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TERRA ET AQUA

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Front cover:
The construction of the container terminal at Pelabuhan Tanjung Pelepas, Malaysia is part of one of the world's most intensive dredging and land reclamation projects (see page 3).

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International Association of Dredging Companies

Contents

TERRA ET AQUA

Editorial

Each quarter as we are preparing *Terra et Aqua* to go to press, we realise that new and exciting dredging projects are taking shape in various corners of the world. Twenty-four hours a day, seven days a week, dredgers are at work making new ports, cleaning up environmentally damaged waters, laying pipelines for energy, creating new infrastructures — roads, houses, container terminals. This all to fulfil an ever-increasing level of economic demand and to benefit the growth of worldwide prosperity.

It is this constant drive of continually being challenged by new situations and seeking innovative means of dealing with them, which makes the maritime industry so exciting. It is the wide range of opportunities for the younger generation to contribute to these developments and to participate in creating a maritime infrastructure for their own future that makes our industry so important. How do we convey this excitement to the next generation? How can we ignite a spark of interest in the youth?

IADC has set itself the task of informing the public at large about the economic necessity of dredging. It is also reaching out actively to attract more talented and skilled young workers to our industry. The International Seminar on Dredging and Reclamation being presented in Singapore in October next is one of our tools. The seminar has been conducted many times in Delft, Buenos Aires, in Egypt as well as in Singapore and each time it is met with enormous enthusiasm.

Our annual “Most Promising Student” awards are also our way of encouraging gifted students to pursue a career in our industry. A monetary reward as well as possible publication in *Terra* (see page 13) offer incentive to continue doing significant research to make dredging ever more sophisticated and accurate. The IADC Annual Award for a paper written by a young author is another means. It was recently bestowed at the WEDA XX in Rhode Island, USA and will appear in the next issue of *Terra*.

These young people are our future. We will continue to dedicate ourselves to educating and attracting them to the dredging industry — an industry that seems to play a more significant role in the world’s technological and economic development with each passing year.

Robert van Gelder
President, IADC Board of Directors

Allard Renkema and David Kinlan

Tanjung Pelepas Port: From Jungle to Malaysia's Newest Container Port

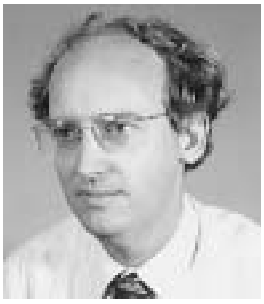
Abstract

The new port development at Tanjung Pelepas is from its inception to its hand-over an excellent example of a fast-track project:
Under the auspices of the Malaysian Government's VISION 2020, Malaysia's blueprint to become a fully developed nation by the year 2020, the port is to be developed in five phases and scheduled to have 12 berths completed by the year 2020. The Ministry of Transport allowed privatisation, awarding a 60-year concession to Seaport Terminal (Johor) and supporting the development by encouraging Malaysian banks to arrange financing. The syndicate of banks agreed to a RM 2 billion loan. The 800 ha port was also granted Free Zone Status.
The decision-making process by Pelabuhan Tanjung Pelepas Sdn. Bhd., a subsidiary of Seaport Terminal Sdn. Bhd., was also fast track. They shortened the time required for feasibility studies without reducing quality. Moffatt & Nicol Consultants were employed to prepare these studies using tested computer simulation techniques. These consultants were supported by the Malaysian consultants EEC, with an impressive track record on port construction and well conversant with the local situation.
The time to select competent competitive contractors was short.
Contract Conditions were drafted to avoid potential cost and time overruns. Although these conditions were onerous towards contractors, the limitation of cost and time overruns increased the Bank's comfort to provide financing.
The project execution programme contained numerous intermediate milestones or partial completion dates. This allowed close monitoring and adherence of progress, minimising delays and financial risks.
In order to avoid heavy liquidated damages the Contractor had to mobilise substantial extra production capacity for site clearing, dredging, reclamation and soil improvement. This turned the river and mangrove area at its peak in 1998 into one of the world's most equipment-intensive dredging projects, with some 12 large dredging vessels being employed in total.

Allard Renkema holds a BSc in Civil Engineering. He joined Amsterdamsche Ballast Maatschappij NV (now Ballast Nedam) in 1963. He has been Ballast Nedam's project manager on many dredging and reclamation projects, including Tanjung Pelepas Port. Presently he is operations manager for South East Asia.

Allard Renkema

David Kinlan holds a BSc in Quantity Surveying. Since 1991 he has been employed in the Legal Department of Ballast Nedam Dredging. He was stationed at the Pelepas Project as Contracts Manager.



David Kinlan

Introduction

The first phase of one of Malaysia's most ambitious new port facilities came on stream in January 2000. Its location: Malay peninsula's most southern tip in the State of Johor, close to the new Malaysia-Singapore Second Crossing, a new 1800-metre bridge linking Singapore with Malaysia's main traffic artery.

In less than five years the area stretching from the state capital Johor towards the west along the Johor Straits, has rapidly changed from a quiet oil palm plantation area into a totally new area to be developed with excellent infrastructure, housing facilities and new areas for industrial development.

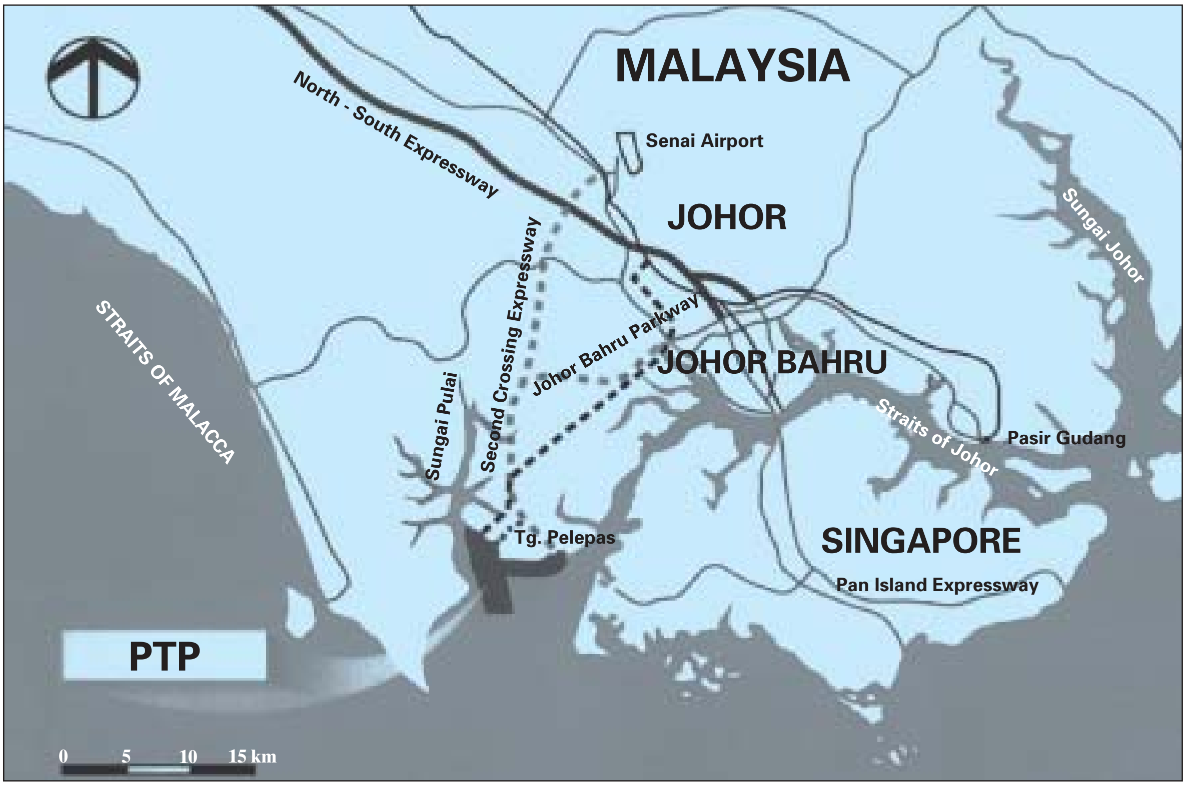


Figure 1. Location map of Port Tanjung Pelepas (PTP) showing the new infrastructure projects, such as the Second Crossing and new airport.

Major infrastructure projects such as the Second Crossing, Johor Airport and the new port development at Tanjung Pelepas at the east bank of the Sungai (River) Pulai, form the cornerstone of the Johor growth triangle west of the city (Figure 1).

Background

Since commencing operations in 1977, the present Johor Port at Pasir Gudang expanded rapidly. Growth predictions showed that the Port would suffer capacity problems by 2000. The Johor Port Authority reached maximum expansion of the Port area with the completion of Phase 4 of Pasir Gudang and began studies in 1990 to identify a site for a new port that would have the capacity to cater to all future demands for cargo traffic. Based on a site selection study, Tanjung Pelepas was selected as the most suitable location for Johor's new port (Figure 2).

On 24 March 1995, the Government of Malaysia and Seaport Terminal (Johor) signed a 60-year concession Privatisation Agreement with the Federal Government setting in motion the development of Pelabuhan (Port) Tanjung Pelepas.

The Port will be developed in Five Phases over a 25-year period up to 2020. Phase 1, comprises the development of 6 container berths or 2 km of quay together with the dredging of an access channel with a draft of 14 metres enabling the Port to cater to post-Panamax vessels (Figure 3).

Preparation of a master plan and preliminary design were done in a very short time in the years 1995-1996, enabling the project to start in 1997 and have its first staged completion in 1999.

The studies were done by Moffatt & Nichol in association with Engineering and Environmental Consultants Sdn. Bnd. (EEC) of Kuala Lumpur. During the execution of the site preparation, dredging and reclamation works, EEC remained the client's consultant.

Moffatt & Nichol's schedule for submitting the master plan did not allow for extensive field measurements normally required for capital projects of this magnitude. Also the client's commitment to have the new port on line within an accelerated timeline required assessment of financial risk and viability in an early stage. Both technical and financial computer simulation studies were carried out based on abbreviated field data and cargo flow projections. This provided the investors with valuable insight into the viability and potential profitability of the project. Critical to this potential profitability was the government's agreement to have the existing port operations at Johor-Pasir Gudang as part of the same concession. Before reaching a confidence level sufficient to proceed with master planning and preliminary

Figure 2. The existing fishing village at Tanjung Pelepas in July 1997, showing the edge of the mangroves which were to be dredged for the new port.

design tasks, over 30 different development and income scenarios were tested.

Computer modelling exercises were done to predict potential siltation rates under varying channel and port configurations, with as a main objective designing the channel so that maintenance dredging would be minimised. Although the master plan has since been changed, the initial port and channel layout remained intact; and the design detailed along these basic lines and eventually the dredging and reclamation works were carried out (Figures 4 and 5).

Description of Dredging and Reclamation Contract

The Contract for Dredging and Reclamation Works forms part of Phase 1, which comprises all works required to provide a fully operational Container Terminal by end of 1999. This included contracts for Dredging and Reclamation, Wharves, Port Infrastructure, Cranes and Equipment as well as Port Buildings.
For the Dredging and Reclamation Contract the scope comprised the removal by dredging of existing soft material to provide an approach channel, turning basin and bund foundation area. The reclamation works under the contract comprised the construction of the Wharf Bund and filling of the terminal and infrastructure areas to provide a stable platform for the Container Area.

The US$ 158 million Contract was awarded in July 1997 with a contract period of three years. Owing to the Client's fast-track programming with multiple contractors, the dredging and reclamation contract contained numerous sectional completions with heavy liquidated damages for time overruns to ensure critical path activities were adhered to.

Type of contract: Re-measure up to lump-sum "ceiling"
The Contract was drafted and tailored to suit the Employer's Lenders requirement that the overall development budget should not be exceeded at any cost. This "Cap" on the Contract Sum has been used on other large infrastructure projects in Malaysia, most notably the Second Link to Singapore. It had been drafted by Masons, UK lawyers and could be described as onerous by curtailing a number of important provisions.

Figure 3. Aerial view of the Reclamation Area.

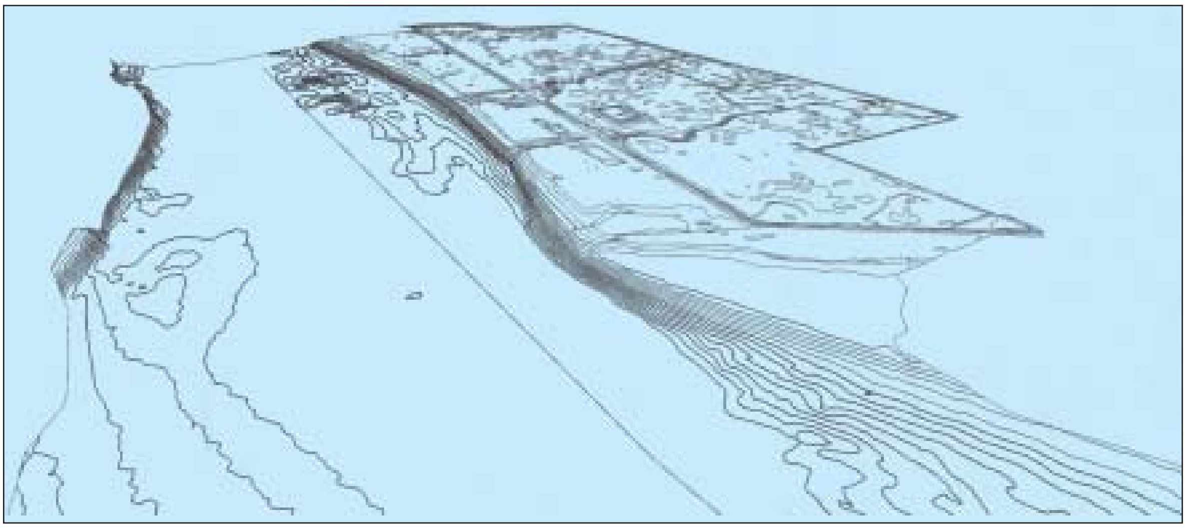


Figure 4. Three-dimensional overview of the original seabed and ground level at the Turning Basin and Land Reclamation Area.

The entire Bill of Quantities was marked "provisional" and was measured during and on completion of the Works. The Tenderer was allowed to submit an amount to cover for the risk that the re-measure could be greater than the maximum allowable Contract Sum. This was titled "Provisional Value Adjustment Item" or PVAI for short. A sum was included in the Summary of Tender by the Contractor as representing the difference between the Total Value of Re-measured Works and the maximum amount payable to the Contractor for the execution of the Re-measured Works.

