Operational Management of the Saint Petersburg Flood Protection Barrier

Report on the International Workshop, 19-20 May 2005
Saint Petersburg Russia

July 2005

Operational Management of the Saint Petersburg Flood Protection Barrier

Report on the International Workshop, 19-20 May 2005
St. Petersburg Russia

Prepared for RIKZ
by WL | Delft Hydraulics
Report No. Z3979

H. Gerritsen, N. Villars

July 2005

Contents

1 Introduction

1.1 Cooperation St. Petersburg and The Netherlands

For more than 10 years, the City of St. Petersburg and the Ministry of Transport, Public Works and Water Management of the Netherlands have had a strong cooperation on Water Management and Transport. One component this is regular meetings by the 'Standing Committee' on cooperation, in which both parties participate. During the last Standing Committee Meeting of September 2003, it was agreed that the future co-operation between the City Administration of St. Petersburg and the Ministry of Transport, Public Works and Water Management of the Netherlands will focus on the following issues:

a) Exchange of experience and methods for flood prediction as a basis for early warning and future operational management of the storm surge barrier. In this respect, a joint seminar will be organized with experts in the field of flood prediction and operational use of methods for gate operation.
b) Continued co-operation on integrated water resources management, also including issues of coastal protection and coastal zone management. In this respect, both parties will exchange expertise and know-how on a variety of subjects like:
    - GIS flood warning and damage assessment;
    - Environmental monitoring;
    - Nuisance algae blooms;
    - Public awareness and communication.
c) Participation of experts and officials of the City Administration in the Conference 'Managing European Water Crisis', which took place on 6 and 7 November 2003 in Amsterdam.

The international workshop organized in St Petersburg on the 19-th and 20-th of May 2005 gives interpretation to the first agreement. The National Institute for Coastal and Marine Management (RIKZ) of the Ministry of Transport, Public Works and Water Management together with the Committee for External Affairs and Morzaschita Department under constant support by the Consulate-General prepared a joint workshop to exchange and to evaluate the experience of operational management of important flood protection barriers. A limited group of Russian and international experts were invited to participate in this event. It has been a fruitful co-operation which resulted in a successful workshop of which this report is a result. The outcome of this workshop includes an overview of lessons learnt and recommendations to prepare the future gate operation of the Flood Protection Barrier of St. Petersburg. The results of the workshop are formally recorded in a Memorandum, which can be found in Chapter 2 of this report.

1.2 St. Petersburg and its history of flooding

Czar Peter the Great founded the city of St. Petersburg in 1703 in a low-lying area, where the delta of the river Neva meets the waters of the Gulf of Finland. And with these three elements – low-lying city, river delta and Gulf – the present problem of St. Petersburg is defined. High water in the Gulf causes frequent flooding of the low areas of the city, while the river outflow carries the effluent of the population and industry of the city of five million people to the shallow eastern part of the Gulf and Neva Bay.

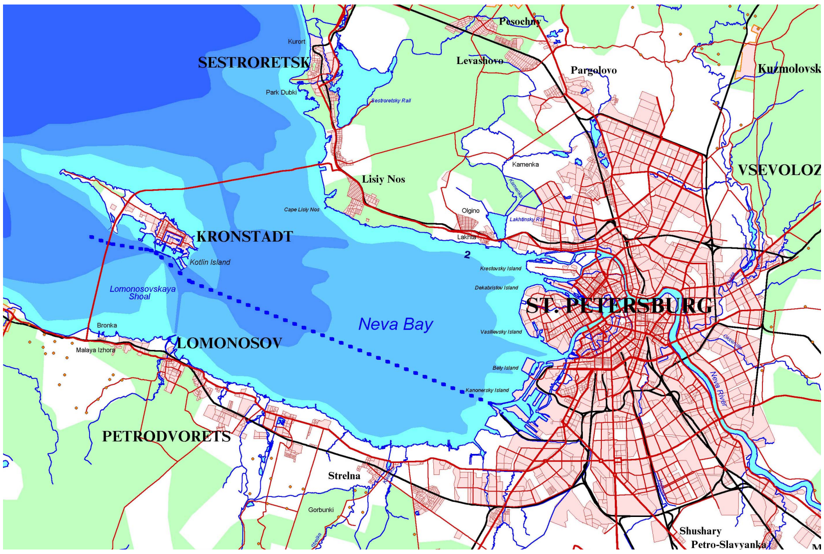

Figure 1: Map of St. Petersburg and the location of the Barrier in Neva Bay.

Flooding of the city has been a concern since its foundation. Between 1703 and now, a total of 300 floods or water level rises with peaks higher than 160 cm BS[1] have been recorded, that is about 1 per year. The most recent one occurred on 9 January 2005. When the water level reaches 160 cm BS, streets and basements in the low lying parts of the city centre start to flood, and a flood is officially recorded. The five largest floods occurred in 1824 (421 cm), 1924 (380 cm), 1777 (321 cm), 1955 (293 cm) and 1975 (281 cm BS). There are indications that the flood frequency is increasing: in the 22 years since 1980, 51 floods have occurred, which is about 2 per year.

The damage incurred by floods increases with flood level and duration of the high water and is not restricted to material damage alone. For example, in 1824 over 300 people lost their lives due to the flood. With the present population, a flood of 300 cm, which has a return period of 50 years, could already be catastrophic. It will lead to damage to public infrastructure such as roads, bridges, embankments, flooding of the metro system, overflow of sewerage systems and to serious flooding of buildings. This notably includes buildings of historic and cultural value, which largely are located in the low lying city centre, such as the Hermitage and many other museums.

1.3 The St. Petersburg Flood Protection Barrier

Planning of the present flood defences started in the 1960s, driven by the serious flood of 1955. An extensive and thorough feasibility study addressed technical issues, environmental impacts, economic aspects and many more. Based on the studies, the Government of the

[1] *BS (Baltic System) is the reference datum for water levels in the Baltic Sea. 0 cm BS roughly corresponds to the long-term mean sea level at Kronstadt.*

Soviet Union in 1979 approved the construction of a western variant, consisting of a 25.4 km long Flood Protection Barrier across the island of Kotlin, west of the city of Kronstadt, see Figure 1. The Barrier is composed of 11 dam sections D1 - D11, 6 water exchange complexes B1 - B6 distributed along the Barrier to allow free passage of water and 2 navigation passages S1 and S2. Figure 2 shows the concept of the Barrier, including the width and depth of each opening.

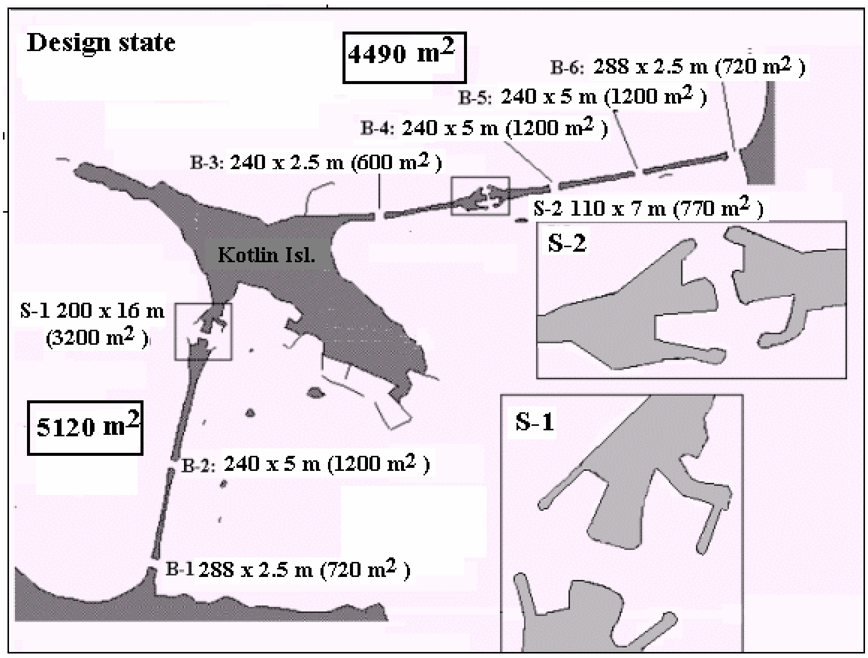

Figure 2: Design of the St. Petersburg Flood Protection Barrier

Construction started in 1980 and by December 1984 Kotlin was connected to the northern coast via the Barrier. In the autumn of 1987 concerned citizens appealed to Secretary General Gorbachev. They felt that the observed pollution of Neva Bay was caused and aggravated by the construction of the Barrier and they protested against its completion. As a result, the construction was temporarily halted. In short succession, three commissions of Soviet experts were nominated to investigate the environmental state of Neva Bay and the possible role of the Barrier in this. The reports of the commissions disagreed on the influence of the Barrier, however. In 1990, an International Commission of experts was subsequently invited to study and evaluate the issue. In its report, this Commission confirmed the serious environmental state of Neva Bay, and made clear that the impact of the completed Barrier on the environmental state would be minimal. It recommended that completion should proceed as planned. In parallel, measures to improve wastewater treatment should be implemented as discharge of untreated or partially treated sewerage was the main cause for the deteriorated environmental state of the Bay. Although these results were generally accepted during the years that followed, the work continued at only a minimal pace. Due to the break-up of the Soviet Union shortly thereafter, work between 1987 and 2002 was largely limited to maintenance of works already completed.

1.4 The Project for the Completion of the Barrier

In 2002, the European Bank for Reconstruction and Development (EBRD) was requested by the Ministry of Finance of the Russian Federation to participate in the funding of the completion of the partially constructed St Petersburg Flood Protection Barrier. As a first step, the EBRD required a four part feasibility study of the project for the completion to be undertaken:

- Technical Feasibility Study (TFS) – financed from the Netherlands' Trust Fund;
- Environmental Study (EIA) – financed from the Japanese Trust Fund (JECF);
- Cost Recovery Study (CRS) – financed from the Netherlands' Trust Fund; and
- Economic Analysis (EA) – financed from the Taiwanese Trust Fund.

The above paved the way for an accelerated completion of the St Petersburg Flood Protection Barrier (FPB) via a loan from an international consortium of banks, led by EBRD, in combination with federal funding from the Russian government. The Loan Agreement between the Government of the Russian Federation and EBRD was signed in December 2002.

As a first step, in 2003 a contract for the Detailed Engineering was awarded to the Consortium lead by Halcrow, with DHV and Norplan as main foreign subcontractors, and Lenhydroproject the lead Russian subcontractor. In 2004, the Project Management contract was awarded to Geningconsult, in combination with sub-consultant Royal Haskoning. In 2004, first contacts were awarded for construction works on the sluices. In 2005, construction contracts for the remaining parts will likely be awarded to joint ventures of Russian and foreign contractors. The full completion is scheduled for the end of 2008 or 2009. This implies that by then the main navigation channel should have been relocated and all the water-passing complexes and both navigation openings are fully operational.

1.5 Operational Management of the Barrier

All through the 1980-ies and 1990-ies, the City of St. Petersburg was responsible for the construction of the Barrier. The requirement of a Sovereign Guarantee for the Loan directly from the Federal Government resulted in a transfer of the responsibilities for the construction to the Federal Government in 2003. The Federal Government has entrusted the responsibilities for the construction and (preparation for) operational management of the FPB to the Federal State Enterprise "Northwest Management of Gosstroy of Russia – Management of the Complex of Protective Constructions St. Petersburg from Flooding", or for short: the Barrier Authority (Government Decree N1521-r of 20 October 2003). The Barrier Authority (BA) is accountable to the Federal authorities. Both from their past, and through present responsibilities, many organisations in St. Petersburg have expertise and duties which are directly relevant for operational management, such as environmental monitoring and forecasting. The Government of St. Petersburg being the main beneficiary of the barrier, further discussions are presently taking place about the specific role of the Government of St Petersburg in the future Operational Management.

During the next few years 2005-2008, key technical aspects need to be realised. Equally, the existing monitoring and flood forecasting system needs to be upgraded to ensure timely and tailored high quality information on expected flood heights, timing and duration.

Operational procedures need to be proposed, discussed and agreed in order that the Barrier Authority and the City Administration can operate with the full consent of the stakeholders.

1.6 Balancing stakeholders interests and sustainability

Besides the St. Petersburg port, the main stakeholders are the City Administration, fisheries, recreation, drinking water supply and water purification organisations (Vodokanal), the emergency services (MChS), institutions of world cultural heritage, and the population as a whole. Implicitly or explicitly, all stakeholder interests need to be properly taken into account in the decision procedures regarding the Barrier management / gate manoeuvring. The discussions on this should start early, as development of workable arrangements requires a high level of consensus between the stakeholders, which takes time.

1.7 Objectives of the International Workshop

The proposed international workshop aims to exchange common practice on criteria and methods for operational management of flood protection barriers and to identify the need for future modifications in view of expected climatological changes (rainfall, storm events) and sea level rise

For St. Petersburg in particular:

- to create awareness and consensus amongst the stakeholders on the need to thoroughly prepare for operational management in the next few years (in parallel to the completion of the construction itself);
- to create awareness and consensus amongst the stakeholders on the issues involved in Operation Management, such as:
  - criteria for closure
  - responsibilities of various stakeholders and related legal issues
  - necessity of an accurate flood warning and forecast system;
- to draft a Workshop Protocol or Memorandum with conclusions and recommendations, focusing on three aspects:
  1. general conclusions on operational management of flood protection barriers;
  2. specific actions needed to prepare the operational management of the St. Petersburg Flood Protection Barrier;
  3. to specify the need and issues for future international cooperation

To structure the Workshop, and optimise the potential use of international experience, the following theme sessions were created:

- Introductions; the Barrier Project
- Experiences with operation of existing barriers in Europe
- Various stakeholder issues
- Flood forecasting, prediction methods, measurements, monitoring
- Legal issues, flood warning requirements for St. Petersburg
- Conclusions and recommendations

For each session, key Russian and international experts were asked to discuss the topic based on their expertise, and their ideas on how they viewed the situation for St. Petersburg Barrier, see Chapter 3 for details.

1.8 Participation and audience

In order to meet the workshop aims, the organisers invited firstly the various key stakeholders in the St. Petersburg area, which have an interest in the future Barrier, either from management, economic activities, environmental protection, its construction or further angles. A second group of participants was formed by foreign specialists bringing in their hands-on experience with flood protection management and operational barrier management, to share their specific relevant expertise. A third group was formed by the representatives of international financing organisations such as the EBRD, EIB and NIB. Various presentations addressed the topics based on existing experience, in order to guide the discussion on possible ways forward for the St. Petersburg case. The presentations and the discussions are summarised in this report, which was disseminated among the participants after the workshop.

Press coverage was pursued. The press release for the workshop (Appendix A) was published in the Informational Bulletin of the Administration of St. Petersburg, and there were announcements in other informational sources. Several journalists for TV, radio and written media participated and interviewed organisers and participants, which resulted in several articles and broadcasts on radio and TV.

The participants include representatives of the following parties:

1. **Russian participants:**
   - City Administration;
   - Oblast administration;
   - Barrier Authority
   - Relevant local authorities (Sea Administration of Port, Civil Protection Agency, Municipalities, Northwest Department of the Hydrometeorological Service);
   - Project Implementation Unit;
   - Engineering organisations / project designers;
   - Scientific organisations.

2. **Foreign participants:**
   - Netherlands Consulate-General;
   - Barrier Managers and specialists – speakers from The Netherlands, Italy, Sweden and UK.
   - Representatives of Dutch Ministry of Transport, Public Works and Water Management;
   - International Consultants involved in the project.

3. **Financial organisations:**
   - EBRD;
   - EIB;
   - NIB.

In Appendix B, a complete list of the participants who attended the Workshop is given.

1.9 Organisation of the Workshop

The Workshop was organised within the framework of the so-called Standing Committee on cooperation between the City Administration of St. Petersburg and the Netherlands Ministry of Transport, Public Works and Water Management. The members of the Standing Committee were the main organisers: the National Institute for Coastal and Marine Management (RIKZ) of the Ministry of Transport, Public Works and Water Management on the Netherlands side and the Morzaschita Department and the Committee for Foreign Relations of the Government of St. Petersburg on the Russian side. The Consulate-General of The Netherlands in St. Petersburg effectively facilitated the organisation.

The international scientific and technical preparation was entrusted to WL | Delft Hydraulics and DHV, which have specialist expertise on key topics of the workshop and have been / are actively involved in projects for the completion of the St. Petersburg Barrier.

The location of the workshop was the House of Architects, a well-known palace in the centre of St. Petersburg.

The organising committee

On the Netherlands side:

- Ms. Bianca Peters and Mr. Hans van Pagee (Ministry of Transport, Public Works and Water Management, Rijkswaterstaat)
- Dr. Herman Gerritsen and Ms. Nicki Villars (WL | Delft Hydraulics)
- Mr. Marius Sokolewicz and Ms. Nicole Kragtwijk (DHV)

On the Russian side:

- Mr. Alexander N. Savin and Mrs. Rosa R. Mikhailenko (Morzaschita Department of the Government of St. Petersburg)
- Mrs. Anna A. Sakharova, (Committee for Foreign Relations; of the Government of St. Petersburg)

(This page intentionally left blank.)

2 Memorandum of the Workshop

One of the aims of the workshop was to document the main results of the workshop in a Memorandum with conclusions and recommendations, focusing on three aspects:

1. General conclusions on operational management of flood protection barriers;
2. Specific actions needed to prepare the operational management of the St. Petersburg Flood Protection Barrier;
3. Need and issues for future international cooperation.

