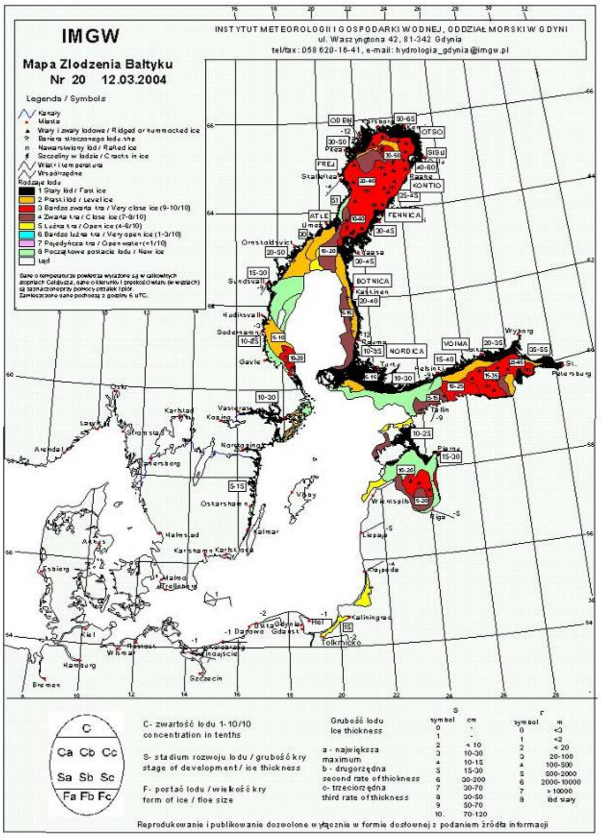

Figure 6. Ice chart of 12 of March 2004, issued by Oddział Morski IMGW in Gdynia

Further enormous development of the telecommunication facilities, as satellite links, internet, simplified both the transmission and preparation of ice charts and allowed for a come-back of coloured charts (Fig.6).

Similar ice charts are edited by the majority of SISs, excluding Lithuania and Latvia. Russia reduces the area of its Ice Chart to the Gulf of Finland only, Estonia to the Gulf of Finland and the Gulf of Riga.

6 SUMMARY

The above discussed Baltic SISs' products (ice messages, reports, bulletins, ice charts and forecasts) do not involve the full list of sea ice information which is collected, processed and disseminated by these bodies. Merely mentioned were the ice development and movement forecasts. Also the users were scarcely mentioned, as the circle of users depends on individual needs of given country's national economy. Once more the role of telecommunication must be stressed. In previous ice seasons sea ice information was broadcast by radio, routinely with weather forecasts. Since nineteen nineties it is available by NAVTEX. Beside of this, the SISSs' products are published by internet – both on the web pages of the particular SISSs' as well as on the web of the BSISs.

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