This meant that the Contractor had to accept the risk of increased dredging and reclamation quantities and it ensured that the Employer's Ceiling Value would not be exceeded.

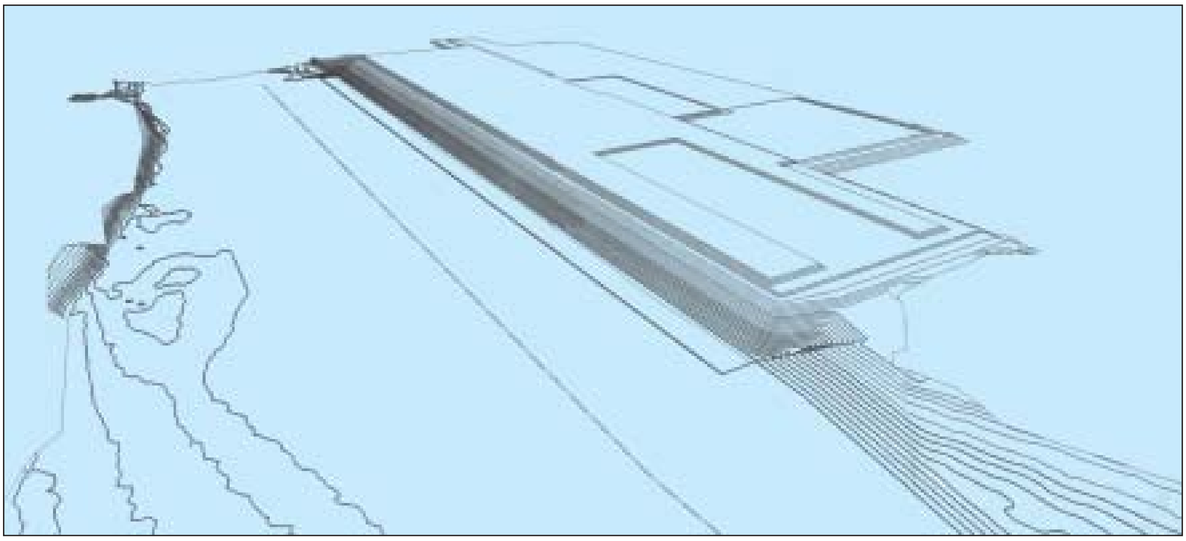
From the commencement of the Contract, the Employer revised the layout of the reclamation adding or omitting work from the contractual scope. Whilst omissions of scope reduced the overall Contract Sum, the additions (at the artificial unit rate) were outside the Ceiling Value and paid against actual quantities.

Summary of work: Main quantities

The specific work can be summarised as follows:

– 200 hectares of Site Clearance, mangrove and bush clearing;
– additional Site Investigation;
– dredging of the 9-km long approach channel and turning basin, approximate volume 16,000,000 m^3;
– dredging to foundation level below Wharf Bund, approximate volume 5,500,000 m^3;
– constructions of the Wharf Bund, approx. volume of sand 4,000,000 m^3;
– installation of 20,000,000 metres of wick drains as ground treatment;
– reclamation and surcharge of Phase 1 Area,

Figure 5. Three-dimensional overview of the dredge and fill design of the Turning Basin and Land Reclamation Area.



amounting to 14,000,000 m^3 of sand fill including Settlement; and
– remove and reuse as fill 4,000,000 m^3 of surcharge.

Principal contract parties
In 1997 the Employer, Pelabuhan Tanjung Pelepas Sdn. Bhd. (PTP), formed a management company titled Upper Plus Sdn. Bhd. (UPSB) to manage and supervise the design and construction activities. This organisation was replaced by PTP Management Sdn. Bhd. (PMSB) in October 1998 when the design tasks were completed.

Environmental and Engineering Consultants Sdn. Bhd. (EEC) was appointed by PTP to directly supervise the construction activities on Site. Ballast Nedam-SKS Joint Venture executed the contract. Ballast Nedam Dredging and Dredging International Asia Pacific carried out the main dredging and reclamation works.

The dredging of the trench forms a part of the soil replacement to construct a total of 2.16 linear km of Wharf and was dredged to a maximum depth of –19 m CD and executed mainly by the cutter suction dredgers.

The dredged material was pumped into the deeper part of the Turning Basin and removed by the hopper dredgers. The Turning Basin and Access Channel were dredged by hopper dredgers. At the end of the dredging works high spots were removed with a sweep bar.

The Project required the importation of some 18,000,000 m^3 of marine sand. This material was won from the vicinity of Karimun (Indonesia) from two separate locations. The sand was dumped directly in the dredged trench or pumped directly into the reclamation area via floating pipeline.

Figure 6. A large fleet of dredging vessels were used simultaneously: Seen here, trailing suction hoppers Rigelstar (left) and Amsterdam (right) were joined by cutter dredgers such as the Hector (center).

Description of the work
The construction, completion and maintenance of the Dredging and Reclamation Works involved the dredging of 16,000,000 m^3 of soft and stiff material to form a 12 km Access Channel and Turning Basin, together with the dredging of 5,500,000 m^3 of soft to medium material from a trench to form the base for the new Wharf Structure.

The initial activity concentrated on dredging an access of 12 metres deep, 100 metres wide and approx. 5000 metres long (pre-dredging depth only approximately 4 metres by low tide) to allow the jumbo hopper dredgers to reach the Site.

Dredging Works

Trench dredging
The trench dredging commenced from the most northern location, working southwards. Prior to commencement the Department of Environment (DOE) raised concerns about the re-handling of marine clay. Modifications were implemented such as extending the discharge pipe to 12 metres below the water level and daily water monitoring to ensure that release of fines was minimised.

The re-handled material placed in the Turning Basin by the cutter dredgers *Vlaanderen XI* and *Hector* was removed by hopper dredgers and dumped at the designated dumping ground in the Malacca Straits. Whilst removing the re-handled material, existing material in the Turning Basin was dredged at the same time.

Figure 7. Overview of Work Area showing sand winning ground and dumping ground.

The cutter suction dredgers suffered considerable stoppage time owing to blockages. These were caused by mangrove roots clogging the cutter head and/or dredge pump, thus decreasing their efficiency.

Access channel

Initially, the TSHD *Amsterdam* sailed single mud trips, but after some weeks, she began sailing "combi" trips taking out soft material in the Access Channel and re-handled material from the dredged Trench whilst bringing in sand from the concession area in NE and SW Karimun. For this activity TSHD *Amsterdam* was joined by TSHD *Pearl River*.

The work of the jumbo dredgers *Amsterdam* and *Pearl River* were supplemented by the medium trailing suction hopper dredgers, *Wado*, *Gogland* and *Rigelstar* (Figure 6). As the material in the shallow areas of the approach channel could not be taken away by the hoppers, cutter dredgers were used to dredge the material and dump it in the deeper parts of the channel, from where the hopper dredgers could remove the same and dump it at the designated dumping ground in the Malacca Straits. For this purpose the cutter dredgers *Hector*, *Rubens* and *Wombat* were used.

Combination trips

Hopper dredger production is dependant on the cycle times of round trips. For the Pelepas Project, the hoppers executed two major activities:

– the removal of unsuitable dredged materials; and
– the importing of suitable fill material for reclamation.

These activities were combined in round trips lasting 8 to 9 hours, executed mainly by Ballast Nedam's trailer *Amsterdam*. Sources for suitable sand were identified in EEC's EIA (Environment Impact Assessment) study, indicating sand winning grounds around the island of Karimun, Indonesia. Deep-sea disposal areas for unsuitable dredged material were identified at deep water off Pulau Kukup, roughly 80 km northwest of the site in Malaysian waters (Figure 7).

Reclamation Works

Site clearance

The initial activities on site included the clearing of 210 ha of mainly mangrove vegetation. All vegetation more than 15 cm above the existing ground surface had to be removed. This caused a substantial migration of snakes, monkeys and large monitor lizards. Mangrove root systems were left in place to serve as a natural reinforcement of the top layer of the very soft marine clay on which the first layer of hydraulic fill could be placed. The mangrove roots made installation of the vertical drains more difficult, but there were clear advantages to leaving them in place.

Trench filling

Although suitable sand sources were known in Indonesia, a large sand search investigation was initiated, which was concentrated around the designated dumping ground in the Malacca Straits northwest of Karimun and along the coast of Pontian up to 120 km from the site. Some small pockets of sand were found, but these were exhausted by the end of 1997. From January 1998 the sand was won from Karimun southeast.

Filling of the trench was done partly by direct dumping. First the jumbo hopper dredgers dumped as much as possible until they were limited by their draught. Then the medium-sized trailers dumped their loads until they were also limited. After this the remaining filling of the bund was achieved by hydraulic filling via pipelines.

The final slope and the berth pocket were trimmed by a cutter dredger to the required profile. Excess material was pumped into the reclamation. The TSHD *Wado* proved to be a very efficient medium-sized hopper with limited draught to dump the top layers of the bund, achieving a much higher density compared to hydraulically placed fill via pipelines.

Slopes designs

During tender evaluation, it was noted that the designs of slopes of 1:2 as specified on the Contract Drawings were not stable. A comment to such effect was included in the Method Statement advising that a revision was required for which a variation order should be issued (Figure 8).

Following Contract award the slopes were revised to 1:3,5, however given the soft underlying material there remained a risk that such slopes were still not stable. The Consultant was of the opinion that a rest period of 3 weeks between each lift was required (although there was no requirement in the Specification) and rejected the Quality Plan for reclamation works on this basis.

This waiting time was impossible to achieve given the tight hand over dates and no further revision to the design slopes was issued. On different dates in April and June 1998, seven large slip failures occurred during filling operations.

Compaction of bund

The most economical filling method for the bund would have been:

- filling up to –6 to –7 CD direct dumping from a hopper dredger;
- from –6 to –7 to +4 CD rainbowing;
- thereafter pumping via pipelines.

From previous experiences at Pasir Gudang Phase IV it was accepted that rainbowing would not achieve the maximum possible density. The operation consisted of initially direct dumping from hoppers, followed by the more expensive method of pumping via floating and shore pipelines. This method did achieve a value of 45% relative density, which was required by the Client's consultants for the later wharf construction (Figure 9).

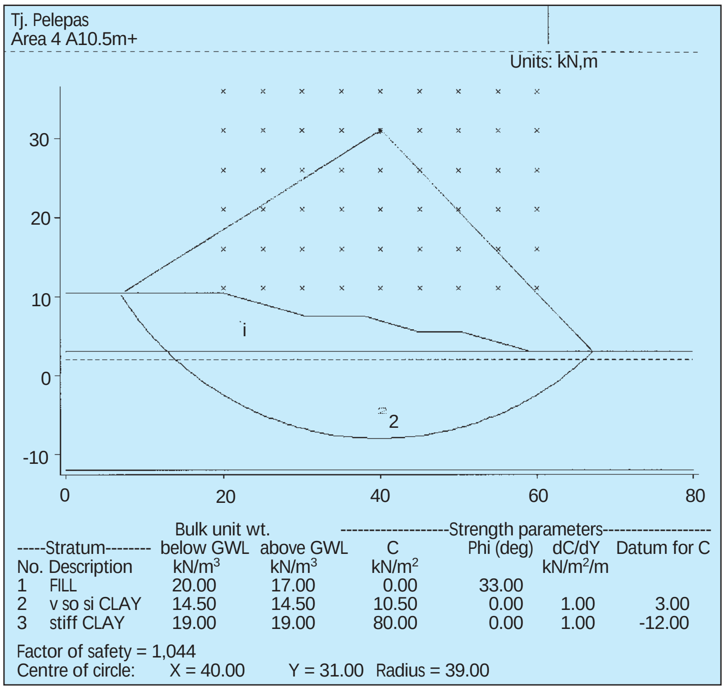


Figure 8. Reclamation slope. Typical slip circle with the minimum safety factor.

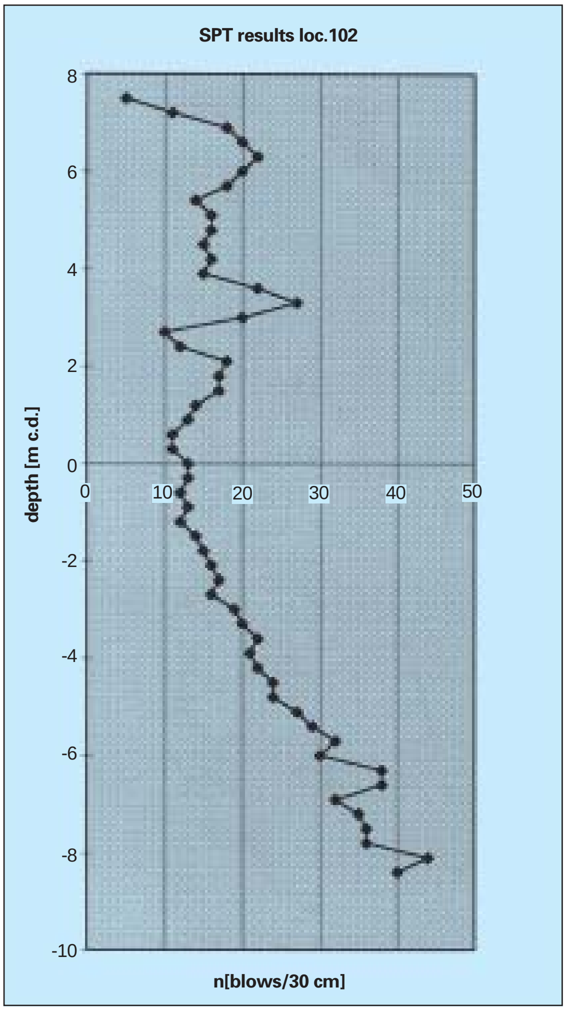


Figure 9. Compaction of bund wall. Typical SPT graph of sandfill.

Reclamation filling

Reclamation was done in principle in 4 layers:

1. First layer up to +3.5 to 4.0 metres CD. This first layer with a thickness of between 0.5 and 1 metre was to facilitate the installation of the vertical drains. These drains were installed in nearly all areas. Because of the relatively thin first layer of sand, jumbo trailers, owing to their high pumping output, could not do this work. Therefore the first layer was done mainly by the medium trailer *Wado* and in the beginning also by the CSD *Vlaanderen XI*, which used the trench as a re-handling pit.