At the end of the workshop, the present Memorandum with the most important findings was prepared. The Memorandum was signed by Mr. A.I. Vakhmistrov, Vice-Governor of St. Petersburg and Mr. E.W.V.M. Hoeks, Consul-General of the Netherlands in St Petersburg to confirm the commitment of both the Netherlands and the City of St. Petersburg to the conclusions presented therein. The full Memorandum is in the next pages.

«AGREED»

Consul General of the Kingdom
of The Netherlands in Saint-Petersburg

__________ E. W. V. M. Hoeks

«__»__________2005

«CONFIRMED»

Vice-Governor of Saint-Petersburg

__________ A.I.Vakhmistrov

«__»__________2005

Memorandum
on the Summary Results of the International Workshop "Operational Management of the Flood Protection Barrier of Saint-Petersburg and Development of Flood Warning System"

20 May 2005 Saint-Petersburg

Within the framework of cooperation between the City of Saint-Petersburg and the Ministry of Transport, Public Works and Water Management of The Netherlands a joint international workshop on the future operational management of the Flood Protection Barrier (FPB) of Saint-Petersburg was held on 20 May 2005. Vice-Governor of Saint-Petersburg A.I.Vakhmistrov, Consul General of the Kingdom of The Netherlands in Saint-Petersburg E.W.V.W. Hoeks, experts, well-known specialists from The Netherlands, the United Kingdom, Italy, Sweden and Russia participated in the workshop.

The main purpose of the workshop was sharing experience with the Russian specialists on operational management of the similar flood protection barriers in European countries, establishing creative and business contacts for setting up a modern and reliable system of the operational management of the Flood Protection Barrier of Saint-Petersburg as an important link to optimally realize "The Programme of Measures on the Development of the Integrated Water Management of Saint-Petersburg for the period of 2005-2009", adopted by Decree of the Government of Saint-Petersburg dated 25.05.2005 №804.

Agreed summary of results

Within the framework of the cooperation between the City of Saint-Petersburg and the Ministry of Transport, Public Works and Water Management of the Netherlands a joint international workshop on the future operational management of the St Petersburg Flood Protection Barrier has been organised. Based on presentations and discussions, the participants have outlined the following summary of results:

1. General conclusions on operational management of Flood Protection Barriers

1.1 The flood protection barriers (FPB): the Thames Barrier, the Eastern Scheldt Barrier, the Maeslant Barrier near Rotterdam, the barrier near Venice and the Barrier of St. Petersburg as presented in this Workshop, are unique in the world.

1.2 The opening and closure criteria for operational management of FPBs ask for dedicated procedures that are tuned to each unique local conditions, including characteristics of water system and regional characteristics as presence of a port entrance, economical activities, ecological and environmental conditions.

1.3 Despite the differences in barrier constructions and local conditions, the operation of the considered FPBs deals with common issues like:
- flood warning systems
- storm surge
- sea level rise
- climate change (increased rainfall, heavier storms)
- environmental protection
- interference with navigation/shipping.

1.4 The formulation of closure (and opening) criteria and procedures is a process that takes time (years), as besides the scientific challenges like an accurate flood prediction model, also the stakeholders and politicians involved should agree upon the procedures and administrative aspects.

1.5 Operation of FPBs need strict closure (and opening) criteria and procedures and clear responsibilities need to be formulated (plus motivation). All this should be legalized in order to prevent discussions during emergency situations.

1.6 These strict closure (and opening) procedures can be either manual, automatic or both. Which one to choose depends on the local situation and related failure analyses.

1.7 An in-depth failure analysis is needed to anticipate failures that may occur in emergency situations and to identify weak links.

1.8 The decision team to decide or control closure (and opening) should be able to operate within and according to the prescribed legislation without interference by politicians or stakeholders.

1.9 Accurate flood predictions are necessary to avoid false closures (economical damage) or avoid failures in closures (failing protection) because no action was taken. This is essential for confidence of the public and stakeholders.

1.10 The accuracy of flood prediction highly depends on the accuracy of meteorological forecasting. Further model improvement, validation and the use of data assimilation can improve short term forecasting.

1.11 Regular training of operation team, testing of materials, and presence of back-up (i.e. back-up team, back-up electricity) is necessary to minimize the chance of failure.

2. Recommendations and actions needed to prepare the operational management of the St Petersburg Flood Protection Barrier

2.1 Complexity. Given the various gate sections (6 for water exchange and 2 for shipping), the St Petersburg Barrier is the most complex system considered in this workshop.

2.2 Preparation time. The operation of the St Petersburg barrier is not straightforward and requires a well-founded preparation that needs to be documented carefully and legally approved. In view of the experience from other barriers in Europe a preparation period of at least 3-5 years is needed (although it is noted that some preparations have already started).

2.3 Decision for closure. A decision needs to be confirmed on manual or automatic closure, or a combination of both (taking into account the complexity of the barrier).

2.4 The operational process and the design and building process are linked.

- Therefore the sequence of closure of the different barrier sections needs to be confirmed. These decisions have enormous consequences for closing criteria and procedures and possibly also for the energy supply and design of the barrier.
- Given the fact that translation waves may occur, it may be better not to close all gates at once but in phases.
- The above points have been and are being considered by the designer.
- It is important that the organization that will be responsible for the (future) maintenance and operation has a role in the building phase of the barrier.

2.5 Opening of the barrier. Opening criteria and its procedures are of the same importance as the closure criteria and also need special attention due to the Neva discharge. The risk that St Petersburg could be flooded due to river discharge when the barrier will be closed for a longer period, needs to be considered in the operational procedures.

2.6 Failure analysis.

- A failure analysis (unwanted or failing opening/closures) should be made to identify weak links and to adapt procedures for improvement.
- A series of test closures is necessary to learn about weak points and avoid failures.

2.7 Flood prediction. As the situation in St Petersburg is very complex, an accurate and reliable flood prediction model is essential.

- Continue the improvement and validation of water level prediction using mathematical modelling connected to meteorological forecasting using HIRLAM data.
- More detailed information / monitoring is needed to improve the quality of the prediction of the water level, which is needed for an optimum closure and opening process of the barrier.
- Modelling of currents and water levels in and around C-1 and C-2 is necessary to provide information for navigation.

2.8 Integrated Water Management. The FPB is an important part of Integrated Water Management of St Petersburg. To improve the ecological situation in Neva Bay and the Eastern part of the Gulf of Finland, it is necessary to investigate and create the capability of manoeuvring the water gates of the FPB in case of - amongst others - toxic algal blooms or accidental oil spills.

2.9 Cooperation. Good cooperation between authorities and institutes is essential to obtain the common aim: protecting the City of St Petersburg from flooding.

2.10 When the barrier is completed it can become a tourist attraction and export product. Together with exhibition facilities for visitors this can be used to promote visits to the City and its environments.

Additionally, the Port Authority advises:

- to consider the possibility of completion of C-2 before C-1 for smooth transition of navigation
- to provide the Barrier staff with the operational information on navigation towards and from St. Petersburg.

3. Needs and issues for future international cooperation

3.1 Sharing experiences and knowledge on operational management of Flood Protection Barriers during this workshop has been considered very fruitful. Continuation of sharing experiences and knowledge by setting up an international network (including ecological aspects) is being considered valuable by managers of the present barriers Thames, Eastern Scheldt, Rotterdam (Maeslant), and future barriers of Venice and St Petersburg. This network can unify managers of the large Flood Protection Barriers in the world and arrange meetings on common issues on a regular basis (once every 1.5 years).

3.2 A good opportunity to organize a follow up Workshop could be linked to the IAHR congress in July 2007 in Venice which will have a focus on Flood Protection and Storm Surge Barriers.

3.3 Issues of interested for future cooperation and exchange of data and information, include:

- use of meteorological data (real time measurements and forecasting, HIRLAM data)
- use of water level data (real time measurements and prediction methods)
- methodology for failure analysis for closure and opening (weak links)
- response to climate change and sea level rise
- use of barrier for environmental protection and rescue operations (accidental oil spills, nuisance algal blooms, etc.).

(This page intentionally left blank.)

3 Workshop programme

Day 1, Thursday, 19 May 2005

9:30 – 10:00	Arrival of participants; coffee	
Session 1	**Introductions; the Barrier Project**	
10:00 – 10:10	Savin, Alexander Nikolaevich, co-chairman, Morzaschita, St. Petersburg Government Vakhmistrov Alexander Ivanovich, Vice-Governor of St. Petersburg Alpat`ev Vladimir Pavlovich, Head - Department for Economic and Capital Investment Rosstroy	Welcome Official opening of the Workshop Welcome on behalf of Rosstroy
10:10 – 10:20	Mr. Ed Hoeks, Consul-General of The Netherlands	Russian – Dutch cooperation of water problems
10:20 – 10:30	Mr. Hans van Pagee, co-chairman; Rijkswaterstaat, The Netherlands	Aims and challenges of this workshop
10:30 – 10:50	Mr. Sergei N. Kuraev, Chief Engineer of the Design and construction of the FPB; LenHydroproject	General Introduction to the Barrier design and time schedule of completion
10:50 – 11:00		Questions and discussion
11:00 – 11:30	Coffee break	
Session 2	**Experiences with operation of existing barriers in Europe**	
Chairman	Mr. Alexander N. Savin	
11:30 – 11:55	Mr. Krijn D. Saman and Mr. Hans Jager, Rijkswaterstaat, Middelburg, The Netherlands	Operational Management of the Eastern Scheldt Barrier
11:55 – 12:20	Mr. Rene Bol, Rijkswaterstaat, Rotterdam, The Netherlands	Operational Management of the Rotterdam Barriers
12:20 – 12:45	Mr. Andrew J. Batchelor, UK Environment Agency, London	Operational Management of the Thames Barrier
12:45 – 13:10	Mr. Yuil Eprim, Technital S.p.A., Milano, Italy	Preparations for Operational Management of the Venice Barrier
13:10 – 13:35	Victor A. Lyukshin, Barrier Authority	Responsibilities and criteria for closure as defined by stakeholders and their roles
13:35 – 14:00	General discussion	
14:00 – 15:00	Lunch	
Session 3	**Various stakeholder issues**	
Chairman:	Mr. Hans van Pagee	
15:00 – 15:25	Dr. Veronika Mikhailovna Tarbaeva Russian Nature Protection Control (RosPrirodNadzor)	Environmental protection issues and Barrier Operation
15:25 – 15:50	Mr. Alexander Nikolaevich Glebov St. Petersburg Port Authority	Navigation issues and Barrier Operation

Session 4	**Flood forecasting; prediction methods, measurements, monitoring**	
Chairman:	Mr. Alexander N. Savin	
15:50 – 16:15	Mr. Herman Gerritsen, Delft Hydraulics, The Netherlands	Flood forecasting for operational management in The Netherlands
16:15 – 16:40	Mr Hans Dahlin, SMHI, Sweden	Meteorological and water level forecasting in Sweden
16:40 – 17:05	Mrs. Rosa R. Mikhailenko, Morzaschita Department	International cooperation and information provision for Integrated Water Management of St.Petersburg
17:05 – 17:20	Anatoliy Ivanovich Grabovskiy, Ludmila Mikhailovna Dren', Alexander Mikhailovich Kolesov (all NWHMS) Yurii Dimitrevich Malashin (LCHMS)	Present flood forecasting and water level monitoring in SPB

Day 2, Friday, 20 May 2005

9:30 – 10:00	Arrival of participants; coffee	
Session 5	**Legal issues; Flood warning requirements for St. Petersburg**	
09:30 – 9:45	Co-chairmen Alexander N. Savin and Hans van Pagee	Introduction, Conclusions Day 1
9:45 – 10:15	Konstantin Alexeevich Klevannii, (Morzaschita Department), Suleyman Mohammed Wahidullah Mostamandy (NWHMS)	Automated flood forecasting system in St. Petersburg
10:15 – 10:45	Mr. Vladimir Alexandrovich Tira, MChS Department for Emergency Situations	Present legal arrangements on flood response in SPB
10:45 – 11:15	Mr. Hans Jager and Mr. Rene Bol, Rijkswaterstaat, The Netherlands	Criteria for closure and institutional and legal arrangements in NL
11:15 – 11:45	Mr. Marius Sokolewicz, DHV and Mr. Alexander Nikolaevich Mel'nikov, Lenhydroproject	Requirements for flood forecasting for the SPB Barrier
11:45 – 12:15	Mr. Bert te Slaa, Royal Haskoning, The Netherlands	Key issues in operational management from the builders' and / or Builder's perspective
12:15 – 12:30		Discussions
12:30 – 13:00	Coffee break	
Session 6	**Conclusions and Recommendations**	
13:00 – 13:45	Mr. Hans van Pagee, Rijkswaterstaat, The Netherlands	Presentation and discussion of draft memorandum with main results
13:45 – 14:00	Mr. Ed Hoeks, Consul-General of The Netherlands	Reaction to the findings and the workshop results
14:00 – 14:10	Mr. Alexander N. Savin, Morzaschita	Formal closure of Workshop

4 Highlights of the presentations and discussion

This chapter presents the summaries and highlights of the workshop presentations and discussions, organised by session. Each session covered a specific topic of relevance for the operational management of the Flood Protection Barrier. In the digital version of this report on CD-ROM all abstracts are also available (as individual pdf files) via hyperlinks (see Appendix C).

4.1 Session 1: Introductions; the Barrier Project

4.1.1 Welcome

A.N.Savin (Head of Morzaschita; co-chairman of the Workshop)

Mr. Savin wishes all participants in the seminar "Operational Management of the St Petersburg Flood Protection Barrier" a warm welcome. He is glad to greet so many participants. He stresses that the seminar is not a scientific but a practical one, aimed to exchange experience between experts from Russia, The Netherlands, Great Britain, Italy and Sweden.

4.1.2 Official opening of the Workshop

A.I.Vakhmistrov (Vice-Governor for Construction, St. Petersburg Government)

Mr. Vakhmistrov thanks the experts from The Netherlands for their efforts made in the preparation of the seminar. He is convinced that the seminar will give benefits to all participants. As is well-known, St Petersburg has suffered from floods many times during its history. Lately, the number of floods has increased. That's why the President has given the order on the highest level to complete of the Flood Protection Barrier in St.-Petersburg. This general construction has to be completed by 2008 and that is a realistic time schedule. However, the construction as such is not sufficient to solve all questions and problems, the Barrier needs to be properly operated as well. Mr. Vakhmistrov expresses the hope that the foreign colleagues will help their St. Petersburg colleagues to create efficient solutions for this. St. Petersburg has started to use modern computer programmes which allow efficient management of the FPB. That's why it is necessary for St. Petersburg to study the experience of the Netherlands and other foreign countries, which successfully use computer programmes to support their decisions. One of the first steps was the development of a computer model for calculating water level variation in the Baltic Sea. This, and the development of a Geographical Information System for Flood Damage proved very important during the joint activities with EBRD. This model assesses the potential damage which may occur at different flood heights.
Finally, on the behalf of Mrs. V.I.Matveenko, Governor of Saint-Petersburg, Mr. Vakhmistrov thanks all the participants for coming and wishes them a successful workshop.

4.1.3 Welcome of behalf of Rosstroy

V.P. Alpat'ev (Head, Department of Economics and Capital Investments of Rosstroy)

This seminar is organized by the Ministry of Transport, Public Works and Water Management of The Netherlands and the Department for Flood Protection Barrier Construction "Morzaschita" of the Government of St.-Petersburg. It is devoted to the consideration of modern techniques of water management and international exchange of experience. The main functions of the Flood Protection Barrier (FPB) are (A) to provide protection of St.-Petersburg against floods; (B) to provide the closing part for the ring road around St.-Petersburg; and (C) to provide safe navigation.

On December 22, 2002 the Loan Agreement was signed for a loan of US$ 245 mln from EBRD, NIB, EIB for the completion of the Barrier. In addition to this loan, considerable funding from the Federal budget is required. The St. Petersburg Investment Fund (FISP) coordinates the state commissions and the realisation of the works.

Mr. Alpat'ev mentions the importance of computer modelling of floods. A computer-based flood warning system should be fully prepared and implemented. St. Petersburg relies on the experience of its foreign colleagues to guide them in this. It should be mentioned that the system should not be a "frozen" design. It has to be upgraded and improved continuously. It is also very important to train the personnel in its proper use to obtain efficient performance. Once again Mr. Alpat'ev would like to welcome all participants to the seminar. He is convinced that all presentations will be very interesting and useful.

4.1.4 Russian-Dutch cooperation on water problems

E.W.V.M. Hoeks (Consul-General of The Netherlands)

Mr. Hoeks stresses that this conference is very important for both Russia and The Netherlands. The Netherlands is a low-lying country with a long history of fight against water. Its low level relative to the sea is even expressed in its name: "Nether"lands, or "The Low Countries". The Dutch have a long experience in water management and land reclamation. But one should not forget that the water can be an enemy. That's why the Netherlands has always invested much in a strong protection against the water. The Dutch pay considerable attention to the North Sea because they want to guarantee safety in the Netherlands. The same is true for St. Petersburg. Mr. Hoeks is therefore very pleased that so many specialists have come together here to exchange their experience on their common theme of interest and he therefore expects the workshop to be successful.

4.1.5 Aims and challenges of this workshop

Hans van Pagee (Rijkswaterstaat; co-chairman of the workshop)

Mr. Van Pagee introduces the aims and objectives of the workshop. He stresses that preparation for operational management is not just a technical issue, but that institutional arrangements between stakeholders and good legal embedding of the management are also very important. For that, consensus needs to be built between the interested parties, supported by confidence in the operational tools. The latter requires thorough analysis and training. The conclusions of the workshop will be summarized into a memorandum that will be presented to the Vice-Governor and the Consul General at the end of the workshop. The results will be structured along 3 main points:

1. General conclusions on operational management of flood protection barriers
2. Recommendations and actions needed to prepare for operational management of the St. Petersburg Flood Protection Barrier
3. Needs and issues for future international cooperation

Mr. Van Pagee emphasizes that this is a workshop and not a conference or a seminar. He therefore expects an active role of all participants to contribute to the results of this workshop.

4.1.6 General introduction to the Barrier design and the time schedule of its completion

Sergey N. Kuraev (Chief Engineer for the design, LenHydroProject)

Summary of presentation

- Work on the Barrier started in the early 1980's, and was stopped around 1987 due to environmental concerns and lack of funding;
- At the present time, 2/3 of the works have been completed; this corresponds to 50% of the total costs;
- The design from 1977 has been updated to meet present standards; the main changes are related to the flood gates design;
- By the decision of the Federal Government, only the dams and flood gates will be completed at this stage; the ring road is not a part of the project.

Discussion

Question (Hans van Pagee): The design of the barrier dates from the mid seventies. Have new insights in climate change, including sea level rise, and new technologies resulted in significant modifications in the design?

Answer Kuraev: The most serious modifications were made during consideration of matters which were aimed at the environmental situation and associated problems of Neva Bay. This has resulted in providing an extra opening in the northern section. The design of the dam has not been changed at all. However, the size of the sector gates in navigation opening C-1 in the South section was changed by decision of the City Administration. In the navigation opening C-2 in the Northern section, there is a flat gate, with a lock opening of the gate. In total already 2/3 of the works has been completed.

Question (Usanov, Boris Pavlovich): In which stage of construction are the navigation openings C-2 and C-1?

Answer Savin: This question should be addressed to people who coordinate this project.

Answer Alpat'ev: On the Meeting of 8 April 2005 by decision of the Federal Government the issue of proposals on competition for FPB construction contracts was approved. Various elements which don't have a direct relation to the FPB were also agreed.

Question (Usanov): Will we have the ability to realise the ring road around the city as well?

Answer Kuraev: The Government is now considering the protection of the city against floods (without the ring road). That's why we concentrate on this main task of the Barrier. The decision regarding construction of the ring road will be taken later, after 2011.

Comment Savin: Within the framework of this seminar matters concerning the ring road will not be discussed.

4.2 Session 2: Experiences with operation of existing barriers in Europe

4.2.1 Operational Management of the Eastern Scheldt Barrier

Hans Jager (Rijkswaterstaat; Head of the Eastern Scheldt Barrier)

Summary of presentation

- In the case of the Easter Scheldt Barrier, there is a potential conflict between safety and environmental issues; both issues have been addressed in the design and operation procedures.
- The Barrier is primarily to be used for the purpose of flood protection, additional allowed use is for environmental protection (oil spills), to regulate the discharge of ice fields through the Barrier and for flood protection in case of a dike slide in the Eastern Scheldt.
- In one special occasion the Barrier has been used to help in water management for the adjacent polders after heavy rainfall.
- No use is allowed to support commercial activities.
- There have been no real changes in design and operation procedures since its official completion in 1986.
- Design of the barrier gives some reserve for the sea level rise, but in the future more closures are to be expected.
- The operator has access to a large hydrological monitoring network along the Dutch coast, measuring water levels; this information is combined with the meteorological input to make a forecast.
- There are 3 teams of 9 people, forming a decision team; the decision to close is taken by the teams, supported by computer systems.
- If human action fails, the automatic computer system will close the barrier.
- The public should be well informed, but discussions on whether or not to close in individual cases should not be allowed (closure is imposed by the law).

Discussion

Question (Monosov, Moisei Lvovich): How do you take the increase of sea level due to climate change into account in your forecasting?

Answer Jager: In the design of the barrier, a safety margin of 50 cm has been included to account for future sea level rise. Apart from that, the gates close against an upper concrete beam, which is fairly high. So, in practice, even higher sea level rise will not immediately lead to situations in which the Barrier can no longer give protection.

Question (Kolesov, Alexander Mikhailovich): Which system of action do you use for forecasting a storm surge?

Answer Jager: By computer modelling atmospheric forecast are made with a forecast time window of 120 hours. These are refreshed using new information, every 12 hours. Additionally, wind, pressure and other observations come in systematically from the national and international monitoring networks. We know about a storm surge at least 24 hours ahead of time. From that moment, we monitor and assess the situation more closely.

Question (Klevannii, Konstantin Alexeevich): I am interested in the Barrier systems in the Eastern Scheldt and near Rotterdam. Are the decisions on closing these Barriers taken separately or together? Does closing take place automatically or does somebody take the decision. Who is responsible?

Answer Jager: The decision procedures are different for these two barriers. For the Eastern Scheldt Barrier, usually I am responsible for the decision. In situations of severe storm threat we have a team of 9 technical people to assess the situation and prepare the decision. These people are highly experienced.

4.2.2 Operational Management of the Maeslant Barrier

René Bol (Rijkswaterstaat/RIKZ. (previously: Maeslant Barrier team))

Summary of presentation

- In the case of the Rotterdam (Maeslant) Barrier, there is a potential conflict between safety and navigation issues; both issues are addressed in the design and operation procedures.
- The Barrier is expected to close once in 10 years, on average.
- Since its completion in 1997, the Barrier has not yet been closed for a storm situation.
- Each year, a test closure is carried out.
- Test closures have revealed various weak points in the system, all problems could be solved.
- The computer takes the decision to close. The system is fully automated and there is no human influence: man is considered to be the weakest link in the decision making process.
- The computer system has a high level of redundancy (4 computers running the same program), but in the event of computer failure there is the possibility to manually implement the closure and opening procedures.

- The decision process is clear and uniform, responsibilities are clear.
- A well-trained organisation for operation and maintenance of such a sophisticated system is required.
- A good understanding and cooperation between the port authority and the Barrier operators is very important.
- During design testing, problems with the resonance of the gates due to seiches were discovered; these were solved by physical model testing and adapting the design and procedures.
- The decision procedures to close the Barrier are embedded in law and are not a subject of discussion between interested parties for individual situations.

Discussion

Question (Usanov): How did you prevent the possibilities that the gates come down heavily on the sill? How did you avoid problems of vibration?

Answer Bol: This is a particular technical problem which was studied and solved during the design.

Answer Gerritsen: When tested in a hydraulic scale model, the initial design of the sector gates showed serious problems of vibration during closure, as a result of wave action and changing flow forces. The gates could come down on the sill in an uncontrolled manner. Extensive further testing showed that with adjustments to the design, in combination with adjustment of closure and opening procedures, the closing and opening can be realized in a fully controlled way, without unacceptable vibration.

Question (Klevannii): The Decision Support System (B.O.S.) is a computer system. Do you have a backup system consisting of manual management?

Answer Bol: The Decision Support System (B.O.S.) is running on a special computer system. It consists of 4 parallel running computers. If the main computer fails, one of the others can fully take over the process without interruption. This system has a high redundancy. If, however, the computer system does fail, there is a human back-up option to execute the closure and opening procedures, applying the same procedure as the computer should do. (I will tell more about that tomorrow).

Question (Monosov): When the gates are closed during a period of 6-12 hours, does this lead to any ecological problem? And how do you investigate these matters?

Answer Bol: The Maeslant Barrier is located in the Rotterdam Waterway, a tidal river along which extensive industrial activities take place. General environmental protection issues are not a key problem: it is safety and navigation. For oil spills and navigation accidents, procedures exist, but these are unrelated to the Barrier.

Question: Have you been faced with the problem of a false (unnecessary) closing of the barrier or with wrong forecasting?

Answer Bol: No we haven't. So far, there has been no case of a flood threat that required closing of the Maeslant barrier.

Question: What is the (water) current speed under the gates when the gates are closing?

Answer Bol: During closure, the current speed changes with the pressure head difference and the gate opening that is left. Values are not measured, but may become more than 5 m/s.

4.2.3 Operational Management of the Thames Barrier

Andrew Batchelor (Tidal Defence Manager, Thames Barrier)

Summary of presentation

- The Thames Barrier is used for safety protection, but also for river control.
- Since its completion in 1983, the Thames Barrier has been closed 92 times.
- The actual freeboard in Central London is the main criterion for closure in case of flood protection.
- Reliability is the key issue in the design and in the operation.
- Accuracy of forecast is of paramount importance.
- All operational procedures are very detailed; the operational team is sufficiently large and well trained.
- Think what may go wrong, and plan procedures; learn from your own mistakes.
- A back-up for the power system is essential: the power supply system has a 1: million chance of failure, yet it has already failed 5 times !!
- The system is regularly tested (once per month partial closure and once per year full closure), agreed with the Port Authority.
- In addition to the above, regular retraining of staff and system testing on emergency scenarios is very important.
- The liaison with the Port Authority is important.
- The Barrier is not intended to be used for ecological problems, only for safety, e.g. oil spills (besides the flood safety protection); up to now there was no reason for closure for such reasons.
- Flood warning and closure procedure starts two tides ahead (~24 hours); closure is realized within approximately 6-8 hours.

Discussion

Question: Is the FPB used for regulation of any environmental problem? Do you have cases when the FPB was managed for solving environmental problems?

Answer Batchelor: I would like to emphasize that the FPB does not impact negatively on the environment. Yes, we will use and have used the FPB when for example there is an oil spill, or an accident, in order that the problem is contained or the rescue services can work more effectively.

Question: What requirements do you have for forecasts? Do you have a critical time for closing the barrier?

Answer Batchelor: The forecast has to be very accurate and a lead time of some 24 hours is generally used to start preparations. 12 hours before the expected event everyone is on alert. From 6-8 hours before the flood is a critical time; the start of the closure procedure.

4.2.4 Preparations for Operational Management of the Venice Barrier

Yuil Eprim (Technital S.p.A., Milano)

Summary of presentation

- The Venice situation is similar to that of St. Petersburg: the Barrier is under construction; use can be made of experience in the Netherlands and UK.
- Construction is expected to be finished in 2012.
- There is a potential conflict between safety of Venice, and environmental and navigation issues; both issues are addressed in the design and operation procedures.
- The Barrier is intended to protect the city and to keep it liveable, but there are no lives at stake.
- The Barrier is expected to close 3-4 times a year at the beginning of its lifetime; because of expected sea level rise, this will increase to 18-25 times a year by the end of the century.
- The quality of meteorological data and forecast is poor, this has been overcome by self-developed correction algorithms, based among others on statistical analysis of a large dataset.
- The barrier is intended to be operated fully automatically, by an automated closure decision system.
- The risks foreseen are: (i) false closures, and (ii) too long duration of a closure.

Discussion

Question: In what stage is the construction of FPB in Venice now?

Answer Eprim: The construction was started in 2003 and it will be completed by the end of 2012. At present, breakwaters are being constructed near the three inlets to the lagoon.

4.2.5 Responsibilities and criteria for closure in St. Petersburg

Victor A. Lyukshin (Director, Barrier Authority)

Summary of presentation

- The Barrier Authority for the FPB is a Federal State Enterprise and was founded in 2003.
- The Barrier Authority wants to use experiences from elsewhere to avoid mistakes made by others.
- The forecasting system SPUN (Flood Forecasting and Warning System) is under development by the North-West Hydromet Center; it includes a hydrodynamic model developed by Morzaschita.
- Further cooperation with other Baltic states is necessary to obtain the necessary hydrometeorological data.
- The existing hydrometeorological station in Kotlin and other stations will be upgraded.
- The existing hydrodynamic model of the Baltic Sea will be further extended and validated.

Discussion

Question (Usanov): Should you not include in the coordination the different views of Rosstroy and the various technical organisations and institutes? Why is it now decided that first the navigation opening C-1 should be built and after that C-2, while the construction sequence was different before? Mr Lobko continues to promote the (early) tendering of navigation opening C-1 because he has an idea about widening (broadening) the Barrier which will lead to increasing of number of traffic lanes. But it is known that these kinds of activities are so to say personal ideas and interests. And a lot of questions are not coordinated, that's why people said that Rosstroy has two faces in St.-Petersburg.

Answer Lukshin: First of all, the matter which you are concerned about is the matter of the investment policy of Lobko. He responsible for the tendering and he is responsible for commercial risks.

Remark (Usanov): Proposal for the Memorandum: this answer does not satisfy me. It is about changing the order of completing the navigation opening, this is a technical issue with consequences. We should put a stop to commercial deals!

Answer Savin: I agree it is necessary to have a single policy.

Answer Usanov: One should not treat this situation as if it is without conflict. The story of relocating the port and the story of the investment policy of Lobko are the same. But the various opinions should not stop the progress in the project. On June 2, 2005 a meeting of representatives of the St. Petersburg Sea Advisors will be held with participation of the Prime Minister. And the representatives of Rosstroy should coordinate their views concerning the navigation openings C-1 and C-2.

Conclusion (Savin): The most important task now is to complete the Barrier because the city presently does not have sufficient flood protection.

4.3 Session 3: Various stakeholder issues

4.3.1 Environmental protection issues and Barrier operation

Veronika Mikhailovna Tarbaeva (RosPrirodnadzor)

Summary of Presentation

- A program has been formulated to complete the construction of new sewer treatment plants and to reconstruct chemical factories to reduce pollution in the Neva Bay.
- In 2002, the Environmental Impact Assessment component of the Technical Feasibility Study of NEDECO indicated that the Flood Protection Barrier does not have negative effects on the environment.
- There are problems with polluted bottom sediments; 11 mln m^3 of sediments have accumulated in the Neva Bay over the last years and require dredging.
- There is wide proof of eutrophication in the Neva Bay, a.o. from satellite images.

- Recommendations have been made for preparing and submitting necessary environmental documents regarding the Barrier, strengthening environmental security measures and ecological monitoring and creating a working group to coordinate environmental aspects.
- An environmental safety permit for the Barrier construction was issued 2 years ago by the Ministry of Natural Resources for a period of 5 years.
- Using the Barrier to improve the environmental quality may be possible, but is not within the scope of operations.

Discussion

Question: Does the construction and operation of the Barrier have to satisfy the legal environmental criteria? Who verifies this?

Answer Tarbaeva: The Barrier has to satisfy the legal environmental requirements. As the barrier is an object within federal jurisdiction, the Ministry of Natural Resources is responsible for this.

Question : Who prepared the Declaration of Safety of the Flood Protection Barrier?

Answer Tarbaeva: Two exploitation permits were prepared by the Ministry of Natural Resources, for a period of 5 years during construction.

Question (Klevannii): What about shallow areas in Neva Bay with low velocities – do they gradually change into land through natural growth of plants and sedimentation?

Answer Tarbaeva: Using the data of the Lake Institute, we could see that this particular gradual process of changing into land indeed takes place.

Question (Mikhailenko, Rosa Rustamovna): Could the Flood Protection Barrier be used for improving the ecological situation?

Answer Tarbaeva: Yes of course, without doubts.

4.3.2 Navigation issues and Barrier operation

Alexander N. Glebov (Sea Port Administration of St. Petersburg)

Summary of Presentation

- The Port Authority is currently working on the reconstruction of the channels in Neva Bay in order to increase the navigation capacity.
- The Port Authority recommends assigning the highest priority to construction of the C-2 opening in order to reduce congestion in the main navigation channel. Additional costs of dredging will be low, because the channel follows natural depths.
- Safe navigation will be ensured by creating anchorage places north and south of the FPB.

- Reconstruction of the main navigation channel (reducing the number of bends from 4 to 2) will improve safety.
- Training of pilots should start before the Barrier is completed.
- Accurate modelling of the local flows around and through C-1 and C-2 under a variety of hydrometeorological conditions is necessary to provide detailed information on currents, and for purpose of training of pilots.

Discussion

Question (Kashkarev, Oleg Viktorovich): For safe passage of the ships through the navigation opening, will information on currents be necessary?

Answer Glebov: Information on the currents is very important because it is rather difficult to manoeuvre a ship under changing or unknown current conditions.

Question (Kashkarev): Should this information about changing currents be available from a monitoring station?

Answer Glebov: Yes of course because this information is changing all the time.

Question: How much time is needed for safe halting and re-arranging navigation given a decision on closing of the Barrier?

Answer Glebov: The Port Authority needs to receive the formal warning 4 hours before the closure of the FPB.

4.4 Session 4: Flood forecasting: prediction methods, measurements and monitoring

4.4.1 Flood forecasting for the operational management in the Netherlands

Herman Gerritsen (WL | Delft Hydraulics)

Summary of Presentation

- A well validated flood forecasting model is essential for operational management of the Barrier.
- Validation of flood forecasting models of the Baltic Sea and Gulf of Finland is more difficult than it is for the models of the Atlantic Ocean and North Sea, due to absence of predictable astronomical tides.
- The quality of wind speed forecasts is a critical point in flood forecasting and requires special attention.
- Information from satellites cannot improve the quality of operational flood forecasts because of the long processing time (~24 hours) and because the quality of information from the existing water level gauges is already very good.

- Data assimilation techniques can significantly improve the quality of the flood forecasts.
- Forecasting is important but must be followed up by an adequate response in case of a flood emergency.
- Different approaches are used in the Netherlands regarding the decision to close the barrier: for the Maeslant Barrier (Rotterdam) the computer system decides, for the Eastern Scheldt Barrier the decision is taken by the manager.