2. Second layer by jumbo trailers up to +5.5 to 6.0 metres CD which provided sufficient sand to construct dikes;

3. Thereafter the third layer up to +7.5 to 8.0 metres CD; and.

4. After a waiting period of 3 weeks the last layer up to +10.5 metres CD was placed.

To avoid any delay by the jumbo trailers, two floating pipelines with two connection points were used.
In addition there was also the opportunity to dump the load in the Trench if any problem on the reclamation area or with the pump-ashore facilities of the dredgers arose.

Soil improvement

The consolidation of the wharf bund and reclamation area was done by a combination of vertical drainage (wick drains) and the placing of sand-surcharge (Figure 10).

In total some 20 million metres of wick drains were installed by a specialist subcontractor as soon as the area was accessible for crawler cranes. The drains were installed with a spacing of 1.25 metres and the total length for each drain was between 20 and 30 metres. Output was maximum 1000 M' per day. The total length of the drains exceeded 20,000 000 metres. The placing of the vertical drains started within five months after contract award. The first two areas 1B and 3B required high installation productions. At its peak 21 rigs were operational. In a 7 month period some 13 million metres of drains were installed over 600,000 drainage points.

Prevailing soils (*from*: EEC, EIA study, PTP, January 1996)

Results of sub-surface investigations indicated the following stratifications:

A. On land:

Dessicated firm crust of alluvium:	1.0 m to 1.5 m thick
Very soft to soft alluvium:	up to 18 m thick
Firm to hard residual soils:	15 m to 19 m below existing ground surfaces

B. Over water:

Very soft to soft alluvium:	up to 18 m thick
Firm to hard residual soils:	up to 19 m below existing ground surface

Figure 10. Some 20 million metres of vertical drainage (wick drains) were installed.

Figure 11. Container terminal at Tanjung Pelepas under construction.

The very soft alluvium will consolidate under loads imposed by site filling and high surface loads, resulting in settlement of finished ground surfaces, if such consolidation has not been eliminated by geo-technical engineering means during construction.

Instrumentation
In order to monitor the behaviour of the reclamation area a programme was executed to install geo-technical instruments and obtain field data.

The following instruments were placed:
- Settlement markers or plates (total 236 nos.) to measure site settlement and consolidation.
- Pneumatic Piezometers (total 129 nos.) to measure groundwater pressure, monitoring the de-watering and drainage of the subsoil and to control the safety of the filling operation and degree of consolidation.
- Inclinometers (total 22 nos.), to monitor lateral movements in embankments, bunds and landslide areas.
- Magnetic Extensometers (total 11 nos.), to monitor settlements and heave. Data from the extensometer indicate the depths at which settlement has occurred as well as the total amount of the settlement.

Monitoring of the behaviour of the reclamation area was important to be able to adjust the filling and surcharge removal operations in order to limit landslips and to plan the removal of surcharge after sufficient consolidation.

Slope failures were predicted and indeed occurred. Minor embankment design changes were introduced to further limit failures without the need to redesign the wharf construction.

Surcharge removal and placing
After a waiting period of 6 months, surcharged areas could be excavated to a level of +5.50 metre CD. The material went to areas more land inward and to the future distri-park area. The total quantity to excavate and transport was approx. 4,000,000 m^3. Output was more than 100,000 m^3 per week. For this work hydraulic excavators and articulated dump trucks were used (Figure 11).

Conclusions

The Pelabuhan Tanjung Pelepas Dredging and Reclamation Works have been executed successfully notwithstanding adverse site conditions and strict contractual requirements. The timely mobilisation of sufficient dredging plant and competent local subcontractors greatly reduced time overrun risks. Changes of work were handled with flexibility from all sides. Technical problems were solved with the intention to complete the works in the shortest possible time.

One of the main success factors was the excellent performance of the large fleet of seven trailing suction hopper dredgers. They achieved an overall efficiency of nearly 90%, working continuously around the clock. The lion's share was undertaken by Ballast Nedam's new 18,000 m^3 jumbo trailing suction hopper dredger *Amsterdam* and its crew, working nearly 70 weeks on this project with weekly sand deliveries in excess of 200,000 m^3 per week.

Judith Bosboom

Wind-Wave Induced Oscillatory Velocities Predicted by Boussinesq Models

Judith Bosboom

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Abstract

Sediment transport predictions are critically dependent on the prediction of near-bed wave-induced velocities. Especially the asymmetry between the forward (onshore) and backward (offshore) velocities plays an important role in determining the magnitude and direction of the wave-induced sediment transport.

Boussinesq wave models are amongst the most advanced wave models presently available to the coastal engineer. Moreover, they are highly efficient from a computational point of view. They are generally applied for wave propagation studies in which the focus is on the prediction of surface elevations.
The knowledge about the capability of these models to predict the horizontal velocities under waves is limited.

This work aims to explore the possibilities of using such a Boussinesq model for the prediction of the near-bed velocities. A spectral Boussinesq model is used in which wave breaking and dissipation in the surf zone are included. The model is tested against measurements of irregular (partially) breaking waves performed in WL | Delft Hydraulics' Delta flume.

The comparison of measured and computed velocity asymmetry indicates that for moderately long waves the Boussinesq model can be succesfully used for sediment transport purposes. For shorter waves the crest velocity values of the higher waves are underestimated and as a result the velocity asymmetry as well.

The work was started as part of the MAST-2 G8 Coastal Morphodynamics Research Programme and finalised as part of the MAST-3 SAFE project. It was funded jointly by the Commission of the European Communities, Directorate General for Science, Research and Development under contract no. MAS2-CT92-0027 and MAS3-CT95-0004, and Delft Hydraulics and Delft University of Technology in the framework of the Netherlands Centre of Coastal Research (NCK). The laboratory data used was obtained during experiments in the framework of the "Access to Large-scale Facilities and Installations Programme" (LIP), which were funded by the Commission of the European Communities, Directorate General for Science, Research and Development under contract no. GE1*-CT91-0032 (HSMU).

This paper is based on work first published in *Coastal Engineering 23* (1997). Figures 8, 9 and 10 are used courtesy of Elsevier Scientific Publishers. The author wishes to thank J.A. Battjes, G. Klopman and J.A. Roelvink, Netherlands Centre for Coastal Research (NCK), for their many suggestions during the performance of this study.

Introduction

Waves in the nearshore zone play a major role in influencing the design of coastal structures, assessing the impact and sustainability of dredging activities and determining the topographical evolution of beaches (Figure 1). In order to answer practical questions related to those issues, it is important to develop wave models which are able to predict the wave propagation from deep water to the shore. As will become clear further on, Boussinesq models are amongst the most advanced and efficient wave models available in coastal engineering today. In this paper the focus is on the application of this type of wave models for the prediction of non-cohesive sediment transport and resulting beach evolution, but it should be recognised that these models are just as important a tool in the determination of for instance wave-agitation in harbours, harbour resonance and seiching.

Questions to be answered about beach evolution concern such issues as the rate of beach erosion to be expected after a certain storm, whether natural beach recovery will take place and how the beach evolution can be influenced by means of for instance nourishments or structures. In order to adequately answer those questions we need to be able to make predictions of sediment transport rates. One of the crucial items in doing so is a proper description of the near-bed velocities under waves, since they are an important agent in stirring up sediment which is then moved by mean currents or by the waves themselves.

Although it has been recognised that Boussinesq models are a powerful tool in describing wave phenomena, not much is known about their capability to predict the near-bed velocity which is needed for sediment transport predictions. This paper presents the results of the verification of the prediction of near-bed velocities by such a Boussinesq model against wave channel measurements of irregular (partially) breaking waves propagating over a monotonic sandy beach.

First, some background is given on the role of waves in sediment transport and on Boussinesq models and their advantages over other models. Second, the wave channel experiments and the results of the verification are described.

How Waves Move Sediment

Surf zone related sediment transport is initiated by the stirring up of sediment by waves. This sediment can then be transported by amongst others currents such as the tidal currents, wind-driven currents or the offshore directed undertow. The undertow is generated by the breaking of waves in the surf zone. It is responsible for the major part of the offshore transport occurring

The IADC "Most Promising Student" Award

This year an IADC student award was granted to Judith Bosboom at the recommendation of Prof. Kees d'Angremond of Delft University of Technology, The Netherlands. Ms Bosboom graduated from Delft University of Technology in Civil Engineering (MSc Honours). She performed her MSc thesis on wave kinematics computations at WL | Delft Hydraulics where she is now employed. Her thesis was then selected as the best Masters thesis of the Civil Engineering Department, Delft University, for the academic year 1995-96. The paper is based on her thesis and published with permission.

In order to stimulate technical universities worldwide to increase their attention to the dredging industry in general, and to improve the quality of their students in dredging-related technologies in particular, the IADC has instituted an awards programme for the most interesting final theses on dredging-related subjects. Each award carries with it a prize of US$500, a certificate of recognition, and the possibility of publication of *Terra et Aqua*.

Professors who would like to recommend students for this award are encouraged to contact Mr Peter Hamburger, Secretary General of the IADC (info@iadc-dredging.com).

Figure 1. Waves in the nearshore zone play a major role in influencing the design of coastal structures and assessing the impact of dredging activities.

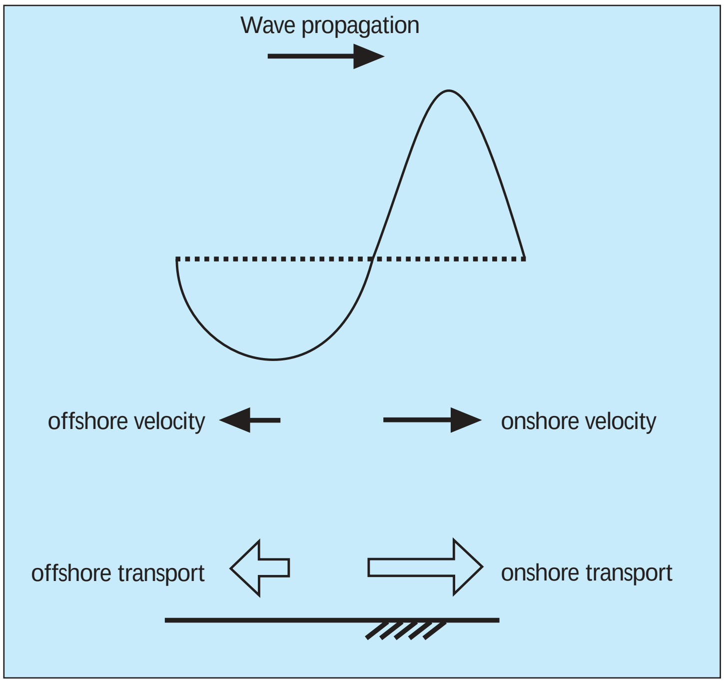


Figure 2. Transport owing to short wave asymmetric wave motion.

along a coastal profile, and therefore for the erosion a beach suffers under storm conditions when the wave breaking in the surf zone and the resulting undertow is strong.

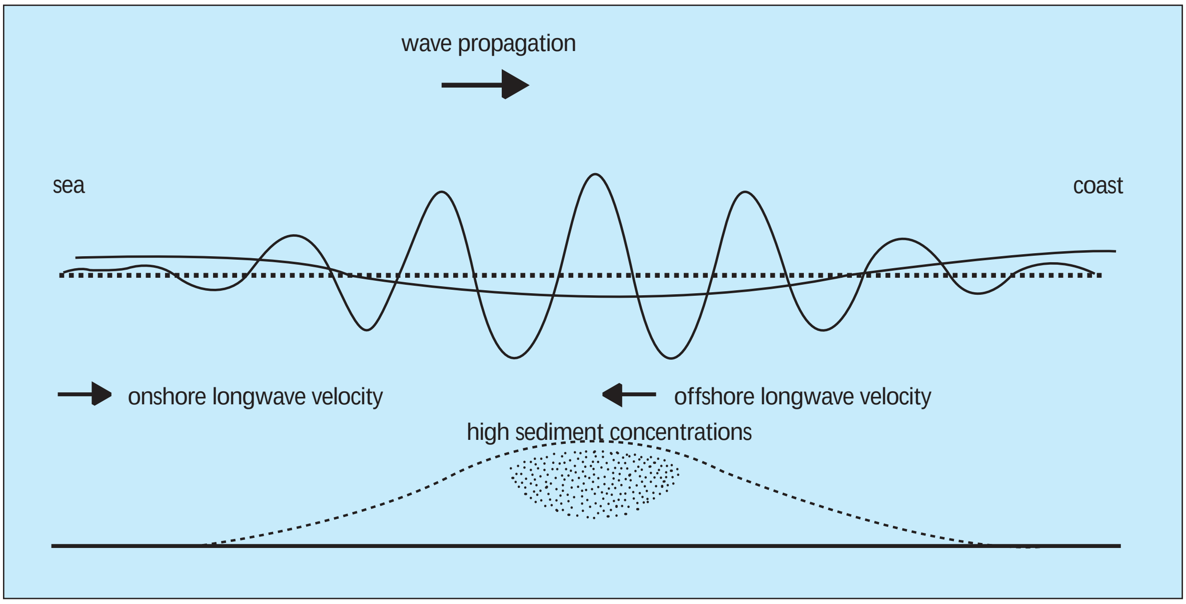
Under gentle conditions with lower waves it can be observed that some natural beach recovery takes place as a result of sediment transported in onshore direction. Again currents play a role in this transport of sediment; it is known that close to the bed a small net onshore current, called wave-induced streaming, exists which transports the material stirred up by waves in onshore direction. However, an important part of the onshore transport is not related to this net current but to direct transportation by the asymmetry of waves in the nearshore zone.

It can be visually observed that waves propagating into shallow water become increasingly asymmetric with peaked wave crests and flat troughs. The forward (onshore) velocities under the wave crests are therefore higher but of shorter duration than the backward (offshore) velocities under the troughs (see Figure 2). More sediment will be stirred up and transported by the onshore directed velocities under the wave crests than by the offshore directed velocities under the wave troughs. In this situation a net onshore transport occurs. This transport owing to wave asymmetry is generally called short wave wave-related transport.

In addition to this short wave induced sediment transport, long waves can give rise to a net transport as well. When observing wind-generated waves, one can see that they travel in groups in which higher and lower waves exist (see Figure 3). Such a wave group typically consists of seven to eight waves, from which the rule-of-thumb results, that every seventh wave is a high wave.