Discussion

Question (Liberman, Yurii Maurikevich): What spatial density and accuracy do you require for the wind data?

Answer Gerritsen: In the Netherlands, the surface wind and surface atmospheric pressure forecasts used for the flood-forecasting model are from the operational HIRLAM22 atmospheric forecast model at KNMI (Royal Netherlands Meteorological Institute). They have a spatial density of 22 km. It is about the best there is for this area. Presently, tests are being made with a 11 km resolution model.

Question: The use of satellite (altimetry) data on water level allows improving the forecasts. If this is true, why don't you use it?

Answer Gerritsen: There two reasons why in the Netherlands and other countries around the North Sea satellite data are not used operationally. The first one is that it takes about 24 hours before the satellite data have been processed and can be used. That is too long for forecast purposes. The second reason is that the North Sea has a very dense network of high quality water level stations (partly in open sea), so satellite information has little or no additional value.

Question : Who takes the decision on closing the Barriers?

Answer Gerritsen: In case of a flood threat, the crisis management team gives the warning to the barriers about the expected time and height of the flood level that exceeds the level for which the particular barrier needs to be closed. For the different barriers, the closure decision is different, either a decision by man (Eastern Scheldt and Krimpen Barriers), or by the computer (Rotterdam-Maeslant Barrier).

4.4.2 Meteorological and water level forecasting in Sweden

Hans Dahlin (SMHI; Director EuroGOOS)

Summary of Presentation

- Operational meteorological forecasts in Sweden are made with the HIRLAM model.
- As a result of international cooperation, the Baltic Operational Oceanographic System (BOOS) has been developed, in which the countries around the Baltic Sea, including Russia, participate. It operationally provides water level and other forecasts; a forecast for St. Petersburg is also available.
- SeaTrackWeb: a continuous drift forecast is available through Internet (for members only).

– Recommendations for St Petersburg:
  1. continue active participation in international oceanographic cooperation
  2. make a long term agreement (contract) with a HIRLAM data supplier for secure delivery of atmospheric forecasting data for local flood forecasting models;

Discussion

Question (Tsepelev, Valerii Yurevich): Please give your opinion how much the participation of Russia in HIRLAM would cost?

Answer Dahlin: The country should first be a member of ECMWF. In that case, it can also participate in HIRLAM. Participation is based on a system of exchange, in which scientists jointly work on further development and operational testing of the HIRLAM code, plus a joint funding of material cost. It is hard to say how much this would cost.

Question (Tsepelev): Can an individual region of Russia participate in HIRLAM, and would this reduce the cost?

Answer Dahlin: An individual meteorological service can be provided with results of HIRLAM forecasts. It requires a bilateral agreement between the service and a HIRLAM member that is willing to provide these data, for instance SMHI.

4.4.3 International cooperation and information provision for Integrated Water Management of St. Petersburg

Rosa Rustamovna Mikhailenko (Morzaschita)

Summary of Presentation

– Cooperation with the Netherlands on Integrated Water Management started in 1996.
– In 1998 - 2000 a flood forecasting model and a GIS based Flood Damage Assessment Model for St. Petersburg were developed.
– The GIS model is useful for estimating flood damage as function of water depth, specified for different land uses.

Discussion

Question: Are you prepared to use statistical and international information from other institutes?

Answer Mikhailenko: For the GIS we are using information from various sources and provided by different institutes and services.

Question : What is the basis of the observations?

Answer Mikhailenko: Before 2002 we used observations obtained through our normal contacts. The scope of the project has been extended to include Integrated Water Management, which is a City project for the coming years. This will imply extending the GIS with additional data and data layers.

4.4.4 Present flood forecasting and water level monitoring in St. Petersburg

Ludmila Mikhailovna Dren' (Northwest Hydromet)

Summary of presentation

- The Northwest Hydrometeorological Centre uses 2 methods for flood forecasting:
  (i) the semi-empirical (regression) method of Belskii, and
  (ii) the hydrodynamic model developed together with Morzaschita .
- The following problems are signalled:
  a) Not all synoptic situations, which give indications of a flood danger, lead to actual floods. The computer system gives advice, but the final decision to give a flood warning is given by a forecaster on duty.
  b) The HIRLAM model that provides the gridded meteorological forecast data for the water level forecast model system in St. Petersburg is different from the operational model for everyday use in the weather forecasting. Russia has decided to develop a Russian atmospheric model analogue. This will require hard work and financial support during a development and introduction period of about 18 months.
  c) The density of the hydrometeorological observation network in the Gulf of Finland is inadequate. Hydromet proposes to include a comprehensive real-time observation system as part of the final Flood Protection Barrier project.
  d) Winter surges together with strong winds cause ice breaking and piling up of ice along the coast and the Barrier sections. The possibility of damage to the barrier control-gear mechanisms in the navigation openings needs to be taken into account.
- Hydromet gives flood warning to the St. Petersburg Department of the Ministry of Emergency Situations, and the Department gives the official warning to all stakeholders.
- After construction is completed, there remains a residual risk (0.1%) of flooding, which will increase in time due to sea level rise.

Discussion

Question (Monosov): Why don't you take into account in your forecasts the longer term variation of Baltic sea level?

Answer Dren': In our calculations we forecast the increase of sea level during a storm, starting from the background water level before the storm.

Question: Does the Ministry of Emergency Situations (MChS) support and help you?

Answer Dren': There is a close cooperation with MChS. The forecasts are prepared by the hydrometeorological service. Together we inform and warn all stakeholders. MChS guides and supports us, as the decision to issue a warning is taken by a special committee, in which MChS plays a key role.

Question: Can you say if the water after the flood becomes clean?

Answer Dren': I apologise for not being able to answer the question. Ecology is not my specialization.

4.4.5 Automated flood forecasting system in St. Petersburg

Konstantin Alexeevich Klevannii (Morzaschita)

Summary of Presentation

– The development of a model-based flood forecasting system started in 1998, in cooperation with WL | Delft Hydraulics and Northwest Hydromet, resulting in the present version of the Baltic Sea Model (BSM).
– Very accurate water level predictions are needed for operation of the Barrier. To realize this the following model developments are presently planned:
  - Generation of a more detailed and improved model grid
  - Improvement of bathymetry
  - Further validation of the model on historic floods
  - Implementation of a data assimilation technique
  - Test runs with wind forecasts from a new atmospheric model MM5
– Until now, HIRLAM data were provided by SMHI for testing purposes; this data delivery should be continued for operational purposes.

Discussion

Question (Bol): Do you give warnings based on those model forecasts?

Answer Klevannii: The forecasts are based on synoptic information and the assessment of the synoptic forecasters on duty. The model is an additional method, supporting the final decision.

Question (Bianca Peters): I get the impression that exceedance of the water level 1.60 m is used as the criterion for closing scenarios. If so, how has that level been decided upon?

Answer Klevannii: The critical flood level of 1.60 m BS was established a long time ago. It is the level at which the lower parts of the city and basements start to flood. The optimal critical level for closing scenarios still needs to be assessed.

Question: Do you calculate a critical maximum water level to guide the Barrier closing procedure?

Answer Klevannii: A critical water level is not the only aspect to guide closure. For instance, the expected rate of rise is also important. A later closure leads to increase of the current speed and as a result it is much more difficult to close the barrier. A detailed modelling study under various meteorological and flood conditions needs to be done to determine the optimal criteria for closure and opening.

Question: In your opinion: who should take the decision on closing?

Answer Klevannii: The system should be automatic. If a person is responsible, he or she should be of the level of a Vice-Governor.

4.5 Session 5: Legal Issues: Flood warning requirements for St. Petersburg

4.5.1 Present legal arrangements on flood response in SPB

Vladimir Alexandrovich Tira (Main Service of the Ministry for Emergency Situations (MChS) for St. Petersburg)

Summary of Presentation

- On 1 January 2005, a reform of the administration's responsibilities was introduced; Federal bodies now have the responsibility for safety matters in St. Petersburg.
- The territorial administration of the Ministry is responsible for planning and execution of activities related to safety.
- The division of responsibilities between the City Administration and the federal bodies is not clear.
- The process in case of a flood threat is as follows:
  1. Hydromet informs MChS on the forecast time and height of the flood peak;
  2. MChS issues a warning to the Governor, City Administration and to large industries;
  3. If the water level is expected to exceed 2.50 m relative to the long term mean sea level (BS), radio, tv, militia groups with speakers are deployed to warn the public.
- Two stations for the emergency services have been planned on the Barrier; this is not sufficient taking in to account the length of the Barrier in relation to the necessary response time.
- The decision chain is presently too long, this needs to be changed when the Barrier is completed.

Discussion

Question: What was the procedure during the flood on January 2005 (peak level 239 cm)?

Answer Tira: I apologise that I cannot answer this in detail; I didn't participate in the emergency activities for that case.

Question: Who has to take the decision on closing?

Answer Tira: We should follow the western examples because our present system takes too much time. An automatic decision support system should assist the decision making, but one person should be responsible for taking the decision on closing the Barrier.

4.5.2 Criteria for closure and institutional and legal arrangements in the Netherlands

Hans Jager and Rene Bol (Rijkswaterstaat)

Summary of Presentation

Hans Jager – Eastern Scheldt Barrier

- Two parallel closure rules exist for the decision on closure:
  1) the decision team: the team optimises the closure strategy, realising optimal water levels in the Eastern Scheldt for reasons of safety and environment;
  2) the emergency system: this automatic system guarantees closure and thus safety if the water level exceeds 3 m (NAP).
- The decision team takes the decision to close the Barrier, but in emergency situations the computer takes over.
- The automatic system guarantees safety, but not the optimum water level in the Eastern Scheldt.
- There is positive experience with this mixed operation process.
- The automatic system initiated closure only once, under extraordinary meteorological circumstances; it was a false closure, without flood danger.

Rene Bol – Maeslant Barrier

- For the Maeslant Barrier, the closure is done fully automatically. Manual process is possible, but only as backup.
- The reason for the choice of the fully automatic system is the required high safety standard (1/10,000 years) and the low closure frequency (1/10 years), which gives little opportunity for building up hands-on operational experience.
- An adequate and well-trained team is essential:
  a) the team consists of experts with a background in hydraulic engineering;
  b) the team trains in conducting the procedures every year.
- Testing has provided experience on what might go wrong (e.g. pump failures, system failures).
- One should realise that erroneous data (forecast or observation) may be a source of failure, or lead to a false closure.
- Close to the barrier, a redundant system of water level gauges (4 at each side of barrier) is placed to exclude a chance of a meter failure; approximately 25 water level gauges and 3 flow gauges are available in the area of the nearby North Sea and the greater port area. This information is also available for ships.

Discussion

Question: During the period of annual testing of the Maeslant Barrier (8 times), did you find any defects in the main systems?

Answer Bol: Many unexpected situations occurred and we learned how sensitive the system is. Malfunctioning of the systems also occurred. One time we had to close the system manually.

Question (Kashkarev): How many current meters do you have for the Barrier?

Answer Bol: There are no current meters in or near the barrier. Water level variations in the area give information on the currents. In the overall area of the harbour and the North Sea entrance, there are many water level gauges, for general manoeuvring and operation purposes.

4.5.3 Requirements for forecasting system for SPB Flood Protection Barrier

Marius Sokolewicz (DHV) and Alexander Mel'nikov (LenHydroProject)

Summary of Presentation

- For correct operation of the Flood Protection Barrier, an accurate forecasting system is of great importance.
- The forecasting system should use the best available up-to-date meteorological predictions (e.g., HIRLAM), complemented with measurements from hydrometeorological stations in the Gulf of Finland.
- Prediction of water levels and wave heights is required, also in winter.
- Issues which require special attention are:
  a) the possibility of large water level differences across the gates during closure of the C-1 flood gates, when the water level in the Gulf of Finland rises extremely fast;
  b) the influence of the Barrier gate closure sequence on the water levels in Neva Bay;
  c) the choice of the initial water level for closure in relation to the influence of wind on the water level in the Neva Bay;
  d) the choice of the initial water level for closure in case of flood situations with several peaks close to each other.
- A Decision Support System is required to optimise the closing and opening procedure; this system will support the operator.
- The Barrier will be controlled by man (a team of specialists), the computer will only advise.
- Analysis of the timing of preparation and closure scenarios on the actual curves of the forecast water level and the observed water level for the flood situation of 9 January shows how critical these choices are.
- It also shows that they can be sensitive to even small changes in forecast levels and timing; this underlines the need for accurate forecasting and on line information flows.

Discussion

Question (Monosov): In which cases could your system not work properly? The problem is that the Neva Bay is very narrow and resonance could occur, which will lead to increase of the water level.

Answer Sokolewicz: The flood forecasting model accounts for this, taking into account the actual situation in the Gulf of Finland and Neva Bay.

Question: The requirements for meteorological forecasts were considered from the hydrological point of view, but what about the economic approach?

Answer Mel'nikov: Economic damage could happen because of losses that occur during the closing of the Barrier and interruption of navigation, especially in case of unnecessary closures. The legal aspects of economic damage will be discussed with the administration of RosMorPort and the Administration of the St. Petersburg Sea Port.

Comment Gerritsen: The economic aspects of the Barrier have been analysed by NEDECO in an Economic Analysis as apart of its Feasibility Study for the completion of the Barrier (2002). The Annual Average Damage (AAD) that can be avoided by the Barrier was estimated to be US$ 69 million. With the Barrier in place, Operational Management in times of flood threats, that is, well founded and timely decisions about closure and opening of the gates will essentially determine whether the Barrier functions as intended: avoiding flood damage by closing when needed, and avoiding economic damage to the port by avoiding unnecessary closures. As with the construction itself, the cost of arranging for meteorological forecasting, flood forecasting and monitoring and decision support systems should also be justified in comparison with the potential damage that can occur if information is insufficiently accurate or too uncertain to take decisions with confidence. The latter damage can easily be several million dollars for a single occurrence.

Question: Will the level of ground water increase during floods? How will such an increase affect the metro system?

Answer Mel'nikov: With a flood, the level of ground water increases in the area of the Barrier but the metro is far from there.

Question: Will the closing of the gates lead to such local increase of water level near the Barrier that as a result, Kronshtadt will become flooded?

Answer Sokolewicz: This is not a problem. The dam sections of the Barrier continue across Kotlin Island, and protect the city of Kronshtadt which is on the Neva Bay side of the Barrier.

Question (Kashkarev): Besides the data on water level, do you need constant information on currents in the navigation opening?

Answer Sokolewicz: This kind of information is necessary for navigation purposes.

4.5.4 Key issues in operational management from a Builder's and builders' perspective

Bert te Slaa (Royal Haskoning, project manager for the completion)

Summary of presentation

- During the present preparation stage, intensive interaction between the designers, the port, and others is needed to ensure common understanding
- The same is true for forecasters, decision makers, and future operators
- Documentation and availability of back ups and spares is vital
- Familiarisation and training of the staff should start at an early stage
- Flexibility to adjust for changing situations is important; this requires training

4.6 Session 6: Conclusions and Recommendations

4.6.1 Presentation and discussion of draft memorandum with main results

Hans van Pagee (Co-chairman)

Mr. Van Pagee thanks all speakers and participants for their constructive participation. He summarises the main results, which are formulated and proposed for the draft Memorandum, distinguishing these in three groups:

1. General conclusions on operational management of flood protection barriers
2. Recommendations and actions to prepare the operational management of the St. Petersburg Flood Protection Barrier
3. Needs and issues for future international cooperation

The summary demonstrates that all participants have made serious contributions and there is a strong interest from all foreign and Dutch experts to this project.

A further conclusion is that effective operational management of a Flood Protection Barrier requires more than a one-time investment and set-up of procedures. Ongoing training of personnel and regular testing and improvement of procedures is required. Exchanging experiences with other barrier operators can be a useful component of this.

The following additions to the draft Memorandum are proposed (Administration of the Port):

- To consider the possibility of completing navigation opening C-2 before C-1 for smooth transition of navigation;
- To provide the Barrier staff with the operational information on navigation to and from St. Petersburg;

On the recommendation to set up an international network of barrier managers for continuation of exchange of experience, Mr. Gerritsen informs the audience about the suggestion and offer made to the workshop organisers by the International Association of Hydraulic Research (IAHR). The IAHR has offered to convene a special session dedicated to Operational Management of Flood Protection Barriers during its next Congress, which will take place in Venice in July 2007. The audience welcomes this as a good opportunity for a follow up to the present Workshop.

Mr. Van Pagee thanks the audience for their contributions. He informs them that the remarks and suggestions will be included in the final version of the Memorandum, which will be signed on behalf of the City of St. Petersburg and the Ministry of Transport, Public Works and Water Management of The Netherlands.

Note: The final version of the Memorandum is presented in Chapter 2 of this report.

4.6.2 Reaction to the findings and the Workshop results

E.W. Hoeks (Consul-General of The Netherlands)

Mr. Hoeks is impressed by the knowledge and expertise on flood protection barriers that was brought together for this Workshop. The results presented in the Memorandum give proof of the intense exchange of experience and information, useful for the St. Petersburg case, but also valid in more general sense. Furthermore, the active participation of the audience through questions and comments has shown the commitment of the participants to preparation for Operational Management, and has given the Workshop much additional value. Altogether, the Workshop has proved to be useful for all participants.

Mr. Hoeks expresses his thanks to the Russian and Dutch organisers for all their work in preparing and organising this successful Workshop. He is very proud that The Netherlands is participating in this project with the City of St. Petersburg. And on behalf of the organisers, he expresses the hope that the existing cooperation can be continued in the same way in future.