When propagating to the shore those groups of short waves are accompanied by longer waves with the length of the group, and which travel at the same speed of the group. In shoaling waves, the highest waves in a wave group occur more or less simultaneously with the trough of the accompanying long waves. Therefore, the highest sediment concentrations, stirred up by the short waves, occur simultaneously with the

Figure 3: Transport owing to long waves accompanying wave groups.



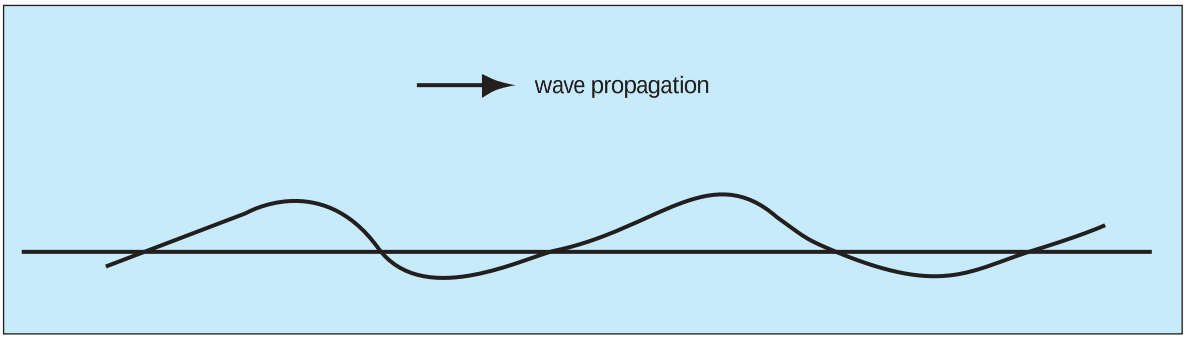


Figure 4: Wave profile as waves propagate from deep water to the shore. The waves develop peaked crests and flat troughs and a shoreward tilt until they finally break.

offshore directed long wave velocity. As a result the larger part of the sediment is transported in offshore direction by the negative trough velocity of the long wave.

Why Use Boussinesq Models?

In most state-of-the-art morphological models the computation of the near-bed velocity is performed in two steps. First time-averaged wave-transformation models are used to determine the wave parameters in the nearshore zone for given offshore wave conditions. An example of such a time-averaged model is the ENDEC/HISWA model (Delft University of Technology). These types of models compute only time-averaged parameters as wave height and set-up. The second step is the determination of the details of the wave-shape and the near-bed velocity. These have to be estimated locally by a non-linear theory which very often assumes a horizontal bottom. In this approach many important wave phenomena can only be treated in a schematised way. In order to overcome this problem more advanced wave models, such as Boussinesq models, can be used to describe the wave propagation from deep water to the shore.

As described above, it can be visually observed that the wave profile changes as waves propagate from deep water to the shore. Their crests become more peaked and the troughs become flatter. In addition, they develop a shoreward tilt until they finally break (see Figure 4). The velocities under the waves exhibit similar asymmetries with higher onshore velocities and smaller offshore velocities and a forward tilting which gives them more and more a sawtooth shape when getting in more and more shallow water. These two shallow water effects influence the asymmetry between backward and forward velocities, which is important for the wave-related sediment transport, and should be represented in a numerical wave model.

The first effect, the increasing asymmetry between backward and forward motion, is the result of the generation of shorter wave components owing to non-linear shallow water effects; the more shorter wave components are generated the more asymmetric the wave becomes. To describe this a model is therefore needed which includes the generation of higher harmonics owing to non-linearities. To describe the second phenomenon, the forward tilting of the waves, it is important that the speed at which the different wave components travel is described well. Freely moving wave components which are not locked any-more to a wave group as would be the case in deep water move at their own speed which depends on the wave length. If those phase speeds or in other words propagation characteristics are wrongly predicted, the resulting wave form will be completely wrong.

Boussinesq models include both of these shallow-water effects. Moreover, models based on Bousinesq equations are efficient from a computational point of view, such that they provide a good and economical tool for the determination of, for instance, wave agitation in harbours and harbour resonance.

Figure 5. Vertical structure of horizontal velocity field in shallow water (left) and intermediate water depths (right). The uniform velocity in shallow water is well described by classical long wave theory, whereas the Boussineq equations will also be able to describe the non-uniform velocity field in larger water depths.

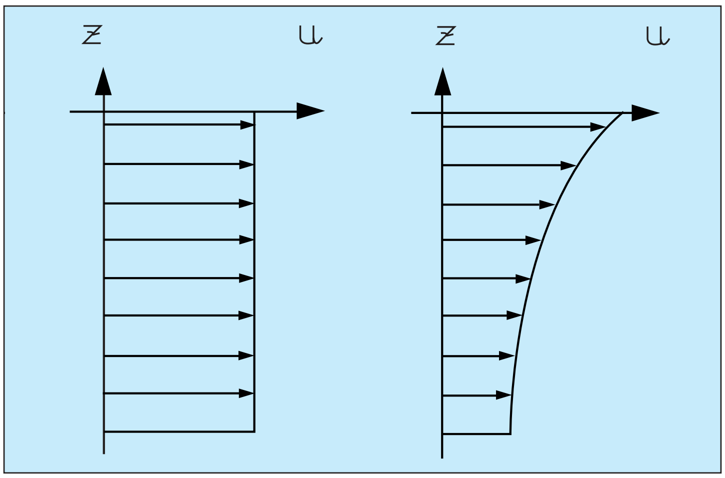


Figure 6. Fundamental research project on the stability of placed block revetments at prototype scale in the large wave flume (Delta flume) of WL | Delft Hydraulics (1992).

Boussinesq Models Compared to Classical Long Wave Theory

The classical shallow-water wave theory or long wave theory is obtained from the Navier Stokes equations by making the assumption of a hydrostatic pressure distribution or, equivalently, a uniform distribution of the velocity over the depth (Figure 5, left plot). In this way the effect of the curvature of the streamlines on the pressure distribution is neglected. By making such an assumption about the vertical structure, the equations can be integrated over the vertical resulting in equations formulated in the horizontal space only, which is attractive from a computational point of view. Since the phase velocity in the shallow water approximation is independent of the wave length, this theory cannot predict the differences in propagation speed of various wave components and will therefore result in correct wave forms only when applied in shallow water.

The Boussinesq equations can be thought of as an extension of the shallow-water theory for somewhat shorter waves or equivalently somewhat larger water depths. In the Boussinesq equations extra terms are introduced in the equations as compared to the shallow-water theory which account for the curvature of the streamlines on the pressure distribution, which is now no longer assumed to be hydrostatic. This implies that the velocities are not uniformly distributed over depth as would be the case in the shallow water theory but that the velocities decrease towards the bed (Figure 5, right).

The Applied Boussinesq Model

A frequency-domain version of the time-domain Boussinesq equations as derived by Madsen and Sørensen (1993) assuming uni-directional wave propagation and using a spectral form of the Boussinesq equations with improved propagation characteristics has been applied here. Herewith, the applicability of the equations is extended to deeper water. In order to extend the applicability of the model to the surf zone, Elderberky and Battjes (1996) incorporated a dissipation formulation to account for wave breaking, which is relatively easily done in a frequency domain model.

Since the Boussinesq equations are integrated over the vertical, the equations only provide the surface elevations and the depth-averaged velocity. To determine the velocity variation over depth, which is necessary for the computation of the near-bed velocity, a parabolic expression is used consistent with the Boussinesq approximation. Reference is made to Bosboom *et al.* (1997) for the exact formulations.

Wave Parameters Relevant to Wave-Related Sediment Transport

The most commonly applied models for the prediction of wave-induced sediment transport relate sediment transport to some power of the instantaneous near-bed velocity. Bed load and suspended load transport rates in the Bailard model, for instance, are proportional to the third and fourth power of the velocity, respectively. The time-averaged transport rates are then proportional to the time-averaged value of the velocity raised to the third or fourth power, the so-called velocity moments, which are non-zero only for a non-linear (asymmetric) wave motion. In this study we focus on the third velocity moment or velocity skewness. Besides, only the oscillatory part of the near-bed velocity is considered here; the mean current such as the undertow generated by wave breaking is not considered here.

As described above, short waves travel in groups – typically consisting of seven to eight waves – in which higher and lower waves occur. When propagating to the shore those groups of short waves are accompanied by longer waves with the length of the group and which travel at the same speed of the group. Therefore the surface elevation but also the velocities under the waves consists of high-frequency short-wave components and a low-frequency long-wave component.

Assuming that the oscillatory velocity signal consists of a relatively small low-frequency component and a dominant high-frequency component , the most important contributions to the velocity skewness are given by Roelvink and Stive (1989):

$$\langle u^3\rangle \approx \langle u_{hi}^{\ 3}\rangle + 3\langle u_{hi}^{\ 2}u_{lo}\rangle,$$

in which the brackets indicate averaging over the short wave and wave group scale. The first term in the right-hand side of this equation is related to the short wave asymmetry and reflects the fact that only owing to an asymmetric short wave motion, a net sediment transport in wave propagation direction occurs (see Figure 2).

The second term is associated with the stirring of sediment by the short waves and the subsequent transportation of the sediment by the velocity under the long wave which accompanies the wave group (see Figure 3).

As explained above, this second term is therefore usually negative in shoaling waves, i.e. before the waves actually start breaking. In breaking waves a different story holds, since the long waves travelling with the groups are released in the surf zone and continue their travels to the shore at a speed differing from the wave group velocity.

From the above, it becomes clear that for a good prediction of sediment transport rates the prediction of the third moment or skewness of the near-bed velocity is crucial. Therefore the below comparison between measured and computed near-bed velocity, focuses on this parameter. Besides the total velocity moment, the short wave and long wave contribution to the velocity moment will be considered separately.

Experimental Data from the Delta Flume

The prediction of horizontal velocities and velocity moments was verified against wave channel measurements of irregular (partially) breaking waves propagating over a concave sandy beach. The experiments were carried out within the framework of the EU-sponsored Large Installations Plan (LIP) (Arcilla *et al.* 1993) in WL | Delft Hydraulics' Delta flume, a large-scale facility with a length of 240 m, a width of 5 m and a height of the walls of 7 m (see Figures 6 and 7). Two different experimental data sets (i.e. test 1a and 1c) were used. These two experiments were already used by Eldeberky and Battjes (1996) for the comparison of measured and computed surface elevation time series and spectra.

The incident wave conditions are listed in Table I, in which T_p is the peak period and H_{m0} the significant wave height.

Table I. Wave parameters for experiments 1a and 1c.

test	T_p (s)	H_{m0} (m)
1a	4.9	0.9
1c	8.0	0.6

Figure 7. Measurement carriage used during the LIP 11D programme in the Delta flume.

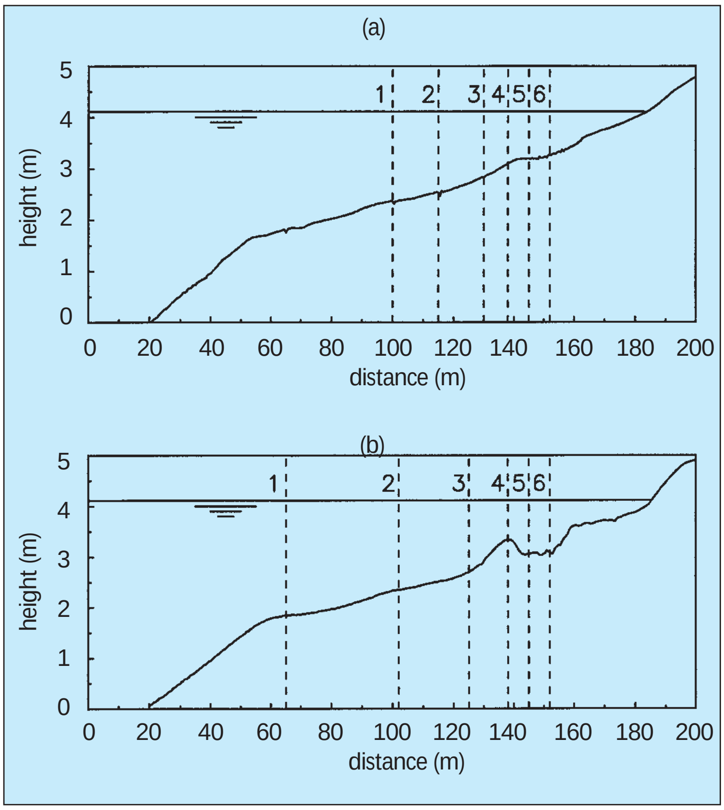


Figure 8. Bed profile and location of electronic current meters for (a) experiment 1a and (b) experiment (1c).

In the experiments the low-frequency wave channel resonances were prevented by an active wave absorption system at the wave-maker. Surface elevations and velocities were measured at several locations along the wave channel. The velocity measurements were carried out at several distances from the bed. The velocity measurement locations are indicated in Figure 8, for both experiments. Since the spectral model in its present form only predicts the purely oscillating part of the velocity, the time-averaged velocity component, such as the undertow velocity, was filtered from the measured signals.

For experiment 1a, the incident wave conditions are such that the wave breaking is strong (H_{m0}= 0.9 m and T_p= 4.9 s). These conditions correspond to highly erosive storm conditions. The monotonic sandy beach profile (Figure 8a) allows for wave breaking to take place over a large distance; the experiments showed a gradual decrease of the significant wave height at distances from 100 m up to about 140 m from the wave board, beyond which the wave breaking gets strong. In experiment 1c on the contrary, a barred beach profile is present (Figure 8b). The conditions are H_{m0}= 0.6 m and T_p= 8.0 s which are gentle accretive conditions corresponding to the recovery stage of a beach after a storm. The wave breaking is mild and is concentrated behind the bar, the crest of which is located around 138 m.

Wave Parameters Which Are Used in the Comparison of Measurements and Computations

The comparison between measurements and computations was carried out on surface elevations, bottom velocity time series, measured at 10 cm above the bed, velocity variance and skewness. Only the results of the comparisons on variance and skewness are discussed in this paper, since they are the most important parameters for sediment transport. For details on the comparison of measured and computed surface elevations and bottom velocity time series, reference is made to Elderberky and Battjes (1996) and Bosboom *et al.* (1997), respectively.

The variance $\langle u^2 \rangle$, the mean of the velocity time series squared, is a measure for the energy contained in the measured in and computed signals. The skewness $\langle u^3 \rangle$, the mean of the velocity time series raised to the third power, is a measure for the asymmetry between the forward and backward motion.
The total velocity variance $\langle u^2 \rangle$, the short wave variance $\langle u_{hi}^{\,2} \rangle$ and the long wave variance $\langle u_{lo}^{\,2} \rangle$ were computed for both the measured and the computed bottom velocity time series, using half the peak frequency for the lowest short wave frequency.

Analogous, the total skewness $\langle u^3 \rangle$ and the short wave and long wave contributions, $\langle u_{hi}^{\,3} \rangle$ and $3\langle u_{hi}^{\,2} u_{lo} \rangle$ respectively, were determined.

The comparisons between the predicted and measured velocity moments are given in Figures 9 and 10 for test 1a and test 1c, respectively.

Results of the Comparison Between Measurements and Computations

Figure 9 (lefthand side) shows that, except for the last station, the short wave velocity variance is very well predicted. The model slightly underestimates the total velocity variance for the stations closest to the bar.

This can be seen to originate from the inaccurate reproduction of the long wave velocity variance for these stations. This could be the result of the fact that the dissipation formulation, which describes the energy dissipation owing to wave breaking, reduces the long wave and short wave energy in the same proportion.

It can be argued that in case of wave breaking, the dissipation of the shorter (and higher) waves is stronger than that of the longer (and lower) waves.

This would mean that a dissipation formulation which depends on the wave frequency or which is only applied for the shorter waves is needed. Another possible

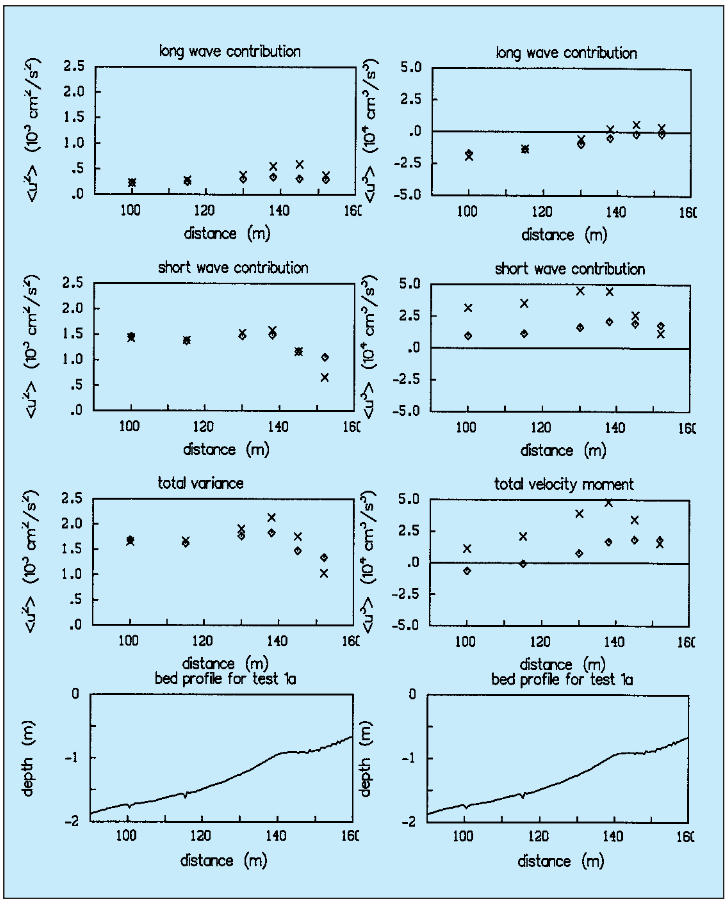


Figure 9. Comparison of measured (crosses) and computed (diamonds) bottom velocity variance (left) and skewness (right): long wave contribution, short wave contribution and total moment respectively; experiment 1a.

explanation might be the presence of a standing low-frequency wave pattern near the beach with a node in the low-frequency surface elevation and hence large velocity amplitudes around station 5. Standing waves are not reproduced by the model because of the assumption of uni-directional wave propagation.

The plots on the righthand side of Figure 9 show the results for the third velocity moment velocity skewness, which is important for the sediment transport. It can be seen that the long wave contribution is predicted fairly well. At deeper water where the long wave is travelling with the wave group this contribution is negative.

This is the case since the trough of the long wave, with offshore (negative) velocities, coincides with the highest waves in the group. Further onshore, closer to the surf zone, the long wave is released from the group, such that the correlation between the group and the long waves becomes smaller and the long wave contribution to the velocity moment becomes less and less important.

However, the third velocity moment can be seen to be dominated by the short wave asymmetry. This term is underestimated by the model. The agreement is reasonable for the last two stations where strong wave breaking occurs. The underestimation means that the computed surface elevation and velocity signals are too symmetrical.

Although not shown here, it was found that this occurs because the model underestimates the peak values of the highest waves. This is believed to partly originate from the transformation of the time-domain Boussinesq equations into the presently used frequency domain equations. Those frequency domain equations are known to yield lower crest values than its time-domain counterpart (Madsen and Sørensen, 1993).

Test 1c shows an encouraging agreement between measured and predicted bottom velocity time series (Bosboom *et al.* 1997), variance and skewness (Figure 10), especially up to the bar crest. The short wave velocity variance in test 1c is predicted well.

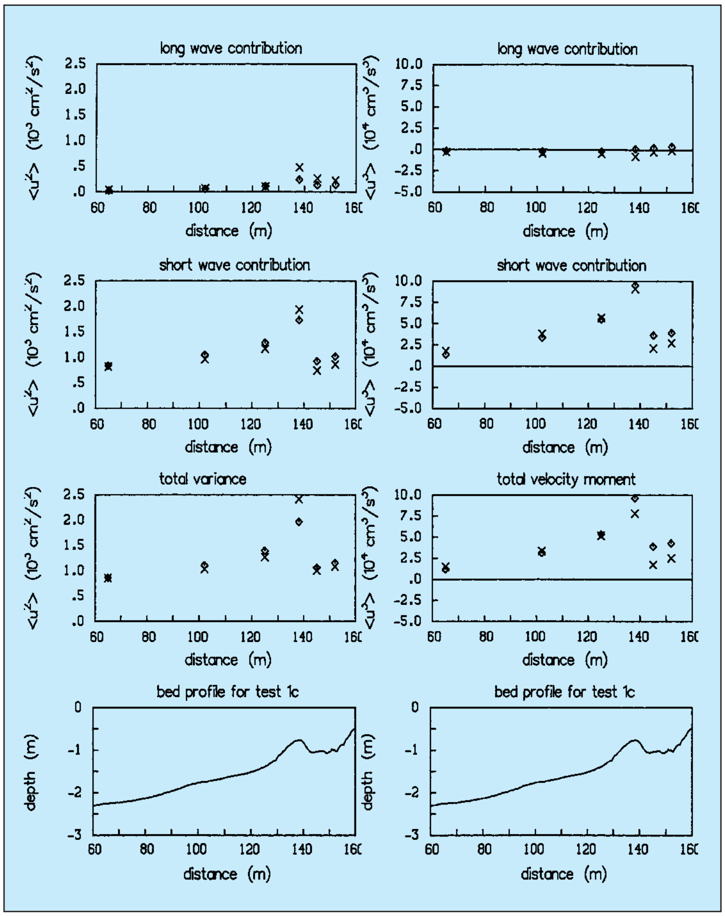


Figure 10. Comparison of measured (crosses) and computed (diamonds) bottom velocity variance (left) and skewness (right): long wave contribution, short wave contribution and total moment respectively; experiment 1c.

The difference between the total velocity variance determined from the computed and measured time series at the bar crest is for the larger part the result of the incorrect representation of the long wave energy. As for test 1a, this can possibly be ascribed to a standing wave pattern near the beach or to too strong a reduction of low-frequency energy by the breaking formulation.

It can be concluded that for test 1c, the velocity skewness compares very well with the measurements. This is a direct result of the good prediction of both the peak values and shape of the velocity signal, with a less significant underestimation of the peak crest values than in test 1a. The less good agreement beyond the bar crest, also found by Eldeberky and Battjes (1996) for surface elevation spectra, can possibly be ascribed to the relatively steep bottom beyond the bar crest, which is in contrast with the assumption of slowly-varying bottom used to derive the equations.

Conclusions

For test 1a as well as 1c, the short wave energy is predicted well by the model. The underprediction of the short wave asymmetry by the model in test 1a must therefore be the result of an incorrect representation of the wave shape. This might be partly owing to the larger ratio of wave height to water depth in test 1a as compared to test 1c, such that the wave breaking already occurs at 100 m from the wave board and continues for a large propagation distance. Note that the Boussinesq equations are only valid for relatively low waves. Besides, the peak period and thus the wave length is smaller which means that the assumption underlying the Boussinesq equations that we are dealing with (fairly) long waves is less appropriate in test 1a than in test 1c.

It can be concluded from the comparison of measured and computed velocity skewness indicates that for moderately long waves the Boussinesq model can be succesfully used to compute velocity moments, relevant to sediment transport predictions. For shorter waves the crest velocity values of the higher waves are significantly underestimated and as a result the short wave velocity skewness as well.

Additional research is relevant in order to determine whether the discrepancies result from the water-depth restrictions of the Boussinesq equations or from additional assumptions made in the derivation of the frequency domain equations underlying the present model. Further, attention should be paid to the inclusion of the mean velocity in the velocity computations and the validity of the wave breaking formulation in the low-frequency band.

It is further interesting to mention that a great deal of research is currently being performed by various institutes and universities in order to further improve the characteristics of the Boussinesq models. This means that improved models may become available which would give better predictions in the case of test 1a with the short and high waves.

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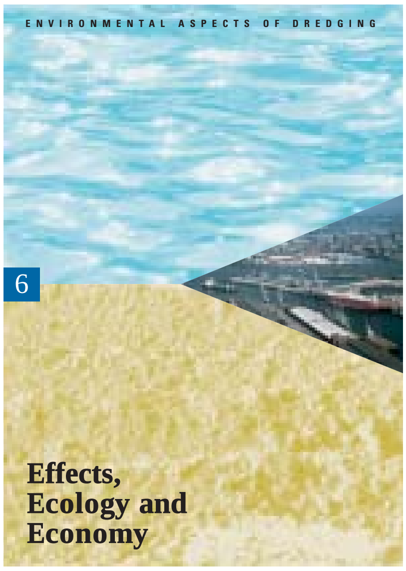
Environmental Aspects of Dredging

Guide 6: Effects, Ecology and Economy



In this sixth guide in the series "Environmental Aspects of Dredging", entitled *Guide 6: Effects, Ecology and Economy*, Mr Anders Jensen and Mr Bo Mogensen of DHI Water & Environment present the environmental and socio-economic effects related to dredging and/or reclamation projects.

The authors give an overview of the natural and human-related effects of dredging and reclamation works, focusing on the effects of entire projects and describing potential effects on a world-wide basis – including tropical, subtropical, temperate and polar regions. Because effects are so numerous and so variable, a selection of the most typical has been made and these are presented in a matrix-like structure, highlighting examples from actual projects.

The first chapter gives a brief introduction to Environmental Impact Assessment as a tool for planning new projects, and evaluating a wide range of impacts including socio-economic effects.
Chapter 2 introduces a classification system for dredging and reclamation projects following the traditional division according to purpose: capital, maintenance and remedial dredging. The third chapter offers a systematic descripition of the effects of these projects, dividing the effects into physical, ecological, socio-economic and political, especially with a duration beyond the construction period.

Chapters 4 through 6 examine and highlight each of the main dredging categories – capital, maintenance, and remedial. And in chapter 7 techniques for the prediction of environmental impacts are described and future trends are evaluated.

An indispensable part of the Guide are the Appendices (A-F) in which concrete impacts are illustrated through specific case studies. These range from the Øresund and Great Belt Fixed Links in Scandinavia to the Beenup mining operations in Australia and other well-known recent infrastructure projects. The book concludes with three Annexes explaining the characteristic features and functions of estuaries and tidal inlets, open wave-exposed coasts, and rivers. References for verification and further study are given throughout.

Other Books in the Series

Though Guide 6 is written as a stand-alone document, it is best used in conjunction with the other Guides in the series. The series, which will comprise seven books at its completion, is a joint effort of the International Association of Dredging Companies (IADC) and the Central Dredging Association (CEDA), and an Editorial Board comprising members from both associations have been actively involved in the development of the concept. Other books in the series already available are:

Guide 1: Players, Processes and Perspectives, written by Jan Bouwman and Hans Noppen of AVECO bv, is an analysis of the players involved in reaching a decision to dredge and creates a system for assisting these decision-makers.

Guide 2: Conventions, Codes and Conditions; Marine Disposal and Land Disposal, written by Elena Paipai, T. Neville Burt and Carolyn Fletcher of HR Wallingford, presents the international conventions governing disposal of dredged materials and examines how various national legislation complies with this.

Guide 3: Investigation, Interpretation, and Impact, written by Richard K. Peddicord and Thomas M. Dillon, independent consultants, describes pre-dredging investigations for material characterisation. This includes field surveys, sampling and laboratory testing for physical, chemical and biological characteristics of dredged materials.

continued on page 33

Peter Whitehead

Environmental Management Framework for Ports and Related Industries

Abstract

Ports act as magnets for related industries, however, their combined activities have the potential for considerable impact on the environment. For sustainable development it is essential that environmental considerations be incorporated into the port management structure. Such considerations require a structured approach towards managing the environment.

The framework presented here aims at introducing a systematic approach to dealing with the impact of actions of ports and their related industries on the environment. The framework devised has four parts:
– a policy development system, which aims to produce a general policy statement that relies on identifying and understanding relevant environmental concerns, legislation and stakeholder views;
– a general management system for formulating management-acceptable, prioritised strategies and goals;
– an implementation system: the mechanism by which the planned improvements are implemented; and
– an audit and review system which evaluates the effectiveness of the procedures and determines whether or not they have been carried out.

The full report was published in 1999 as the Report of Working Group 4 of PIANC's Permanent Environmental Commission (PEC) entitled *Environmental Management Framework for Ports and Related Industries* (see Books Reviewed page 31) The numbers shown on the diagrams in this paper refer to specific sections in the full report.

Introduction

Over the past decade environmental issues have begun to dominate the agenda of many national and international organisations. As the overall global environmental quality has declined, a need has developed for a proactive approach to environmental and resource issues to halt this decline in order to help safeguard the environment in the future. This is embodied in the concept of "sustainable development" promoted by Dr Gro Harlem Brundtland in the United Nations' Report, *Our Common Future*, issued in 1987.