4.6.3 Formal closure of the Workshop

Alexander Nikolaevich Savin (co-chairman)

Mr. Savin adds his thanks to the speakers and audience for their efforts and active participation during these two days, which have made the Workshop a real success. The Workshop may not have touched in-depth on all issues, but nevertheless Mr. Savin is sure that this Workshop has given great insight and provided a stimulus for addressing the broad range of issues related to Barrier operational management. He expresses the hope that this type of Workshop, with such fruitful interaction between specialists in this field, can be organised more often in the years to come.

(This page intentionally left blank.)

5 Summary, conclusions and afterword

The international workshop of 19-20 May 2005 was organised in order to bring together specialists from across Europe to discuss and exchange their views and experiences on Barrier operational management and to make recommendations for operational management of the Saint Petersburg Flood Protection Barrier.

Seventeen presentations were made, 8 by Russian specialists, 8 by foreign specialists and one joint Russian-foreign presentation. The topics covered the experiences with operational management of the existing European barriers (including the Venice barrier under construction), stakeholder issues, prediction methods, monitoring, legal issues, and flood forecasting requirements for operational management. There was intensive and constructive response by the audience via questions and answers, which enhanced the exchange of information and provided important insights for all participants.

The presentations and the subsequent discussions contributed much to creating awareness about the problems to be solved in St. Petersburg, at the organisational and at the technical level. They also provided guidance to solving many of the identified issues, benefiting from lessons learnt elsewhere.

Participants expressed their enthusiasm about the Workshop, and particularly appreciated the ample opportunity for further informal discussions with the speakers. The Workshop and the exchange of information proved useful both for St. Petersburg, and for the specialists responsible for the other European flood protection barriers.

It was realised that many important aspects of operational management are common for all barriers. For that reason, an initiative was taken to meet more regularly to discuss and exchange experiences of operational barrier management. The offer of IAHR to convene a special session on Operational Barrier Management during the 32nd IAHR Congress in Venice in July 2007, was welcomed.

It is concluded that this intense two day workshop was highly successful, both in content and outcome. Its timing was right, since St. Petersburg is presently in the definition stage of a range of activities which are needed in order to be fully prepared for operational management of the Barrier upon its completion in a few years time. Preparations for operational management require time.

In the case of the Saint Petersburg Barrier, there is still time left before the construction will be completed. This time should be used optimally. It is the expectation from the organisers that the Workshop has given an impulse to proceed with these preparations and to concentrate on important issues at hand, in order to have the Saint Petersburg Flood Protection Barrier *operational* in 2008.

The signed Memorandum of the main results, and the present Workshop report with the summaries of presentations and discussions plus the copies of the power point presentations on the annexed CD-ROM are seen as important steps toward this goal.

A Workshop press release

Press Release

Within the framework of the international cooperation between The Netherlands and St. Petersburg the Government of St. Petersburg initiated organizing the workshop "Operational Management of the St. Petersburg Flood Protection Barrier and Creating the Flood Threat Warning System in St. Petersburg" on 19-20 May 2005.

The main aim of the workshop is the acquaintance of the Russian specialists with the operational management experience of the similar constructions in other European countries, and, as a result, establishing scientific and business contacts for cooperation with the purpose of creating a modern and reliable system of operational management of the St. Petersburg Flood Protection Barrier as an important link in successful realization of "The Programme of Measures for Creating the System of Integrated Water Management in St. Petersburg for the period of 2005-2009", adopted by Decree of the Government of St. Petersburg dated 25.05.2004 No. 804.

Vice-Governor of St. Petersburg Mr. Vakhmistrov, Consul - General of The Kingdom of the Netherlands Mr. Ed W. Hoeks, representatives of the European Bank for Reconstruction and Development, Rosstroy, well-known specialists from The Netherlands, The United Kingdom, Italy, Sweden, Russia are expected to participate in the workshop.

In the 19 presentations, which have been prepared, the speakers will cover different aspects: the international experience of flood protection barrier operational management in Europe, for example, in the Eastern Scheldt, near Rotterdam, on the Thames, criteria for their closure, the present state of operational flood forecasting systems in St. Petersburg, The Netherlands, The United Kingdom and Sweden. Besides, the programme of the Flood Protection Barrier completion, the plans for creating the operational management of flood protection barriers in St. Petersburg and Italy will be presented, the problems of navigation when the barrier is in operation, legal aspects, responsibilities of stakeholders in the period of floods, etc. will be discussed during the seminar.

The workshop is organized by the Committee for External Affairs and Tourism of St. Petersburg, Morzaschita Department of the St. Petersburg City Government, the Ministry of Transport, Public Works and Water Management of The Netherlands and WL | Delft Hydraulics. The Organizing Committee also includes the Federal State Enterprise "North-Western Directorate of Gosstroy of Russia - Directorate of the St. Petersburg Flood Protection Barrier", the Construction Project Investment Fund of St. Petersburg, North-West Department of Hydrometeorology and Monitoring.

The workshop takes place in the Architect Palace, 52, Bolshaya Morskaya Street,
St. Petersburg, Russia on 19-20 May 2005 at 9.30 a.m.

Contact telephone:
Mikhailenko Rosa R. 571 5110, e-mail: morzashita@gov.spb.ru
Sakharova Anna A. 576 61 82

The press release was published in the Informational Bulletin of the Administration of St. Petersburg, and was used for announcements in other informational sources.

B List of participants

The table below gives a list of the participants in the workshop, and their affiliation.

Organisation	Name & position
Russian participants	
Government of St. Petersburg Committee of External Affairs and Tourism Committee on City Construction and Architecture Committee on Economic development, Industrial policy and Trade Morzaschita Department	Vakhmistrov Alexander Ivanovich (Vice-Governor) Sakharova , Anna Andreevna (Coordinator for the Netherlands) Mr. Barsukov , Valerii Venyaminovich (Head of Department) Mrs. Kurichina, Elena Viktorovna (Main Specialist) Mr. Usanov, Boris Pavlovich (Advisor for the international transport corridor) Mr. Savin Alexander N. (Head); Co-chairman Workshop Mrs. Mikhailenko Rosa R. (Head of Research and Environmental Department) Dr. Konstantin A. Klevannii (Senior research scientist)
Committee of Transit-transport policy of the Leningrad Oblast' Administration	Mrs. Bagaeva, Natalia Georgievna, (Deputy Committee Chairman)
Civil Protection Agency Department for St. Petersburg (MChS)	Ivanov, Alexander Georgevich (Head) Tira, Vladimir Alexandrovich, (Head of Department for monitoring and forecasts)
FISP	Mr. Alpat'ev, Vladimir Pavlovich, (Head of Department of Economics and Capital Investments of FISP)
Barrier Authority	Mr. Lyukshin Viktor Anatolievich (Director) Mr. Kuratov, Leonid Evgenievich (Leading ecologist) Mr. Zlobin, Alexander Valentinovich, (Head of the Equipment Department)
FISP St. Petersburg	Mrs. Stenina, Natalia Vladimirovna (Ecologist)
FISP, Directorate for the Barrier project of St. Petersburg	Mr Zotov Vladimir Mikhailovich (FPB Project Director; Deputy General Director of FISP) Mr Gorshkov, Anatolii Ivanovich (Project leader of FPB Directorate)
LenHydroProject	Mr. Kuraev Sergey Nikolaevich (Chief engineer) Mr. Mel'nikov, Alexander Nikolaevich (Deputy Chief engineer) Mr. Stotskii, Alexander Danilovich (Deputy Chief engineer on technological equipment)
Lenmorniiproject	(none)
Institute Stroiproject	Mr. Terletskii, S.K. (Head of the team for control of the FPB construction)
Northwest Hydromet Service	Mr. Ivanov , Georgii Vladimirovich (Deputy Head) Mrs. Dren' Ludmila Mikhailovna (Main Forecaster) Dr. Mostamandy, Suleiman Mohammed (Weather and Flood forecasting) Mr. Kolesov, Alexander Mikhailovich (Head, Weather forecasting division) Dr. Liberman, Yurii Maurikevich (Atmospheric modelling) Dr. Tsepelev, Valerii Yurevich (Atmospheric modelling) Mrs. Varlashina, Valentina Mikhailovna Dr. Basova, Svetlana Leonidovna, (Head Environmental Monitoring section)
RosPrirodNadzor	Dr. Tarbaeva, Veronika Mikhailovna, (Head of Department)

Department on Neva-Ladoga Water Basin	Mr. Kazarov, Ruben Arkad'evich (Main specialist of the department on water economics)
Sea Administration of the Port	Mr. Glebov, Alexander Nikolaevich (Head of department) Mr. Vladimirov, Mikhail Georgevich (Captain of the Port)
RosMorPort	Mr. Gotovchits, Ivan Konstantinovich (Head Regional service for vessel guidance)
Leningrad Oblast Centre for Hydrometeorology and Environmental Monitoring	Mr. Kashkarev, Oleg Viktorovich (Head of information centre "Weather") Mr. Bessan, Gennadii Nikolaevich Mrs. Shscherbakova, Nadezhda Nikolaevna
NW International Centre for clean production of United Nations on industrial development (YuNIDO)	Startsev, Alexander Alexandrovich (General Director)
--	Mr. Carl Hofman
--	Mr. Rodionov, Vladimir Arkadievich
--	Mr. Kovalevskii, Andrei Nikolaevich
All-Russian society "Motherland"	Mr. Kamnev, Alexander Stepanovich
--	Mr. Pravdivets, Yurii Petrovich
--	Mrs. Kholodi, Lyudmilla Grigorievna
Institute on Satellite-, Air- and Geological methods	Dr. Sukhacheva, Leontina Leonidovna
--	Dr. Monosov, Moisei Lvovich Mr. Monosov, Lev Moiseevich (First Marine Institute)
OO "SeismoFOND"	Mr. Zhigulin (Chairman of Public Organisation of Engineers)
Foreign participants	
Netherlands Consulate-General	Mr. Ed W.V.M. Hoeks (Consul-General) Ms. Chausskaya, Ekaterina (Assistant for economic affairs)
EBRD / Jacobs-GIBB, United Kingdom	Mr. Peter Hunter, representative for EBRD (Lender's Engineer for the Project of Completion of the FPB Construction)
Technital S.p.a.A., Milano, Italy	Mr. Yuil Eprim (Branch Director of Technital)
Environment Agency of the United Kingdom	Mr. Andrew Batchelor (Tidal Defence Manager for the Thames Barrier)
Swedish Meteorological and Hydrological Institute, Sweden	Dr. Hans Dahlin (Operational forecasting; Director EuroGOOS)
Rijkswaterstaat, Ministry of Transport, Public Works and Water Management of The Netherlands	Mr. Hans van Pagee (RIKZ; Co-chairman Workshop) Mrs. Bianca Peters (RIKZ) Mr. Rene Bol (Rotterdam Barrier) Mr. Tom Dullemond (Rotterdam Barrier) Mr. Krijn Saman (Eastern Scheldt Barrier) Mr. Hans Jager (Eastern Scheldt Barrier)
WL | Delft Hydraulics, The Netherlands	Mr. Herman Gerritsen (Senior Researcher Oceanography)
Royal Haskoning, The Netherlands	Mr. Bert te Slaa (Project Manager Implementation)
Halcrow, United Kingdom	Mr. David Edwards (Project Manager Design)
DHV, The Netherlands	Mr. Marius Sokolewicz (Task manager Hydraulics for the Project) Ms. Nicole Kragtwijk
Press presence	
"Fontanka.ru"	Mrs. Zaitseva, Nadezhda (journalist)
Tv. "5th Channel"	Mr. Sukhorukov, Alexei, (journalist)
"Business Peterburg"	Mrs. Ziryanova (journalist)
"Radio Rossiya"	Mr. Desyaterik (journalist)
"Real Estate and Construction"	Mr. Myagchenko (journalist)
" Nevskoe Vremya"	Mr. Kirpichnikov, Timofei (journalist)

C Abstracts and presentations

The abstracts of the workshop presentations, which were provided to participants as part of the workshop handout at the start of the workshop, are given in this appendix, in the order of the presentations.

In the digital version of this report on CD-ROM, all abstracts and presentations are also available (as individual pdf files) via hyperlinks on "Abstract" or "Presentation".

No.	Author(s)	Title	Hyperlink to Abstract	Hyperlink to powerpoint presentation
1.	Kuraev	General Introduction to the St. Petersburg Barrier design	Abstract	Presentation
2.	Saman & Jager	Operational Management of the Eastern Scheldt Barrier	Abstract	Presentation
3.	Bol	Operational Management of the Rotterdam Barriers	Abstract	Presentation
4.	Batchelor	Operational Management of the Thames Barrier	Abstract	Presentation
5.	Eprim	Preparations for Operational Management of the Venice Barrier	Abstract	Presentation
6.	Lyukshin	Responsibilities and criteria for closure as defined by stakeholders	Abstract	Presentation
7.	Tarbaeva	Environmental protection issues and Barrier Operation	Abstract	Presentation
8.	Glebov	Navigation issues and Barrier Operation	Abstract	Presentation
9.	Gerritsen	Flood forecasting for operational management in The Netherlands	Abstract	Presentation
10.	Dahlin	Meteorological and water level forecasting in Sweden	Abstract	Presentation
11.	Mikhailenko	International cooperation and information provision for IWM in St. P.	Abstract	Presentation
12.	Dren'	Present flood forecasting and water level monitoring in St. Petersburg	Abstract	Presentation
13.	Klevannii	Automated flood forecasting system in St. Petersburg	Abstract	Presentation
14.	Tira	Present legal arrangements on flood response in St. Petersburg	(no abstract)	Presentation
15.	Jager & Bol	Criteria for closure and institutional arrangements in th Netherlands	Abstract	Presentation
16.	Sokolewicz & Mel'nikov	Requirements for Flood Forecasting	Abstract	Presentation-A Presentation-B
17.	Te Slaa	Key issues from the builders' and Builder's perspective	(no abstract)	Presentation

General Description of the St.Petersburg Flood Protection Barrier Project

S.N.Kuraev
(Chief Engineer, LENHYDROPROJECT)

- Floods in St.Petersburg; data on catastrophic floods
- Reasons of flooding in St.Petersburg, basic features of floods, flooded area
- Choice between variants of flood protection designs, project development, expertise, formal approval of the FPB project
- Description of the Barrier location, natural conditions, the Barrier construction parts
- Short description of the present state of the Barrier construction
  - The protective dams
  - The water sluices
  - The navigation openings
- Conditions of the Barrier exploitation, disposition of the different services on the Barrier
- The basics of the Project of the Barrier completion:
  - Proof of the necessity of the Barrier completion
  - Tasks, list of works and the time schedule of the realization of the Barrier completion project in 2005 -2011
  - Financing of the project
  - Division of tasks between organizations involved in the project
  - Estimation of the efficiency of the project realization
- Conclusions

The Eastern Scheldt Barrier
Storm surge barrier in the Eastern Scheldt, the Netherlands

Krijn Saman (Senior Advisor)
Hans Jager (Head of the Delta-district Zeeland)

Location
The Eastern Scheldt Barrier is situated in the southwestern part of the Netherlands, in the province of Zeeland. The barrier separates the Eastern Scheldt from the North Sea.
The Eastern Scheldt is an estuary approx. 50 x 5 km.

Construction
The Eastern Scheldt Barrier comprises two artificial islands and three flow channels.
The barrier is 9000 metres long altogether. There are 65 large piers (each 25 x 50 m) made of concrete. Between the piers there are 62 steel gates, which can be lowered and raised with hydraulic equipment. The 62 lockable gates are 2800 metres long in total.

The barrier has its own power plant in the central control building. The diesel generators can produce six million kVA to close or open the barrier under storm conditions.

Why was the Eastern Scheldt Barrier built?
After the flood disaster of 1953, protection against flooding was laid down by law. This was the start of a huge project called the "Delta Plan". New closed dams were intended to protect the southwestern part of the Netherlands against the threat of dangerous high water situations during storms. Several dams were built and the initial plan for the Eastern Scheldt was also to completely close off the area with a closed dam. However a closed dam would bring to an end the daily tidal movement. Every twelve hours there is a high tide (approx. 170 cm above Mean Sea Level), followed by a low tide six hours later (approx. 170 cm below MSL). This tidal movement is very important for the environment and for the fisheries in the Eastern Scheldt (especially mussels and oysters). Between 1972-1976 increasing protest was being heard from the fisheries and the environmental lobby. A public and political debate led in 1976 to a decision by the Dutch government both to preserve the unique ecosystem of the Eastern Scheldt and to guarantee safety.

A storm surge barrier was to be constructed which would let through the tidal movement under normal conditions, while it would close off the Eastern Scheldt during storm conditions in order to protect the area from flooding. After the act was passed in 1976, the design and construction phase began. The project was completed in 1986.

Optimum barrier control and conflicting interests
During the design and construction phase a study was carried out, called BARCON. (i.e. BARrier CONtrol) The aim of Barcon was to define and initiate the research required on the influence of the barrier on the Eastern Scheldt: the safety requirements, the demands of the public, fisheries and environmental lobby and, ultimately, to make recommendations on the optimum use and control of the barrier. For safety reasons the barrier should be closed at a relatively low water level. However, this would lead to more closures. For environmental reasons it would be better to close the barrier at a higher water level. The fewer closures, the

better. By weighing up these conflicting interests, the recommendations of the Barcon report were as follows:

- The barrier should remain open under normal conditions.
- The barrier should be closed if the forecast water level is higher than 300 cm above MSL.
- The 1-2-1 strategy should be used. If the barrier has to be closed then the moment of closing should be set such that the interior water level in the Eastern Scheldt (after closing) reaches 100 cm above MSL. And the barrier should be opened after high water as soon as the water level in the Eastern Scheldt is equal again with the water level at the North Sea side.
- If the storm continues and the barrier has to be closed again during the following high tide, then it should be closed at such a moment that the water level in the Eastern Scheldt reaches 200 cm above MSL. The reason for changing from 100 cm to 200 cm is mainly to reduce the amount of damage at one particular level, due to wave-attack. It is better for the sandy shoals and vegetated mud flats to spread this out over different levels.