Economic development, existing practices an environmental quality are very closely linked within the activities of ports and their related industries in respect to a wide range of operations, associated functions and natural habitats. To enable progress towards the goal of "sustainable development" the Permanent Environment Commission (PEC) of the International Navigation Association (PIANC) recognised the need for a proactive approach to environmental management.
It was realised that environmental issues were global in nature and therefore any guidelines should be applicable world-wide and therefore need to be able to take into account the range of wealth, resources, legislative and organisational structures of individual countries. For this reason the development of a "best practice guide" was considered not to be practical.

The aims and objectives for a working group were set to develop an Environmental Management Framework (EMF) to provide generic guidelines for managing environmental issues in ports and their related industries to a level appropriate to a particular company. Such a framework needs therefore to be applicable to the wide range in size of individual organisations as well as the entire range of activities associated with waterborne transport and its infrastructure (Figures 1 and 2). There is also the need to conform, if required, to international standards for environmental management, such as those given in the ISO 14000 series.

The EMF that has been developed and the flow diagrams that form the four component systems of the framework are:
– the derivation of the **policy** overview, referred to as the "Policy Development System";
– the management process of **planning**, agreeing strategy and prioritising environmental goals, the "General Management System";

– the **actions**, procedures and monitoring required to achieve the set goals, the "Implementation System"; and
– the procedures to evaluate whether the goals have been achieved, invoke corrective actions and the means for **continual improvement**, referred to as the "Audit and Review System".

Peter Whitehead graduated with BSc (Hons) in Geography in 1979. He then joined ABP Research & Consultancy Ltd as a technical assistant working on physical models of estuary and harbour developments. Since 1992 he has worked on dredging and siltation studies, and hydrodynamic and environmental assessments of port and harbour developments. He is presently Quality Assurance Manager and Principal Consultant at ABP Research with responsibility for dredging.

Peter Whitehead

Environmental Management Framework

The Environmental Management Framework (EMF) has been developed in such a way that environmental considerations can be made at different scales, from the international overview through to site-specific application/operation. The overall system is tiered in form. It is designed to be dynamic yet flexible, providing both proactive and reactive approaches that can be used to continually amend and improve legislation, the perception of the people, technology, standards, codes of practice and most importantly the conditions on the ground. The framework takes into account that we live in an ever-changing world and provides a method whereby social, political, economic and environmental issues can be integrated. The framework is meant to be transparent.

An overall summary of the general EMF is shown in Figure 3. The individual steps and feedback loops conform to the model advocated by the International Organisation for Standardisation (ISO) through its "Standard 14001, Environmental Management Systems - specifications with guidance for use".

The framework allows ISO 14001 to be implemented in its entirety, or in part, as individual organisations require, and provides a method by which environmental considerations can be integrated into any existing corporate management structure. The following sections give an overview of the procedures involved in using the EMF.

Figure 1. Left, a low-tech dredging solution in China.

Figure 2. Right, a high-tech solution in Germany. The EMF must be applicable to both.

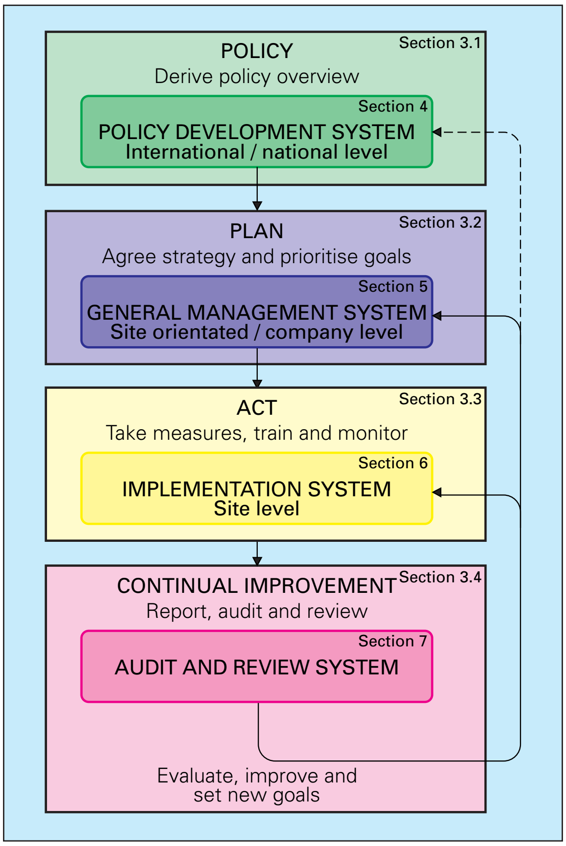


Figure 3. Summary of the General Environment Management Framework.

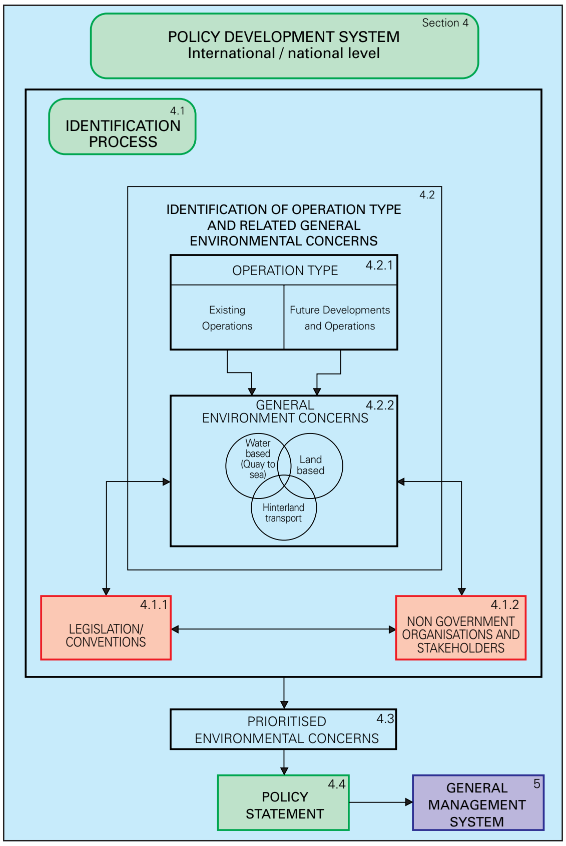


Figure 4. Policy development system which will lead to a specific strategy.

Policy Development System

The aim of this system is to develop the governing environmental policy that will be used as a guideline for environmental practices and to provide a mechanism that is able to influence the creation of legislation at the international, national or company level. The system comprises three main elements:

- the identification of environmental concerns owing to the type of operation;
- prioritisation of these concerns; and
- derivation of a policy statement that is used to steer planning for environmental improvement according to set priorities. The type of statement will depend on the level that is being considered.

Figure 4 shows the issues and considerations required for the formulation of general policy objectives which can then be developed into a specific strategy for actions.

Identification process

The process of identifying the main environmental concerns has three components that must be integrated in order to derive balanced policy (Figure 5). These components are:

- identification of the general environmental concerns, which are likely to result owing to the existing and future operations or developments within the port and the related industries using the port estate. These operations can be either water based, land based or associated with hinterland transport. The most significant environmental concerns are however most likely to be caused by transfer between these different environments;
- compliance with the applicable legislation/conventions. The text box opposite lists some of the important international conventions; and
- taking into account the views/policy of non-government organisations (NGOs) and other stakeholders by means of consultation.

This identification process is important as it can be used to affect the setting of new, and the modification of older, legislation. It will also affect company policy and is the basic information required to carry out environmental improvement. However, this evaluation and the integration of the different views and emphases concerning the environment make the derivation of worldwide policy difficult to achieve, except in the very broadest sense.

The "picture" is further complicated by inconsistencies in the interpretation of legislation and conventions amongst different regions and even amongst countries in the same region. By virtue of their activities at the

Relevant international legislation and conventions

- Convention on Biological Diversity, 1992, (Biodiversity Convention-Rio de Janeiro)
- London Convention on the Prevention of Marine Pollution by Dumping of Waste and other Matters, 1972, (London Convention)
- Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal, 1989, (Basel Convention)
- International Convention for the Prevention of Pollution from Ships (MARPOL) 1973/78
- Convention for the Protection of the Marine Environment for the North-East Atlantic (OSPAR Convention) 1992, Paris
- United Nations Convention on the Law of the Sea (UNCLOS), 1982
- 1991 Convention on Environmental Impact Assessment in a Transboundary Context, 1991, Espoo
- 1971 Convention on Wetlands of International Importance especially as Waterfowl Habitat (RAMSAR)
- International Maritime Dangerous Goods Code (IMDG), 1990

land/water interface, PIANC and other representative organisations (e.g. Central Dredging Association (CEDA) and the International Association of Ports and Harbours (IAPH)), that have a remit to advise and guide ports and related industries in respect of their environmental responsibilities, are in a strong position to represent the interests of their member ports and industries in the international environmental legislation forum.

As NGOs, PIANC, CEDA and IAPH should be able to participate in the world-wide and national environmental legislation making processes, presenting a practical view and thus ensuring workable legislation. This practice is already a feature at the London Convention on Prevention of Marine Pollution by Dumping of Waste and other Matters (LC72), which is most significant for the dredging industry. Large port or company associations can perform a similar role at a national level.

Prioritisation of concerns

Once the general concerns, taking in the views of NGOs and the specific legislation at the particular level of consideration have been identified, these should be prioritised. The emphasis given to each concern is likely to depend on whether the policy is being developed for general application, for a specific country or for an organisation. It will also depend on the location in the world, level of technology available and social reliance.

The prioritising process should, where possible, be based on current scientific knowledge and evidence of the actual need for each environmental measure. Taking the above considerations into account, it should be possible to produce a clear set of prioritised broad concerns that comply with various legislation and conventions, but are also workable within the multitude of individual port and waterway activities.

Figure 5. A harbour in disrepair: Identification of environmental concerns, such as rusty barrels and a dilapidated quay, is an essential step in the EMF.

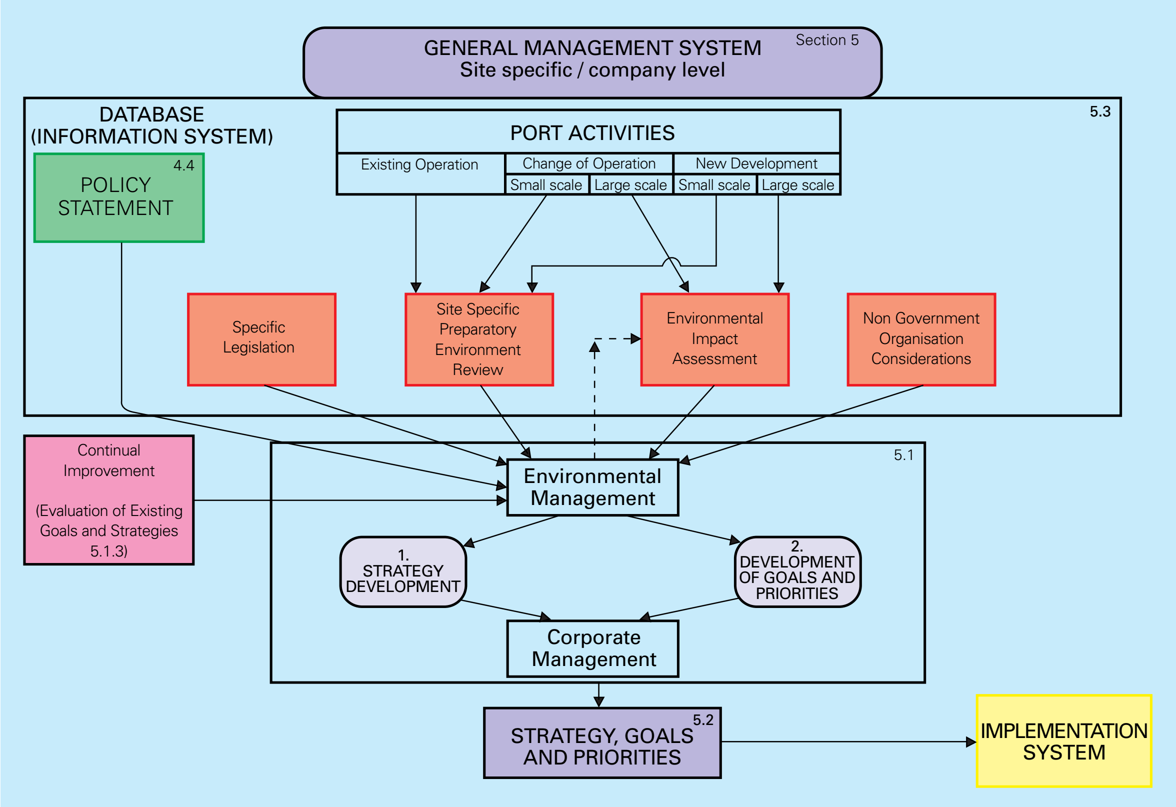


Figure 6. General Management System.

Policy statement
The output from the Policy Development System is a policy statement that can be used to "drive" the management of environmental issues at the organisation or site level. The statement should provide clear outline guidance, whilst being flexible enough to allow specific environmental issues to be managed in the most appropriate manner for the specific location.

The "general section" of the policy statement should include, as a minimum, a commitment to:
- continual improvement and prevention of pollution;
- compliance with legislation and regulations;
- establishing a procedure for setting objectives;
- informing and training employees; and
- if appropriate, informing the public of the policy.

General Management System

Once realistic policy objectives have been set, a plan for management of the environment within an organisation's structure, or with reference to a particular site, can be developed. The plan should take account of the various functions of the ports and related industries.

The plan has two ultimate aims:
- to produce an environmental strategy for the organisation or site that has the full agreement of the corporate management; and
- to develop specific and prioritised environmental goals that are achievable within the commercial and socio-economics of the organisation and the locality.

To achieve these aims the role of management has three main functions:
- environmental strategy development;
- development of prioritised goals; and
- evaluation and review of existing goals (continual improvement).

These functions are accomplished by the establishment of baseline information on the environmental impacts resulting from the ports and related industries, both existing and planned, at the company or specific site location. This information forms the base to drive the management approval process. The schematic presented in Figure 6 gives an overview of this General Management System.

Database (Information System)
For any management system to be effective, an accurate, up-to-date and flexible information database is required. This information system, which can be in any format suitable for the company, forms the baseline for future assessment of any environmental improvement practices as well as identifying the specific problems at the outset (Figures 7 and 8).