Barcon also investigated other possible uses of the barrier. Clearly there are many purposes, which the barrier could be put to. However only three were finally allowed:

- In the event of major ice fields.
- In the event of oil-pollution.
- In case of a dike-slide.

The Minister of Transport, Public Works and Water Management took the formal decision in 1986, based on the recommendations made in the Barcon report.

Lessons learned

There have been no real changes in the rules and operational procedures of the Eastern Scheldt Barrier so far. The Barcon recommendations and the formal decision are still valid.

Because the rules are clear, there is no discussion or misunderstanding during the operational process. The press watch us. With every closure we have the newspapers and the cameras of the local television stations on our doorstep, sometimes even live. They are very well informed about the procedures and they follow our activities very closely. We give them this opportunity because we want to be an open organisation. This is good for the barrier.

The decision-making process for exceptional situations also has to be organised. Special circumstances can arise. The Eastern Scheldt Barrier has closed 25 times. Two of them were exceptional due to extremely heavy rainfall. The formal procedure did not allow for the Barrier to be used for this purpose. However, because of the special nature of the situation the barrier was closed for two subsequent high water tides. The decision was taken at a high level within the organisations concerned.

The long-term morphological effects of building and using the barrier in the Eastern Scheldt are still difficult to predict. A monitoring programme is very important to closely follow the process of change.

The rise in the sea level will have an impact on the operational use of the barrier in the future. The frequency of closing the barrier will increase. It is now approximately once a year, but in the future it could 4, 5, 6 or 7 times a year. Who knows?

The Maeslant Storm Surge Barrier in the Rotterdam Waterway.

René Bol MSc,
Senior Adviser Water Management

Location

The Maeslant-barrier is situated in the southwestern part of the Netherlands near Hook of Holland, at 30 kilometers west of the centre of Rotterdam.
The Maeslant-barrier comprises two huge sector-gates, each 22 meters high and with a width of 210 meters. The total construction of each gate has a length of about 300 meter. Standing up the Measlant barrier should be as tall as the Eiffel Tower.

Description of the water system

The Maeslant Barrier is part of the water management system of the lower Rhine and Meuse rivers. It's an estuary in which the lower reaches of the rivers meet the sea, through a network of rivers branches.
The land to be protected against flooding is the economical and political heart of the Netherlands. The land, consisting of the well-known Dutch polders, is lying down to 6 meter below sea level. In this area, that partly may be flooded up to 10 meters deep, about 5 million Dutch inhabitants are living.

Aim of the barrier

In 1985 a more severe threat by higher calculated water levels was expected for the area. This threat could be dealt with by either heightening and strengthening of the existing dikes in the area (about 300 kilometre), or build a storm surge barrier. The Maeslant Barrier has therefore been built to eliminate the need of raising the dikes along the estuary, and especially in and around the city-centre of Rotterdam and the historical city Dordrecht.

Unlike the Eastern Scheldt barrier, the Maeslant barrier was designed not pose an obstacle of any kind to the shipping towards the Main port of Rotterdam. A shipping channel of 17 meters deep and 360 meters width should be available under normal conditions. Closure of the barrier was limited to once per five to ten years. The design was the result of a design competition in which 6 contractors cooperated. Building started in 1991 and the barrier was completed and taken into operation in 1997.

Operation

A computer system decides whether or not to close the Maeslant barrier, calculating the expected water levels at Rotterdam and Dordrecht on the basis of water and weather forecasts.

Under normal weather conditions the gates lie in their docks. If a severe storm is expected, the docks are submerged, so that the doors start floating. Within half an hour they can be transported to the middle of the New Waterway. Next, the hollow doors are filled with water and start sinking. This procedure is fully controlled by the computer. Within two hours the gates are landing smoothly on the concrete sill, closing the New Waterway, and protecting the area behind from flooding.

Operational management of The Thames Barrier

Andrew Batchelor,
Tidal Defence Manager, UK Environment Agency

The Thames Barrier and associated defences protect London and the Thames Estuary to a very high standard – the highest standard in Great Britain.

The flood risk area comprises 125 square km of central London – and is home to 1.25 million people and the infrastructure valued at £80 billion on which London is dependent.

The Thames Barrier Act was passed in 1972, which allowed the construction of the Barrier to begin in 1974 and for it to become operational in 1982.

Designed to protect London from a tidal surge, the Thames Barrier and associated defences currently provide London and most of the Thames Estuary with a flood defence standard of about 1:2000 years (0.05 per cent risk of flooding in any given year) – a world class level of protection.

The Thames Barrier team constantly monitor predicted tides in order to be prepared for tidal surge activity in the North Sea, and over the past 23 years have closed a total of 92 times for flood defence purposes. This includes closure against tidal surges and also closures to aid the protection of the upper reaches in times of heavy rainfall which may lead to fluvial flooding.

Reliability in operation was a key requirement in the barrier design and remains today in its operation. Complex backup systems to all key equipment are maintained by a specialist team of engineers operating a planned preventative maintenance system, which together ensure a standard of reliability of 1×10^{-4}.

The Thames Barrier, albeit the largest single asset remains only part of the complex system of associated floodgates, walls and embankments that make up the Thames Tidal Defences. When operation is required instruction is given to the Port of London Authority to provide river closure to navigation. This is just part of the comprehensive flood warning procedures which ensure that liaison is made with the relevant authorities and general public.

The presentation will explore and share the experiences of the last 23 years of operation and how issues change over time.

Venice flood defence system
Mobile barriers closure management

Y. Eprim / Technital S.pA

The surface ground level of the inhabited areas of Venice and the other minor lagoon cities varies between 80 and 150 cm above the zero of the official Venice datum, which is about 23 cm below mean sea level. The average frequency of flooding, which at the present is about 45 times per year is expected to increase to more than 200 by the end of the century. At stake is the survival of Venice.

Using the mobile barriers to defend the lagoon cities from flooding, must however take into account the effects on the Venetian lagoon ecosystem and its port facilities. More than 6000 ships per year call at the lagoon ports transporting some 24 million tons of goods and more than one million passengers. The water quality in the lagoon is almost at a critical level.
The main stake holders are the Venice Water Authority (MAV), which is the owner, the Veneto region, and the municipalities and the port authorities of Venice and Chioggia.

It is unthinkable to operate the flood defence system with such a high frequency of closures without causing serious negative impacts on the lagoon environment and on the port activities. Thus, right from the early stages of the project development (1992), complimentary interventions were proposed by the designers and agreed upon by the main stakeholders and incorporated in the overall Venice flood defence system. These interventions are:

- raising the surface ground level of the lower areas to at least + 110 cm with respect to Venice datum,
- providing navigational locks at each of the three channels connecting the lagoon to the sea,
- introducing environmentally sustainable permanent head losses between the sea and the lagoon to reduce the frequency of barriers closures,
- developing a closure management tool with the aim of reducing the number and the duration of the closures.

With these interventions, it is possible to operate the mobile barriers safely, closing, on the average, 3 to 4 times a year with the present mean level of the Adriatic sea. With the expected rise of the mean sea level by the end of this century, the average number of closures will be 18 to 25 per year.

All the above interventions have been designed and the works are underway. For the Malamocco inlet channel, which is the main navigational channel, no works on the barrier may commence before the big navigation lock becomes operative, expected to be completed by the end of 2007.

The closure management tool, which is a computerized decision making model, connected on-line with the meteomarine forecasting and the measurements monitoring stations, is at present being tested. To do this, it was necessary to introduce in the model a unit which simulates, on the basis of the forecasted and/or estimated data, what would have happened in the lagoon had the barriers been operative. The outcome of the closure events are then checked on the basis of the measured data.

Analysis of the results of a 2 year test period showed that the decision model succeeded in closing the barriers for all the high water events with a good safety margin against flooding, but due to the uncertainties in the forecasting instruments, it had also some false closures, about 25% of the closure events, and some closures were 12% longer than necessary.

Since after closing the barriers, the lagoon level can rise due to incoming flow of water from the surrounding water shed and due to direct rainfall and local wind set up, all efforts must be made to improve the accuracy and robustness not only of the high water forecasting system but also of the local meteorological conditions forecasting instruments.

Development and implementation of Flood Warning System for effective exploitation of St. Petersburg Flood Protection Barrier

Victor Anatol'evich Lyukshin
(NW Directorate for the Barrier of GOSSTROI of Russia)

The Directorate of the Flood Protection Barrier is glad to welcome all participants of the International Seminar on the Operational Management of St. Petersburg Flood Protection Barrier. We are sure that use of the international experience obtained during many years of exploitation of flood protection barriers in different countries will be a guarantee of a reliable protection of our wonderful City from constantly increasing number of floods.

At the present time, a correction of the Program of the Barrier completions is made in accordance with the assignment of the Russian Government. After it, the Federal project budget will be considerably increased. It will make it possible to increase the intensity of the construction works. And as a consequence, all documents, which are necessary for safe and reliable Barrier exploitation should be developed in a short time.

In 2003 the Russian Government organized the Federal state enterprise 'Direction (Directorate) of the St. Petersburg Flood Protection Barrier', with the functions of customer, builder and management of the Barrier. Its tasks include also the development of the Flood Warning System (SPUN), which is one the key issues of the Barrier operation. The Russian budget provides 46 million roubles (~ 1,300,000 Euro) for financing the SPUN system development.

The main task of the Barrier construction is prevention of harmful impacts of flooding on St. Petersburg. Therefore all actions aimed to the Barrier construction and its operation should be subjected to this task. Taking in mind the necessity of coordination of activities of many organizations, which are involved in the SPUN project, and also the necessity of the project completion in accordance with the demands of ''Agreement on loan between Russian Federation and EBRD' before 1 January 2007, a working team for the SPUN project realization was installed. It includes representatives of Rosstroi, Roshydromet, Administration of St.Petersburg Port, Center of the Navigation, design institutes and MORZASCHITA.

During the team meetings the most complicated problems are discussed. Opinions of different stakeholders already are taken into account in this stage of the design. The basis for the SPUN project has been described in the Technical Feasibility Study Report of NEDECO produced in 2002. It should be noted that the main approaches outlined in the NEDECO Report are valid for the present.

Development of the optimal decisions on the Barrier closures and openings in view of threat of flood consists of many particular problems. The main one is a reliable forecast of water level oscillations during flood. We clearly understand that this complex task can not be solved without close cooperation with relevant organizations around the Baltic Sea, because only constant exchange of hydrometeorological information and forecasts can guarantee reliable warnings of flood thread in due time.

At the same time, work with this big amount of incoming hydrometeorological information and development of forecasts of time history of water level during floods should be done by highly qualified specialists. As their work rooms a modern hydrological station is foreseen in the Central Building of the Barrier Management. The station will be equipped with all necessary connection lines and computers.

To increase the reliability of operationally collected hydrometeorological information, further development and modernization of the monitoring net is planned within the framework of the SPUN project. In particular, in 2004 the Barrier Direction ordered to develop a part of the project, titled 'Arrangement and Equipment of the Meteo Complex for SPUN'. Cost of construction of 7 additional meteorological stations is 6.7 million. roubles (~ 200,000 Euro).

Development of the hydrological complex within the framework of the SPUN project includes construction of posts for water level observations in different points. The complex will consists of 15 automated water level gauges, 11 gauge rods and 12 special wells. Their equipment with constant connection lines is planned. We consider that integration of these hydrometeorological data in the system of international exchange, should improve the accuracy of forecasts.

At the same time we realize that the increase of the number of observation stations is not enough to get good forecasts. It is necessary to implement widely the modern methods of mathematical modelling of the Baltic Sea hydrodynamics. These methods allow estimating the incoming information, to take into account a large number of different factors, which influence of water level in the Gulf of Finland. For example, there is such factor, as ice, which is absent in warmer countries.

During the process of realization of the SPUN project and its further management the Direction of the Barrier intends to pay the utmost serious attention to development and updating of the existing hydrodynamic model of the Baltic Sea. We are sure that the progress in the modelling and computer technology provide a basis for increasing significantly the accuracy of the forecasts, but only if close international contacts will exists. Mathematical modelling methods should also provide a basis for training the staff, which will be in charge of the Barrier operation and also the pilots, who will pilot the ships through the Barrier in and out of Neva Bay.

One of the main aspects of the Barrier operational management is the safety of navigation. By the order of the Direction of the Barrier, a plan for modernization of the fairways leading to the Barrier openings has been developed. In accordance with this plan the number of turns will be decreased from 4 to 2, and the length of the straight parts of the fairways, their width and depth will be increased. New anchor places will be made for ships sailing during periods, when the Barrier is closed. We have to decide the number and locations of current meters in the fairways and wave wind meters in the navigation openings and to organize the transfer of data on currents and waves to captains and pilots.

Another important aspect of the Barrier management is the development, agreement and formal legally based introduction of the documentation for the Barrier management, where different scenarios should be foreseen and decision support system for persons, who will operate the Barrier, should be developed. Of the utmost value here is the international experience of the Barrier operation management. It will allow prevention of mistakes, which could lead to extremely heavy consequences for St. Petersburg. Therefore we will be grateful and will study carefully all proposals, comments and wishes coming from the seminar participants.

In conclusion, let me express the hope, that during this meeting we will establish a fruitful cooperation and will continue close contacts for the achievement of our mutual goal – to protect lives and health of the people of our countries from natural catastrophes.

Environmental protection and Flood Protection Barrier

V.M. Tarbaeva
Department of Federal Service Rospripodnadzor of Leningrad Oblast, St.-Petersburg.

The environmental situation in the Finnish Gulf plays a key role in the environmental situation of Eastern part of the Baltic Sea basin. Although, in comparison with the end of the 1980ies the environmental condition of the ecosystem of the Finnish Gulf has become slightly better now, this fact should not create a faulty optimistic impression because the mentioned improvement was caused not by nature protection activities but by the overall drop in production in the region and thus a reduction of harmful emissions. At the same time the overall level of anthropogenic loading on the water system, determined by the concentration of production in the basin of the Finnish Gulf is high and it exceeds the all-Russian level. The biodiversity of the sea is relatively low and its ecosystems are very vulnerable and non-sustainable. The consequences of economic activities effect negatively on the situation in the gulf and existing conditions of its inhabitants. Among the negative factors there are pollution substances from very different sources. During researches of many years by different organizations that conduct ecological monitoring, assessments of the influence of the main nature users (including the construction of the Flood Protection Barrier (FPB) on the situation of water and coastal parts of the Finish Gulf were made. The results of these assessments were summarised in the monograph "Analysis of the environmental situation in the Baltic Sea basin (problems and perspectives)" (Lebed', Tarbaeva, Markovec and others, 2004). Later we will consider the assessment of the influence on Neva Bay (the area of the FPB construction).

The complexity of the environmental condition of the Finnish Gulf ecosystem as a water body is caused by the peculiarities of the anthropogenic and natural factors. After analysis of the anthropogenic influence on Neva Bay the following types of influence can be distinguished: coastal buildings and infrastructure, trash dumps, recreation, agriculture, water supply and drainage system, navigation, timber-rafting, fishery and amateur fishing, atmospheric loads and industrial loadings on the water bodies (Databases on ecology of the Finnish Gulf, 2003).

Municipal sewage. The most important and still unsolved problem is the strong pollution of the water environment in the Finnish Gulf by the SPB city sewerage system. Through the sewerage, annually about 1400 mln m^3 of sewage are discharged into the water area of the Neva river and Neva Bay. The problem of discharge of untreated sewage (till 30% of the whole volume) cannot be solved in the nearest future. Every day the city treatment plant accumulates about 1500 tons of sediments which is transported by specially equipped transport to the dumping grounds (Trash treatment, 2003). The high concentration of sediments with toxic elements implies a complicated problem for their future processing, This problem started to be solved only after entering into exploitation of the sediment incineration plant, which is located on Beliy Island. The construction of the South-Western Treatment Plant (SWTP) was effectively stopped in 1996. This problem can't be solved on the basis of regional resources without participation of the federal bodies. At the same time without solving this problem, a significant improvement of the environmental situation in the Finnish Gulf is impossible. The strong attention of the SPB City Administration to this problem, the great interest of EU countries, especially Finland gives hope on a step by step construction of South-Western Treatment Plant (SWTP) before 2005. The federal programme "The protection of the Baltic Sea basin from pollution" includes statements on:

1. construction of a city system of sewage treatment (construction of South-Western Treatment Plant), including the reconstruction of sewerage collector network in the central part of the city;
2. reconstruction of galvano-chemical enterprises, creation of a plant for disinfection and using of bottom sediments from the rivers and channels in SPB.

Obvious problems of state government importance remain:

1. completion of the construction of the South-Western Treatment Plant (SWTP) ;
2. completion of construction of the right-bank city sewerage collector leading to the Northern Treatment Plant;
3. connection of direct discharges to the collector network;
4. introduction in all places of water-saving technologies (including systems of reverse water-supply).