The database, as a minimum, should include details of, make reference to or provide information on where the detail can be found:
- the company environmental policy as derived from the Policy Development System;
- legislation applicable to the site and activities both present and future;
- details of any NGO considerations and requirements including a contacts database;
- details of personnel responsible for specific actions that could have environmental implications; and
- specific details of the causes of environmental concerns and their possible consequences. In ports and industries all activities can be categorised into either:

– existing operations;
– changes of operation; and/or
– new developments

To populate the database with the environmental effects of the port and related industry activities, the existing and future operations and developments should be identified either by:
– undertaking a site-specific Preparatory Environmental Review (PER); or
– a formal Environmental Impact Assessment (EIA).

The decision whether to undertake an EIA or a PER will depend on the type of activity, its size, whether it is an existing operation or a new development, the legislation and the level of NGO interest. The main difference between an EIA and a PER is that the former is a legislative requirement in most countries with set formal requirements involving outside consultation, whereas the latter is not. A PER can be carried out in any manner and to a level appropriate to the company and can be applied to areas of smaller concern where a formal EIA is not a requirement.

Management process

Strategy development
The environmental management, which could be a single person or a large team depending on the size of the organisation, firstly evaluates the information in the database. This evaluation should identify the main areas of concern and (see text box above) then rank them in order of importance with respect to:
– overall environmental significance;
– likely benefit to the company, if addressed (some may be compulsory); and
– financial implications of undertaking or ignoring any remedial action.

Sources of contamination of water and sediment

- Industrial discharges
- Discharges of untreated waste water
- Effluent of treatment plants
- Discharges of waste (particularly illegal)
- Run-off from roads, which carries contaminated silt/sand and soot particles etc.
- Run-off from industrial sites (e.g. storm water runoff, i.e. non point sources)
- Contamination from up-river sources, controlled by watershed or catchment management
- Accidents
- Spills (land and marine)
- Debris thrown overboard from ships
- Pollution from shipyards
- Run-off from fields carrying fertilisers and pesticides
- Deposition from the atmosphere
- Re-suspension of contaminated sediments
- Ship anti-fouling paint e.g. TBT
- Ship ballast water (causing spread of non indigenous species)
- Cooling water discharges (temperature effects)
- Munitions (ordnance, chemical and biological)

This ranking combined with the policy objectives provides the basis for a strategy that can be submitted for corporate management approval. Once approval has been reached the strategy will then have full "Company Ownership" and funds should be made available for its implementation.

Development of goals and priorities
After agreement to the strategy, a series of specific goals need to be developed which, if implemented, will provide environmental enhancement. If the goals are to be successfully achieved they should be developed

Figure 7. One specified problem that is of major concern to the aquatic environment is industrial discharge.

Figure 8. Another problem is debris. Seen here: debris removed from the draghead of a dredger.

according to the **SMART** concept. Each goal is required to be:
– **S**pecific; i.e. clearly defined in a simple unambiguous manner;
– **M**easurable; i.e. allowing quantitative assessment of the achievement or otherwise of the goal;
– **A**chievable; i.e. the actions required to achieve the goal must be practical to implement;
– **R**ealistic; e.g. the cost of implementation must be realistic when considered against the potential benefit; and
– **T**ime-scale; i.e. it should be able to be carried out within a realistic set time.

Once developed the goals should be prioritised since some will be easier than others to implement and some will give greater environmental benefit against cost. This prioritised list should again be sent to seek corporate approval, since in most cases there will be a cost to the implementation.

At this stage it is important to communicate the environmental policy, strategy and most importantly the goals to the workforce who will be required to carry out the actions to achieve the environmental benefit.

The specific goals are the "building blocks" of the environmental strategy and, if they are to be successful in preventing environmental harm, or cleaning up the existing environment, they must be clearly stated.
Goal statements should include:
– a summary of the specific environmental concern;
– a clear definition of the task required;
– the time-scale in which it is to be completed or progress reviewed;
– the nominated person who will be responsible for its implementation;
– the methods of measurement or monitoring that are required to determine whether the goal is being achieved (including a statement of any standards, discharge or emission consents that are applicable);
– any applicable legislation (e.g. a summary and a formal reference);
– any sources of additional information; and
– any training requirements

The individual goal statements are the main output from the General Management System.

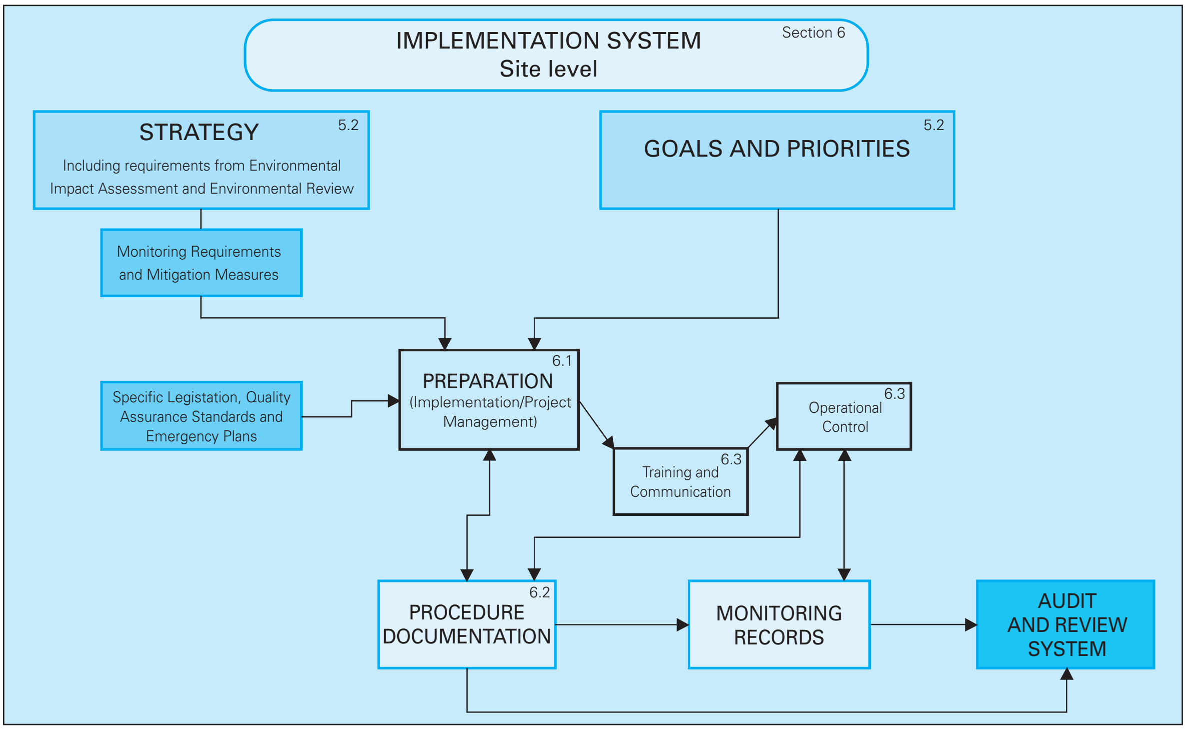
Evaluation and review of goals and strategy

The role of management is not complete once the goal statements have been developed. Once the actions have been put in place the results from the monitoring will need to be evaluated and reviewed. The results of these reviews will indicate any changes required to the goals, strategies, procedures and actions that are necessary for continual improvement.

Implementation System

The Implementation System (shown schematically in Figure 9) is the process by which actual improvement or prevention of harm to the environment occurs.

Figure 9. Implementation system for prevention of harm to the environment.



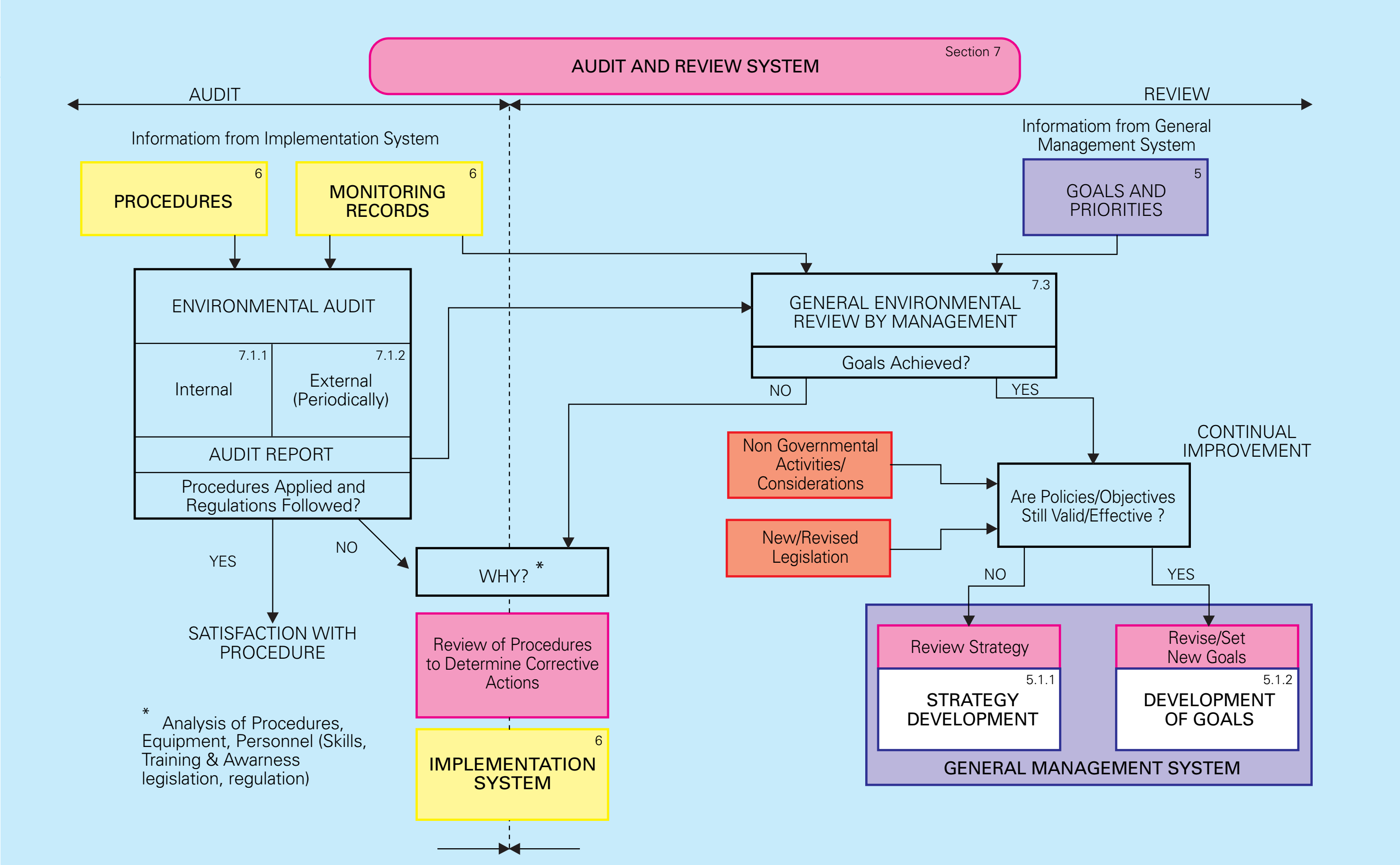


Figure 10. The final step: Audit and Review.

The scale of actions required will depend on the scope of the individual goals. However, the achievement of each goal will involve the allocation of responsibility for tasks, either directly to an individual or to a project management team with specific knowledge relating to the goal. The main functions in successfully implementing the environmental goals include:

– formulation of the methodology for achieving the goal (i.e. the project plan/preparation). This must take into account the goal statement and any existing plans and procedures that are the result of specific contingency and emergency plans;
– definition and documentation of the specific procedures required. In many cases this is laid down by laws or professional standards;
– communication of the procedure requirements and undertaking of any training of the work force which may be necessary; and
– carrying out the agreed procedures (operational control).

To measure whether the completion of a task or tasks has achieved its aim, procedures for documentation and methods of monitoring must be implemented. These must be undertaken as part of the day-to-day operation. In many cases, set procedures, training and communication programmes must be established. These will give the necessary details for the implementation of legislation, of safe working practices and of the overall environmental policy of the organisation.

The result of the actions should be improved environmental conditions or safer working practices. These reduce the risk of accident and, therefore, of possible

Figure 11. Monitoring system on board a dredger is a necessary part of the auditing system which forms the basis for the environmental review.

environmental degradation in the area specifically addressed by the individual goal. In many cases the improvements may not be obvious to the eye, so simple records of monitoring procedures and results are required.

The effectiveness of the measures implemented can be assessed to determine whether the procedures implemented and actions taken have been successful in achieving the goals or whether they should be modified. The procedural documentation and monitoring records are an important output from the Implementation System that forms the basis for the audit and review.

Audit and Review System

The Audit and Review System is shown in Figure 10 and indicates the two distinct parts: the environmental audit and the environmental review which when combined provide the mechanism for defining both corrective action and ultimately continual improvement. In this part of the EMF the records of the procedures for improvement and the results of the monitoring or measurement programmes from the Implementation System provide the basic information for the environmental audit of the procedures.

Two types of audit may be undertaken:
- an internal audit undertaken by staff within the organisation on a regular basis; or
- an external audit which is carried out as an independent check from time to time.

The audit determines whether the procedures developed as part of the implementation system have been followed. If it shows they have not been carried out and the specific goal has not been achieved then an evaluation as to why this occurred is made. This evaluation should analyse the procedures and consider the availability of equipment. The skills, training and awareness of personnel should also be assessed.

This review of the procedures should lead to corrective actions that feedback to the Implementation System. This allows the methods of implementation or operation control to be refined to improve performance to the required level. The feedback loop should continue until the environmental audit indicates that procedures have been followed.

The environmental review procedure (usually undertaken by management) is the process of evaluating the success (or otherwise) of the actions implemented to achieve the specific goals. This review is based on:
- the individual goal statements from the General Management System;
- the monitoring records (Figure 11) from the Implementation System; and
- the audit report.

If the review indicates the goal has not been achieved then the corrective action review is invoked and new actions or procedures are implemented.

If the goal has been achieved the process of continual improvement is invoked. This will involve a management review to establish whether the organisation, national and international objectives and strategy are still valid. These may be changed as a result of new or refined legislation or of a change in emphasis by NGOs and other stakeholders. This process determines the level to which the manager should return within the EMF and implements the concept of continual improvement.

Conclusion: Overview

Ports act as magnets for related industries and are generators of economic growth and prosperity. However, their activities have the potential for considerable impact on the environment. For sustainable development (which requires growing awareness of the responsibility for future generations) to be achieved it is essential that environmental considerations are incorporated into the port management structure. Such considerations require a structured approach towards managing the environment.