The Helsinki Convention initiated the construction of Treatment Plants in SPB. During the last 25 years Treatment Plant with capacity 2.8 mln m^3. per day were built, and in the suburbs – 350 mln. m^3 in day. Within the framework of the programme JCP ("Baltic Sea Comprehensive Environmental Programme") it was foreseen to reduce the volume of discharges of pollution sediments to 50 % from the level of 1987 year for biogenic sediments, heavy metal and toxic or stable organic sediments. For nitrogen and phosphorus the 50% reduction has not been reached, which was primarily caused because of lack of enough capacity for treatment of household waste water. The problem can in fact be solved after introduction of the South-Western Treatment Plant in 2005. For oil pollution and heavy metals the reduction to the 50% level of 1987 has been reached.

Dredging works. The rivers and channels of SPB require conducting of dredging works every year. The total volume of materials entering the city waters is of the order 1.5 million m^3 per year. In previous years that type of work was done regularly. From 1981 about 3 mln ton. m^3. of bottom sediments were removed annually. These sediments were dumped in open submarine dumps which are located in the Eastern part of the Finnish Gulf. During the last years no dredging works in the rivers and channels of the city took place. Because of this bottom sediments have accumulated and the total volume now reaches 11 mln. m^3. The situation has become critical. At the same time the level of pollution of bottom sediments dredged from the SPB rivers and canals does not allow to dump the material into the Finnish Gulf as was done before, because of the discrepancy between the quality of the material and the requirements of the London Convention on dumping (Pitulko, Spiridonov, 2003).
Concerns are also raised by the process of the gradual bogging up of shallow areas of the Finnish Gulf between St.-Petersburg and the Barrier, because the autumn storms are weakened by the presence of the dam and are no longer able to clean the bottom of the Neva Bay sufficiently of the higher plants growing there. The bogging up and the associated overall rotting of plants does not yet effect on the water quality in the Finnish Gulf but in future it can lead to additional eutrophication of the water body and the disappearance from the Neva Bay of large parts (on which, furthermore, a significant amount of harmful compounds will be buried in the soil). What kind of negative consequences can entail the completion of the construction of the Flood Protection Barrier? The answer to this question can be found in the materials which were prepared during the realization of the NEDECO project "Environmental Impact Assessment Study" in 2002 (the study was conducted by a

NEDECO consortium with WL/Delft Hydraulics as leading partner, it was funded by the JECF at the EBRD). In the general conclusions of the project report concerning the potential impacts of the completed construction of the FPB on the environment it is clearly indicated that compared with the current situation the FPB will not have significant negative impacts on the environmental state in the Neva Bay and the Finnish Gulf, including animals and plants nor on people health. The report also includes a Plan of environmental protection measures related to reduction of impacts, monitoring and management.

In 2001-2004, the Department of Goscontrol in the sphere of Nature Use and Nature Protection of the Northwest Federal Region, together with the Main Service for Natural Resources of St. Petersburg and Leningrad Oblast' has conducted a number of inspector examinations on the state of the FPB. During these examinations administrative irregularities were found and directions on their removal were produced. In total, these breaches of regulations concerned the right to land, the absence of a conclusion of the State Environmental Review on the FPB, draft procedures on emission and discharging of polluted materials and a Declaration of Safety for the FPB. Negative impacts of the FPB on the environment were not established in the results of the examinations / investigations.

After consideration and analysis of all materials concerning the FPB construction, as well as the environmental state of the Finnish Gulf in the light of compliance with international agreements, in 2004 the Main Service for Natural Resources of St. Petersburg and Leningrad Oblast' (GUPR of SPB and LO), prepared the following general conclusions:

1. The main documents during the design, construction and operation of the FPB must be the EIA documents (OVOS – environmental impact assessment), as foreseen by the legislation of the Russian Federation. In relation to that is is necessary to prepare the available materials on impact assessment for the Ministry of Nature Resources in agreement with the requirements of OVOS. Is is necessary to conduct a State Environmental Review on the federal level of the materials of the update ("korrektirovka") of the design documentation
2. The completion of the FPB construction is extremely necessary in the shortest terms, but not before the construction of treatment plants of Saint Petersburg and Leningrad region which were registered in the project «Protection of SPb against flooding. Update of the Design» and were confirmed by order of the Ministry of Construction of the Russian Federation N 17-122 from 10.09.1996
3. Strengthening of safety measures against accident situations, first of all against oil spills and fires as a result of road transport of dangerous materials, through the organization of coast and sea protection service of the FPB (system of fire safety, fire extinction, monitoring and protection). (Following the recommendations of the conclusions of the State Environmental Review Leningrad Committee on Environment (Lenkomekology) on the economic substantiation of the St. Petersburg Ring Road #834 from 20.09.2000)
4. Organization of a system of state environmental monitoring in the area where the FPB is constructed, using available technologies and laboratories with application of other modern methods and technologies, including satellite technologies. As a whole, it is necessary to prepare a programme on organization and conducting state environmental monitoring of the Ladoga Lake – Neva river- Finnish Gulf water basin (of which the dam is considered to be part) – on conditions of federal and regional financing with attraction of international investments under coordination of the Nevsko-Ladoga Water

Basin Department, the Main Service for Natural Resources of St. Petersburg and Leningrad Oblast' and the Governments of St. Petersburg and Leningrad Oblast'.

5. Installation of a Working Group under coordination of the Main Service for Natural Resources of St. Petersburg and Leningrad Oblast' and the invitation of leading organizations which are carrying out the control, examination, design and construction of FPB, representatives of the Administration of Saint Petersburg and Leningrad Oblast' with the purpose of revealing vulnerable parts in the realization of the FPB project, prevention of idle times, improvement of nature protection activities in the influence zone of the FPB.

Possible problems of navigation when the Saint-Petersburg Flood Protection Barrier is operational

P.P. Parinov,
Administration of the St.-Petersburg Sea Port

The main factors which influence the development of St.-Petersburg Sea Trade Port are the following:

- The possibility of attracting additional sea-borne freight turnover;
- Increase of the carrying capacity of the shipping routes towards the port and in the Neva Bay.

Therefore, the matter of the development of shipping routes towards the port is one of the most important matters.

Currently ship movements to the St.-Petersburg port and transit ship movements take place through the main sea route, which includes:

- Kronshtadt Ship Fairway (KSF) – length 22 km;
- St.-Petersburg Sea Channel (SPB SC) – length 31.1 km;
- Part of the Bolshaya Neva river from the Neva mouth till the Lieutenant Schmidt bridge– length 4 km.

Presently, the St.-Petersburg Port can take ships of sizes not exceeding the following:

- on length -260m;
- on width – 40 m;
- on draught – 11m.

By special agreement of the Captain of the Port a ship with exceeding sizes can be allowed to enter.

Navigation in the external and internal port waters is regulated by Obligatory Statements of the Sea Administration of the St.-Petersburg Port.

Along a considerable length the Kronshtadt Ship Fairway follows natural depths from the St.-Petersburg reception light buoy till buoys #23 and #24. Currently the KSF goes through the temporary navigation gap, in future, after completion of the construction of the navigation opening in the Barrier, the KSF will be directed through navigation opening C-1. Currently the width of KSF is 100 – 120 m., the indicated (maximum) draught of ships is 11,0 m.

The St.-Petersburg Sea Channel includes an open and a closed part. The open part of the channel passes through Neva Bay from the buoys ##23 and 24 till picket 132. The closed part of the Channel goes from picket 132 between the Northern and Southern channel guidance dams, through the Golden Gates and the waters of the Coal Harbour and Forest breakwater, past the mooring area of the 2nd district of the St.-Petersburg port and further till the Neva mouth ("Neva Gates").

The width of the channel in the open part is 100 m, in the closed part it is 80m, and the indicated maximum draught is 8.3-11,0m.

The ship road leads further along the Big Neva River from the beam of Gorniy Institute till the Lieutenant Schmidt Bridge, where the announced draught is 8.1m.

Besides the main sea route for navigation in the Neva Bay there is a system of branched canals and fairways.

The carrying capacity of the branched channels and fairways does not influence the carrying capacity of the main sea road and vice versa.

However the conditions of intersection of the branched channels and fairways with the main sea way can limit the volume of navigation and not allow to reach the theoretically calculated carrying capacity.

Taking into account this problem, as part of the construction of Flood Barrier Protection Barrier the company "Lenmorniiproect" presently carries out a design for reconstruction and construction of sea ways. As a result, ships will able to go to port mooring places or make the transit navigation either along KSF and through C-1, or bypassing this, and go through C-2; which will at the same time allow to relieve the main sea road.

According to the design prepared in 1988 and largely implemented now, the track of the Flood Protection Barrier goes from Gorskaya on the Northern coast of the Finnish Gulf to Kotlin Island and further to Bronka on the southern coast. The total length of the track is 25,4km; its height is about 7m above sea level. For navigation through the dam there are two navigations opening C-1 and C-2.

Navigation opening C-1 between Kotlin and the southern coast will have a width 200m and depth 16m. C-1 is intended for passage of ships with a deadweight up to 70,000 tons. Navigation opening C-2 between Kotlin and the northern coast will have a width 110m and depth 7m. C-2 is intended for navigation of ships with relatively small displacement and draught 5.5m; first of all for ships of "river-sea" type, as well as ships of small size (yachts and cutters). Ships which will able to go through the C-2 must have a total height not exceeding 16m.

Along the whole length of the dam, including C-1 and C-2 a highway of international level is planned (over C-2 via the road-transport bridge and under C-1 through the road-transport tunnel).

As part (task) of the Feasibility Study (TEO) (of the project) for the reconstruction of the Kronshtadt fairways and the design preparations the following aspects are considered (**in the part devoted to C-1**):

- Extension of fairway #1 (Big Ship Fairway);
- Transfer of the St.-Petersburg reception light buoy (with given new number #1) to the of crossing of fairway #1 with the new part of the KSF (fairway #2);
- Changing the boundaries of anchorage area #3 on the Big Kronshtadt Road;
- Straightening of KSF: building of a new part with length 8.3 miles, width – 150m (first phase), 200m (second phase), depth 14m (first phase), 16m (second phase). These actions consider removal of the 2 existing elbows of the fairway, to remove from exploitation a range of light signs of Big Kronshtadt Road (direction 271.2-91.2) and a range of Kronshtadt light houses (direction 286.9-106.9), construction, instead of existing ranges the light signs of Middle Harbour, a new range of signs (which are close in terms of direction), which are able to provide a safe navigation along the whole distance from turning of light signs' range Perekhodnyi in the district of island Kronshlot until the new place of reception buoy #1.
- Protection of the new part of KSF with new Floating Warning Signs (FWS) – 13 light buoys;
- Construction of new Light Navigation Signs (LNS) on the protecting breakwaters of navigation opening C-1;
- Construction of new anchorage (#4A) which is located southward of fairway #1 on the beam of Krasnaya Gorka for large tonnage ships, which go to the entrance of the port.

(**In the part devoted to C-2**)

1. Reconstruction of the Northern Kronshtadt fairway with length 9.2 miles, providing a depth not less than 6m by width 80m (first phase), providing of depth not less than 7m by width 110m of fairway's channel (second phase); equipment of the fairway with new light navigation signs (LNS) including new reception buoy #2, LNS on protection breakwaters of C-2 and on the bridge's crossing through C-2; with new FWS - 17 ice buoys.
2. Construction of new Western Kronshtadt fairway (2 elbows) by width 600m on natural depths from 12 till 25 m, its equipment with FWS - 9 light buoys along the axis of the fairway;
3. Construction of new anchorages (#4B, #4V with capacity of 5 and 4 anchor places respectively) in the North and in the South of Northern dam of the Flood Protection Barrier (FPB) and protection around anchorages by FWS - 3 and 5 light ice buoys, accordingly.
4. Construction of a car transport bridge over the Northern Kronshtadt fairway. In order to choosing its optimal height the specialists of Lenmorniiproject conducted scientific investigations using statistical data on navigation by types of ships; these investigations demonstrated that a bridge height of 16m is suitable for the overwhelming majority of ships, which given their size are able to go through C-2.

In order to avoid various types of problems related to safe navigation in the waters of the St.-Petersburg Port in the situation of a functioning Flood Protection Barrier and to solve the tasks above mentioned, it is necessary to take into consideration the following:

- The reconstruction works on the sea roads and their entering into exploitation with the designed sizes have to be completed by the moment the navigation openings C-1 and C-2 enter into exploitation;
- The priority in terms of entering into exploitation is given to C-2 because this action will allow to relieve the main sea road and at the same time to increase sea-borne freight turnover from (*non specified*) mln tons per year (currently) to 60-80 mln tons per year (as projected).
- During the implementation of submarine technical works a deepening of the engineering communications (cables and pipelines; which are crossing channels and fairways; and require taking up or moving) has to be considered that will be sufficient for unhindered conducting of the projected dredging of the fairway, that means, without further taking-out or moving of the engineering communications, in accordance with the threshold level of the navigation openings.
- The items of navigation equipment which are necessary for service of new and reconstructed sea roads have to be put into operation in strict accordance with design decisions and to be served during exploitation in uninterrupted regime.
- The build-up of experience by navigators regarding the new conditions of navigation (increase of sizes of the ships, which are taken by port; changing of the hydrological regime of the water body, the new characteristics of the FWS, new characteristics of the sea roads and etc) has to take place systematically using computer modeling and preparation of practical recommendations.

The main obstacle for development of anchorage places is the danger of mines from the Second World War, which was declared for the water area of the Finnish Gulf by decision of the leadership of the Baltic Fleet Staff. The result of this decision is the prohibition for ships to drop anchor, with the exception of specified places. Instead of executing its functions on liquidation of such kind of danger and the announcement of new places for anchorage, the Hydrographic Service and the Leadership of the Baltic Fleet, without agreement by the Captain of the Port, have unilaterally changed the functions of the existing anchorages in the water area of the port. They gave to these anchorages the non-defined status “district of waiting”, a short–term staying of a ship without dropping anchor. Such kind of actions were taken for anchorages #1A and #1B (they are renamed into “districts of waiting” #8 and #9 accordingly), and for the anchorages on the Eastern and Big Kronshtadt Road.

For building the newly created anchorage #4A, which was above mentioned, the Central Scientific Research Institute of the Navy (“CSRISN”) has presently prepared a scientific research project, which has passed acceptance by the leadership of Leningrad Military-Sea Base, and is submitted for approval to the nature safety and monitoring bodies. Based on this plan, the St.-Petersburg branch of “Rosmorport” will in future, from its own finances. implement the construction of this anchorage and its opening for navigation

Through fault of the Ministry of Defence, the Decision of the Meeting with the Chairman of Russian Government (art.16 Protocol #MK-P102p of 26.01.01) on transfer of a number of hydro technical objects from the Ministry of Defence of the Russian Federation to the balance of the Ministry of Transport of the Russian Federation has not been realized till now. Without solving this problem, it is impossible to provide money for reconstruction of sea roads, to provide these with navigation equipment. This means that full implementation of the activities aimed at providing navigation safety is also impossible.

In conclusion I would like to mention that the development of the sea roads of the St.-Petersburg Port is a task of great importance in order to provide navigation safety with continually growing sea-borne freight turnover. This development will give the opportunity to remove a number of currently existing limitations for navigation. It will also allow accepting big tonnage ships with length till 300m, width till 50m, and in general will heighten the attraction of the trade port of the St.-Petersburg.

Flood forecasting for Operational Management in The Netherlands

Herman Gerritsen,
WL | Delft Hydraulics

The water level along the coasts of The Netherlands is characterised by a strong but well predictable rise and fall, which occurs twice a day, and is due to astronomical tide. Superposed on this, water level rise due to irregular wind effects and larger storm effects occur. Both tide and (most) storm surge effects originate from the Atlantic Ocean, enter the North Sea along Scotland and propagate southeast along the eastern English coast, toward the coasts of The Netherlands, which is located in the most southern part of this continental shelf basin. Due to decreasing depths and the funnel shape of the southern North Sea, strong resonance effects and intensification takes place. The historically most disastrous storm surge of 1 February 1953 led to extreme high waters and collapse of the dikes, both since the peak storm effect occurred at the time of high water during a spring tide, while the storm also had an extreme duration, covering three tidal high waters.

In the early 1980-ies, in view of the completion and operational management of the Eastern Scheldt Barrier (1986), a full redesign of the then existing computer model based flood forecasting, driven by wind and pressure, was decided). A new model application was designed, covering all of the shelf, and extending sufficiently far into the Atlantic Ocean, to allow inclusion of depression effects already in deep ocean waters . The new model was set up and developed to simultaneously model the wind and pressure induced storm surge effects together with the tide, thus including the interaction and enhancement / decrease of the surge by the tide - surge dynamics.

The model application, which was started in 1984 as a joint development of Rijkswaterstaat and WL | Delft Hydraulics, is used for operational surge forecasting at the Royal Netherlands Meteorological Institute. While the model area has not changed, the model quality is now significantly higher. Performance analysis and studies to improve the model quality and the forecasts are ongoing activities, using quantitative assessment techniques and data assimilation. A further stimulus for improvement was the completion of the Rotterdam Waterway Storm Surge Barrier, which demands even higher forecast lead times and accuracy, since port operations need to be taken into account. Forecasts are made at KNMI for a period of 48 hours ahead, and are refreshed four times each day (forecasting cycle of 6 hours), using most recent surface wind and surface pressure forecasts, and including most recent coastal water level observations from up-wind stations in the Kalman Filter data assimilation.

The presentation introduces this so-called Dutch Continental Shelf Model and shows several examples of its accuracy and the forecast improvement by using the data assimilation. New developments include the cooperation of the North Sea countries in the NOOS and EuroGOOS projects, which stimulates the exchange of operational forecasts as a means to improve the understanding and the forecasting quality to the user.
The operational forecasting and warning system at KNMI is outlined, using three different levels and types of warnings.

A second part of the presentation addresses the response system in case of storm threats. The so-called SVSD crisis management unit is then called into session and prepares the response, by mobilising the many agencies having responsibilities for storm threat situations. For a large number of potential situations, detailed response scenarios are available, which are trained from time to time. The SVSD crisis management unit also updates the forecasts as soon as new information is coming in, and distributes the warnings to all organisations involved, including the Barrier Management teams. Detailed evaluation of each storm situation is standard practice, and forms an effective means to re-assess preparedness and initiate improvements or adjustments in procedures in order to be ever better prepared for the essential natural hazard that may result from storm situations.

Meteorological and ocean forecasting in Sweden

Hans Dahlin,
Director EuroGOOS / SMHI

The operational meteorological, hydrological and oceanographic forecasting in Sweden is performed by SMHI. Computerisation of te forecasting models started more than 50 years ago. Most systems are fully automatic, and are only supervised by technical personnel. Scientists work in the background with further development, and step in when problems occur. A set of basic models are forcing special models for different applications and services. Forecasts and forcing are also derived from external forecasting centres (for example, ECMWF) and as back up from institutes in neighbouring countries. Products to users are delivered by specialised units, one for each of the disciplines meteorology, hydrology and oceanography.

The meteorological forecasts are based on the HIRLAM model nested into the ECMWF model. The basic oceanographic model is HIROMB, a model for the Baltic Sea and North Sea developed from the German BSH-c model. HIROMB forecasts the 3D current fields, salinity, temperature, sea ice and sea level. Forecasts are run twice a day for 48 hours ahead. HIROMB is operated, developed and used through an inter-agency agreement, with participation from five Baltic countries. Separate models are used for wave forecasts: HYPAS and SWAN.

The forecasts need to be validated and the models require data for assimilation. Exchange of data and products are objectives for the development of BOOS, the Baltic Operational Oceanographic System. The main objective of BOOS is increased efficiency and quality in the production of national and common services in the Baltic countries. The resources in a single country are not sufficient for the production of the required services. Collaboration between countries and between professional agencies is essential in order to obtain the social and economic benefits from operating efficiently within and achieving sustainable management of the oceans and coastal zones.

The presentation demonstrates products and services in Sweden but also core services available for use in other countries through existing international cooperation.

International Cooperation and Information Provision for Integrated Water Management of St. Petersburg

Rosa R. Mikhailenko
Head of Research and Environmental Department of Morzaschita Department of the St. Petersburg City Government

---

The geographical situation of Saint Petersburg as one of the most important strategic cities of the Russian Federation is unique because it is located on the Baltic Sea Coast on the eastern end of the Gulf of Finland, part of the Lake Ladoga-the Neva river- Neva Bay-Eastern Gulf of Finland system, which is the largest in Europe.

The theme "Integrated Water Management" has for a long time been one of the priorities in the activities of the "Morzaschita" Department. When estimating the ecological condition of the water system Ladoga Lake-the Neva River-Neva Bay-Eastern part of the Gulf of Finland in connection with construction of the Flood Protection Barrier in 1990, the International Commission of Experts pointed out the necessity of integrated water management for St.Petersburg.

International cooperation in the sphere of integrated water management of the St. Petersburg Region started in 1990. The first joint activities were mainly connected with estimation of ecological condition of the water system. Representatives of 6 countries, including specialists from The Netherlands, The United Kingdom, Italy, Finland, Denmark and the United States took part in the work of the Commission. The International Commission recommended the approach of integrated water management in St. Petersburg as the best way to solve the ecological problems.

Taking into account the similarity of the main settings in the Netherlands and St.Petersburg such as their location in estuaries of large rivers, the drainage basin of which are both inside and outside their countries, they both require step by step water management development; the construction of ports; protection problems and what is very important – The Netherlands has successfully solved the flood protection problems and at the same time environmental problems connected with construction of flood protection barriers. The rich experience of the Netherlands and other European countries is very relevant for our region. International cooperation has already helped in creating a scientific approach to integrated water management. In 1996 we started the joint Russian-Dutch project "Integrated Water Management for St. Petersburg". In 2000, as a result of the third stage of the project, the GIS of flood warning and flood damage estimation for St. Petersburg and the coastal area of Neva Bay was created. Specialists from WL|Delft Hydraulics, Morzaschita, Aerogeodesy, IRE, PAS, Civic Protection, Emergency Situation Agencies, VNIIKAM and the North-West Polytechnic Institute created a digital map of St. Petersburg and Neva Bay using the GIS ArcView3.1 programme, including the geodetic height of the area. The relief which is so shown in the digital map makes it possible to define the flooded territories of the city when the level of water is from 1.5 metres up to 6 metres relative to the zero level of the Baltic Sea level system. Classification of objects according to their categories of land use, districts, streets and numbers of the houses and other buildings, as well as information on the cost or value and the potential damage with flood water level increase has been introduced. It so gives the possibility to estimate potential flood damage for each district, each building and for all categories of land use. Besides, a model system for water level forecast was developed. Within this development, data from the Swedish Meteorological Hydrological Institute is obtained for testing purposes. Potential users of the flood forecasting system and GIS have been trained. Furthermore, documentation has been prepared.

The FPB is in the completion stage and it is necessary to make every effort to take into account the interests of all stakeholders to achieve consensus in decision making in flood threat situations.

Floods in Saint Petersburg and Flood Forecasting

Grabovsky A.I., Dren L.M., Kolesov A.M.
North-West Hydrometeorological Office (NWHMS)
Malashin, Yu.D. (LCHMS)

Floods in Saint Petersburg occur when the water level rises up to or exceeds 160 cm relative to the long period Baltic Sea mean level ("Kronstadskii footstock"). The main water level observation is known as Gornyi Institute and is placed at the right bank of the Neva river 2.8 km from its mouth. The observations have been made since 1877.

Water level rises over 200 cm are of serious hazard to the city. During the last 20 years 33 floods have been registered at Saint Petersburg, among them 11 cases exceeded 211 cm.

It is usage to classify all water level raises at the Neva mouth by their reasons under three groups:

- rises caused by wind surges in the East Gulf of Finland,
- rises, resulting from seiche oscillations of the Baltic Sea level,
- rises, due to the long waves entering into the Gulf of Finland from the Baltic Sea. Specifically the latter rises cause significant floods, among them the catastrophic ones.

For flood forecasting we use the formula taking into account two main predictors:

- height of the surge wave at the entry of the Gulf of Finland,
- increase of this height due to wind over the area of water.

The author of that synoptic method is N.I.Belskyi. His method makes it possible to forecast the maximum rise but not earlier than 5-8 hours before the event. Such a time window is insufficient for a drastic reduction of damage in a megapolis such as St. Petersburg. Since December 1999, along with the synoptic method, the St. Petersburg Weather Service uses the pre-operational hydrodynamic computerized flood forecasting system. This system was created by Morzaschita, North-West Hydrometeorological Office and Delft Hydraulics, the Netherlands.

The present-day problems:

1. Not all synoptic situations, which have indications of danger, lead to real floods. The computer system gives evidence, but the final decision is the result of the synoptic activity.
2. The high resolution local model HIRLAM that produces the meteorological information for the water level forecast model system here in St.Petersburg is another than the operational model for everyday use. Financial support and hard work during about 18 months are necessary for creation of a Russian model analogue.
3. The density of the observation network in the Gulf of Finland is absolutely inadequate. We put forward a proposal for making a comprehensive observational real time system as part of the final project.

4. The winter surges together with strong winds provoke ice breaking and forming of ice barrages along the banks. It is necessary to take into account the possibility of damage to the barrier control-gear mechanisms and in the navigation openings.

The possibility of a catastrophic flood in Saint Petersburg increases with time. Therefore, elaboration of the right management decisions during the final stage of the completion of the construction and the subsequent operational regime of the Flood Protection Barrier is extremely important.

Automated Flood Forecasting System for St. Petersburg

K.A.Klevanny (MORZASCHITA)
M.S.W.Mostamandi (NWHMS).

In 1998-2000, the Flood Defense Department MORZASCHITA of the St. Petersburg Government, North-West Administration on Hydrometeorology of Russia (NWHMS) and WL | Delft Hydraulics conducted two joint projects, funded by the Ministry of Economics of the Netherlands. As a result of these projects, a fully automated flood forecasting system for St. Petersburg was developed. In 2002-2004 as a result of joint work by MORZASCHITA, KNMI, the Russian State Hydrometeorological University and NWHMS and funded by a NWO scientific research grant, the module for wind stress calculations was updated. Since December 1999 the system was implemented at NWHMS for pre-operational use and it helps the meteorologists on duty to produce water level forecasts. In October 2002 the system was approved by ROSKOMHYDROMET.

The system is based on forecasts of surface wind and surface pressure over the Baltic Sea produced at SMHI with the HIRLAM model with step 0.2o and the advance time 48 hours. After the HIRLAM simulation is done, once per day the forecasted fields of surface wind and surface pressure with the time step 1 hour are loaded on the ftp server of SMHI, from where they are received at NWHMS. In addition, BSH provides NWHMS with daily forecasts of discharges through the Danish Straits. Also monthly mean discharges of main rivers are taken into account.

The hydrodynamical model of the Baltic Sea BSM5, installed at the NWHMS, was produced with the CARDINAL modelling system (Klevanny et al., 1994). The model decodes input data and makes simulations for the next 48 hours. The meteorologist on duty can view the forecasted time history of water level in St. Petersburg together with the observed one in the real time regime. The whole process of data input, simulations, post processing and dissimilation of the results is fully automated.

The program system CARDINAL uses curvilinear boundary fitted co-ordinates. The mean grid size in the BSM5 model is 7400 m, minimal grid size (in Neva Bay) is 400 m. The St. Petersburg Flood Protection Barrier is approximated in the model with dams with 4 openings. The total open cross section of the present state – 14900 m2 - area is preserved. A user friendly interface of the system allows graphical presentation of the evolution of the wind, pressure, water level fields. The system makes it possible for the first time to analyze in detail the processes, which lead to flooding in St. Petersburg. The presentation shows such examples of flood fields evolution.

Validation of the system performance on hourly data for St. Petersburg for a three years period shows the following results: observed and simulated means are 15 and 12 cm, root mean square error is 17 cm, mean absolute error is 13 cm, spread is 17 cm, observed and simulated deviations are 30 and 31 cm, correlation coefficient is 0.85. 15 recent significant water level rises (with mean height 143 cm) were simulated with mean absolute error in 38 cm. The moment of peak flood of the largest flood in the modelled period occurred on 9 January 2005. It was forecasted practically exactly – at 11 h 35 min. (Moscow time), but the peak value was considerably overestimated. Analysis of the possible reasons of this is done in the presentation.

The presentation also contains an estimation how the present accuracy of forecasts fulfils the demands of the operational management of St. Petersburg Flood Protection Barrier. This operational system should consist of an automated flood forecasting system, automated water level monitoring, a data assimilation module, a decision support system for closing and opening of the Barrier gates, reliable connection lines and a flood alert system. Warning about closing the Barrier and following amendments should be given in due time. The system should forecast the optimal timing for closing and opening of the Barrier, such that the water level in the City would not exceed a certain level (at present it is 160 cm) while at the same time the period of closing would be minimized.

It should be taken into account that opening of the main navigation sluice is possible only if the water level difference between both sides will not exceed 40 cm. Probably, also a delay in the closing, when velocities in the sluice will reach several m/s may give rise to problems. For the flood of 9 January 2005 a closing, based on the model forecast, should be done for 21 hours. Afterwards, using observations, it is found that the Barrier should be closed for 11 hours. It is seen that for the effective operation of the Barrier flood forecasts should be very accurate.

For the improvement of the forecast accuracy, further steps are planned: improvements in bathymetry, generation of a more detailed grid, development of data assimilation block, test runs with another local atmospheric model.

The Eastern Scheldt barrier and The Maeslant barrier
From formal rules to practical operation

Hans Jager, Head of the Delta-district Zeeland,
René Bol MSc, Senior Adviser Water Management

The Eastern Scheldt Barrier
The formal rules for the use of the Eastern Scheldt Barrier are as follows:
- Barrier is kept open under normal conditions.
- Barrier is closed if a storm surge is forecast > 300 cm above Mean Sea Level. In which event the 1-2-1 strategy is used. This means achieving a level of 100 cm + MSL in the Eastern Scheldt for the first high water. If the storm continues and the barrier has to be closed again, a level of 200 cm + MSL is set for the second high tide. If it has to be closed a third time, the level is 100 cm +MSL again, and so on.
- Additional use of the barrier is permitted in the event of oil-pollution, ice fields or a dike-slide.

It has been laid down by law that the risk of flooding in the southwestern part of the Netherlands must be less than once in 4000 years. Because the safety of the hinterland depends on the Eastern Scheldt Barrier when storm surges occur, the safety requirements for the operational processes are very high. In situations where the barrier "fails to close" or in the situation of an "incorrectly open", this would constitute a direct threat to safety.

The operational procedure for closing and opening the barrier is divided into two parallel processes. The first is the decision-support team process. The decision-support team is a group of experts, which comes to the barrier if there is a storm surge warning. They advise the head of the district on whether the barrier should be closed and if so, at what precise moment this should take place to achieve optimum water levels in the Eastern Scheldt (the 1-2-1 strategy). The second process is the Emergency Closing System. This is a fully automatic process. The computer decides to close the barrier as soon as the measured water level reaches more than 300 cm + MSL. This process cannot be stopped by anyone. The computer takes over the control of the barrier if the water level gets too high.

Both processes are complementary. The decision-support team will implement the most suitable 1-2-1 strategy. But it is very difficult to meet the exacting safety requirements, if a process is only based on human decisions. The Emergency Closing System is called a "high availability system". It safeguards the high safety requirements, but it cannot implement the necessary 1-2-1 strategy.

So far, all 25 closures since 1986 have been carried out by the decision support team. There has been no intervention by the Emergency Closing System during storm surges. On one occasion, in November 2001, there was an "incorrect closure". The computers rejected the measured water levels of the tide gauges. If there are no water levels available, the Emergency Closing Systems takes over control and closes the barrier for safety reasons.

The Maeslant barrier

The formal rules laid down for closure are solely intended for flood protection. The high safety requirements resulted in a very low acceptable risk of failure of less than once per 1000 closures.

The decision was made to use a fully autonomous computer system (the Decision and Support System; in Dutch: B.O.S.) for the operation of the barrier. Operation Leaders are on duty during closure, although only as a human back-up in case the computer system should stop functioning.

The advantage of this system is that it provides a clear and uniform decision-making process, and clear responsibilities during closure. At the same time, the exacting safety requirements can be met, given the complex closing (and opening) procedure and the fact the Maeslant Barrier will only close once in every in 10 years. So far, the Maeslant Barrier has been closed once a year to test all the systems and procedures, although it has not yet been used in the event of a storm surge.

Requirements for flood forecasting for the St. Petersburg Flood Protection Barrier

Marius Sokolewicz ,
Task Manager Hydraulics within the designers consortium of
Halcrow/DHV/Norplan/LenHydroProject
Mel'nikov, Alexander Nikolaevich,
Deputy Chief Engineer for the Design, LenHydroProject

The Flood Protection Barrier is a rather complicated hydraulic system, consisting of 6 large sluice complexes and 2 wide navigation openings equipped with flood gates, each controlled separately Its function is to protect the City of St. Petersburg against catastrophic floods. The Barrier can only adequately fulfil its task in combination with a sophisticated forecast system.

The primary function of the forecast system will be to predict the flood threat early enough to close the flood gates before the flood wave arrives in St. Petersburg, and to make detailed predictions of hydraulic conditions for operation of the gates. Additionally, the forecast system can be used for the detailed prediction of currents near the Barrier. This will increase the safety of navigation and reduce the risk of a collision in (or close to) the navigation opening, which may damage the structure or block the gates.

The forecast system will issue 3 warnings:

1. pre-warning, 1 day before flood wave arrives in Kronstadt; this will allow to alert the responsible organisations and to start preparations for possible closure
2. early warning, 8 hours ahead; Alert State 1 will be announced, preparations to close the gates will be started (in the winter, this includes heating of the steel gates, which takes 6 hours)
3. final warning, 2 hours ahead; final decision to close the gates will be taken, and Alert State 0 will be announced; closing of all gates of the Barrier takes approximately 1.5 hours.

The forecast system will form the hart of the Decision Support System. This system is necessary to optimise the timing of the closing and opening operation of the Barrier. The flood gates in the C1-opening are rather sensitive to high speed of water level rise and to high waves, the forecast system will help to determine the moment when these gates have to start closing. It will also help to optimise the timing of closing the sluices to keep the water levels in the Neva Bay low enough not to flood the City but high enough not to endanger the Barrier. The forecast system will also indicate the best moment and sequence of opening the Barrier.

The requirements for the operational forecast for the Barrier are as follows:

- forecast should include the following:
  - prediction of water levels (accuracy of final prediction: 10 – 20 cm)
  - prediction of wave parameters to optimise closing
  - prediction of effects of closing the gates on water levels near the Barrier
  - prediction of effect of wind on water levels near the Barrier

- forecast should be reliable also in the winter conditions (with ice cover)
- forecast system should be professionally operated and maintained.