The framework presented here aims at introducing a systematic approach to deal with the impact of actions of ports and their related industries on the environment. Such an approach is essential to achieve a continual improvement in the effects of the waterborne transport industry on the environment. It is hoped that the framework will be able to be implemented in existing management structures either in its entirety or in its specific parts.

Reference

PIANC (1999).
Environmental management framework for ports and related industries. Report of PIANC PEC Working Group 4. Brussels, Belgium.

Charles W. Hummer, Jr.

Books/ Periodicals Reviewed

Environmental Management Framework for Ports and Related Industries
Report of Working Group 4 of the Permanent Environmental Commission (PEC). Brussels, Belgium, 1999. A4 -sized booklet, 38 pp.
International Navigation Association (PIANC)

The Permanent Environmental Commission is continuing its intensive initiative of producing relevant, useful and valuable reports related to dredging works. This book is another in that series of publications.

Typical of the PIANC mode of operation, a distinct working group was formed to produce this report. The working group comprised experts from five European countries and was assisted by a Dutch working group of national dredging experts. The processes by which these working groups operate make the resulting product particularly valuable and globally worthwhile.

Environmental issues have dominated the agenda of many national and international organisations. The need for proactive approaches to environmental and resource issues has intensified as the overall global environmental quality has declined. This proactive approach to safeguard the future environment led to the concept of "sustainable development". Port activities and the industries related to them are closely linked to economic development and environmental quality.
Ergo, the concept of "sustainable development", is directly involved with ports and port industries.
It was in this context that the Permanent Environmental Committee recognised the need for a framework for environmental management. It also recognised that such a framework must have global application being able to take into account the range of wealth and of resources of individual countries.

The stated aim of the Working Group was to develop a generic framework which could be used as a guide to implementing environmental management in ports and related industries to the level appropriate for that particular country. At the same time the framework had to be sufficiently detailed to assist those organisations attempting to conform to the International Organisation for Standardisation (ISO).

The report is organised into 9 sections:
1. Introduction
2. Background
3. Environmental Management Framework
4. Policy Development System
5. General Management System
6. Implementation System
7. Audit and Review System
8. Final Remarks
9. Useful Sources of Information

As stated above, Section 1 is an introduction. Section 2 briefly examines the main relevant international legislation and conventions as well as the highlights of other background issues. Section 3 is an overview of the Environmental Management Framework that has four main components; namely, Policy, Plan, Act and Continual Improvement. The detail to which each component is applied depends on the level of application, that is, at international, regional national or company levels. At the same time the EMF is sufficiently generic to allow the socio-economic status of the country to be considered. Accordingly, the framework should have global application.

The report utilises text boxes to describe and highlight certain terms, concepts and elements. This along with flow diagrams and photos makes the report very reader-friendly and effective. Of particular note and interest is the text box on the Precautionary Principle, a concept that if not well understood potentially has serious negative ramifications. The subchapters of each chapter elaborate the outline and substance of the framework, its components, philosophy and applications.

The report is a concise but creative presentation of the subject matter. It should have very wide circulation for a variety of stakeholders, regulatory bodies at the local, national and international levels.

Site Investigation Requirements for Dredging Works
Report of Working Group 23, Supplement to Bulletin No. 103 (2000), Brussels, Belgium, 1999. A4 -sized booklet, 32 pp.
International Navigation Association (PIANC)

PIANC has Permanent Technical Commissions (PTCs) concerned with inland waterways and ports (PTC I), coastal and waterways (including ports and harbours) (PTC II), environmental aspects (PEC) and sports and navigation (SRN). This report was produced by the international working group under PTC II. The working group comprised experts from eight countries.

Site investigation is a critical element of all port and waterways construction projects and most maintenance projects. Its importance is sometimes under appreciated both by technical and management elements.
This report does a fine job of concisely but effectively raising the awareness and appreciation of this subject.

This report focuses on the requirements for planning, executing, interpreting and reporting site investigation for the planning and costing of dredging operations. Because dredging operations are often complex and costly, accounting for a substantial proportion of the cost of maritime projects, the precursor site investigation is very important. Many of the elements involved in dredging projects are distinctly different from those applicable on land projects. The report makes those distinctions clear.

The report is organised into 9 sections:

1. Introduction
2. Contractual Considerations
    - 2.1. Responsibility for Data
    - 2.2. Choice of Contract Policy
    - 2.3. FIDIC Form of Contract
    - 2.4. Employer Awareness
3. Objectives and General Requirements of Site Investigations
    - 3.1. General Objectives
    - 3.2. Geological and Geotechnical Investigations
    - 3.3. Environmental Conditions
    - 3.4. Other Investigations
4. Implementation of Investigations
    - 4.1. Management of Investigations
    - 4.2. Staffing
    - 4.3. Standards and Quality Assurance
5. Bathymetric Surveys
    - 5.1. Depth Measurement
    - 5.2. Horizontal Positioning
    - 5.3. Water Level
    - 5.4. Data Processing and Presentation
    - 5.5. Other Related Investigations
6. Geological and Geotechnical Investigations
    - 6.1. Geological Data Requirements
    - 6.2. Geotechnical Data Requirements
    - 6.3. Ground Investigation Design
    - 6.4. Field Methods of Ground Investigation
    - 6.5. Laboratory Testing
    - 6.6. Soil and Rock Description
    - 6.7. Intensity of Investigation
7. Environmental Conditions
    - 7.1. Hydraulic Data
    - 7.2. Sediment Transport
    - 7.3. Meteorological Data
8. Other Aspects
    - 8.1. Site Access and Obstructions
    - 8.2. Other Marine Traffic
    - 8.3. National and Local Laws
    - 8.4. Harbour Regulations
    - 8.5. Navigation Marks
    - 8.6. Local Support Services
    - 8.7. Safety
9. Bibliography

From the Table of Contents one gets a good appreciation for the structure and content of the report. The authors have done a fine job making a synopsis of a complex subject and doing so in a clear and coherent way. They have included sufficient detail for each section and subsection to convey to the reader the essentials of the subject without becoming too detailed and distracting. This is no minor accomplishment.

The tables are well on point and serve to clarify and simplify the facts presented. All of the tables are in Section 6 where they serve a very useful purpose and strengthen the report significantly.

The report appears to meet or exceed the intent of the working group. PIANC and its working groups must be commended for their continuing contribution to the technical literature on maritime matters and particularly with quality, colourful and relevant reports that are suitable for a broad audience.

Both these booklets can be acquired from:
International Navigation Association
PIANC Secretariat
Graff de Ferraris, 11ème étage, Boîte 3 Bld.
Emile Jacqmain 156
B-1000 Brussels, Belgium
Tel. +32 2 553 7159 or 7160
Fax +32 2 553 7155
Email: navigation-aipcn-pianc@tornado.be

Geosynthetics and Geosystems in Hydraulic and Coastal Engineering

Road and Hydraulic Engineering Division, Rijkswaterstaat, Ministry of Transport, Public Works and Water Management. A. Balkema. Hardbound, 913 pp., 170x245 mm, illustrated, indexes. Euro 145.00

Krystian W. Pilarczyk

This volume is substantial in size, scope and content. The author's stated intent is to meet an obvious need for a book which provides the latest state-of-the-art and research results in the specialised field of geosynthetics and geosystems as they relate to hydraulic and coastal engineering.
In view of the tremendous strides made in these fields that have been captured in journals and proceedings from specialty conferences, a synthesis of this material into a single volume was needed for the practising engineer as well as the graduate students in the field of hydraulic and coastal engineering.

The book reviews the existing applications of geosynthetics and geosystems, specifically as they relate to the narrow civil engineering fields of hydraulics and coastal engineering. The author presents an overview of each system on the material specifications, structural components, and relevant tools during both conceptual and detail design. He also discusses possible applications and execution aspects. He gives a special emphasis to new and less known systems and applications.

The author states that the book should be treated as a supplement to *Designing with Geosynthetics*, by Dr. Robert M. Koerner and the Dutch handbook, *Geotextiles and Geomembranes in Civil Engineering*.

The introductory chapter is an excellent primer on the subject, and would be an excellent article for the literature in its own right and serves quite effectively to introduce the book. Of particular note is the listing of geosystems and their applications and a series of figures that graphically portray these applications. Moreover, the interest by the developed and developing countries in low cost or novel engineering methods makes the subject of geosynthetics a globally timely subject. The book is organised into 12 chapters, and contains a listing of useful addresses, professional help, and a detailed index. There is also a very useful glossary of geosynthetic terms.

True to his objective, the author lays out the subject in a series of chapters, each of which is fairly complete in its own right. Each chapter is followed by an often extensive list of references. The author has chosen to place appendices in several of the chapters rather than at the end of the book. This method ties the appendices directly to the chapter at hand. Likewise, the author liberally employs case studies and examples in the individual chapters. The chapters are:

General design methodology
Geosynthetics; properties and functions
Fill-containing geosystems (bags, mattresses and geotubes)
Geocontainers
Geotextile forms for sand structures
Screens and curtains
Inflatable dams
Geosynthetics in dams, dikes, banks and dune reinforcement
Erosion-control systems
Remaining questions and closing remarks; durability, execution and damage, and quality control.

Illustrations abound and are effectively used to supplement the textual material. The quality of the illustrations is very good and the complement the book in terms of relevance and context.

The final chapter speaks to some of the aspects of geosynthetics that remain transitory in resolution or study and adds to the objectivity and value of the book as a whole.

Publication may be obtained from:
A. Balkema Publishers
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3000 BR Rotterdam, The Netherlands
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Email: balkema@balkema.nl

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Old Post Office Road
Brookfield, Vermont 05036-9704 USA

Environmental Aspects *continued from page 21*

Guide 4: Machines, Mitigation and Monitoring, written by Jos Smits, General Manager of International Marine & Dredging Consultants NV, discusses dredging equipment, mitigating measures and the monitoring and control of the dredging process.

Guide 5: Reuse, Recycle or Relocate, written by Anna Csiti, General Manager of the Central Dredging Association, and T. Neville Burt, Principal Engineer at HR Wallingford, addresses the question, "What should be done with removed sediment?". The book reflects the concern of the public and the industry with the destination of the millions of cubic metres of sediments dredged each year.

Guide 7: Frameworks, Philosophies and the Future, to be authored by R. Nick Bray, will round out the series and should be ready late in 2000.

All books in the series may be ordered from the IADC Secretariat in The Hague.

Seminars/ Conferences/ Events

BaltExpo-2000

Olivia Hall, Gdańsk, Poland
September 5-8 2000

This 10th International Maritime Exhibition BaltExpo-2000 has established itself amongst Europe's leading exhibition in the maritime sector and has created a forum for Polish and foreign suppliers and end-users. The exhibit is sponsored the Polish President, Prime Minister and Minister of Transportation and Maritime Economy. Exhibits will include shipbuilding, repairs and conversion; equipment, machines and engines; communication, navigation and position; ports, services and terminals; cargo handling; offshore; pollution control and much more.

For further information please contact:
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email: agpol@pol.pl

Biuro Reklamy SA
9, Flory Str., 00-586 Warsaw, Poland
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fax +48 22 849 3584
email: BRSA@pol.pl

4th PIANC-PCDC Seminar

Buenos Aires, Argentina
November 20-24 2000

Camara Argentina de Consultores with the support of the Subsecretaria de Puertos y Vias Navegables and in cooperation with the Spanish National Section of PIANC is organising this seminar in Buenos Aires. Papers will be presented on inland waterways and shipping; capital and maintenance dredging; maritime ports and shipping, including port and channel planning, container and dry bulk terminals, and environmental and safety aspects; multi-modal transport, fishing ports and coastal zone managment.

The seminar will be conducted in Spanish with simultaneous translation into English and vice versa.

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http://www.tornado.be/~navigation-aipcn-pianc

WODCON XVI and Exhibition

Hotel Shangri-la,
Kuala Lumpur, Malaysia
April 2-5 2001

The Sixteenth World Dredging Congress and Exhibition will be entitled "Dredging for Prosperity; Achieving Social and Economic Benefits". New ways of dredging and handling dredged materials are continually being found. These need to be promoted in order to achieve social and economic benefits. Papers showing the benefit/cost relationship of dredging works are especially encouraged, including new forms of dredging, developments in education and training, case studies and other developments in the industry.
An international exhibition will be held in conjunction with the conference. In addition, a technical visit to Paya Indah, Malaysia's prestigious wetland sanctuary will be featured. For up-to-date and detailed information visit the WODA website at http://www.woda.org.

For further information, please contact:
Congress Secretariat
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email: ceda@dredging.org

Oceanology International 2001 Americas

Miami Beach Convention Center,
Miami Beach, Florida, USA
April 3-5 2001

The first OI Americas exhibition and conference will be held in April 2001 and will be held biennially thereafter. It is et to become a joint ocean forum bringing together all sides of industry, science, research,government and academia, with a natural focus on the opportunities facing the Americas.
As a transportation hub handling 60 percent of airline traffic between the Americas, Miami has been chosen for ease of travel for the global ocean community as well as for the concentrations of ocean science and technology institutions in Florida.

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http://www.oiamericas.com

India International Maritime Expo (INMEX) 2001

Mumbai (Bombay), India
October 10-13 2001

The second India International Maritime Expo (INMEX) will provide an opportunity for overseas companies to enter the maritime market in India and to meet with representatives from government such as the Ministries of Surface Transport (MoST) and Defence, and the Coast Guard.The MoST is responsible for policies for the development of modes of transport including the maritime sector.

In order to decongest the present major port facilities the MoST has launched an ambitious plans for infrastructure development in the port sector, the shipbuilding industry and inland water transport. Private investments are being encouraged for port development as well as ship building and repair.

For further information contact:
INMEX Secretariat Pradeep Deviah & Associates
No. 35, Gover Road, Cox Town,
Bangalore 560 005, India
tel. +91 80 54 84 155/ 54 84 389
fax +91 80 54 85 214
email: pda@blr.vsnl.net.in
www.inmexindia.com

Call for Papers

1st International Congress of Seas and Oceans

Szczecin Maritime University
Szczecin and Miedzyzdroje, Poland
September 18-23 2001

On behalf of the West Pomeranian University Rectors Conference this congress is being organised to exchange ideas and experiences in the field of sustainable use of maritime resources for the development of humanity. The following topics are within the scope of the congress:
- research of seas and oceans (waves, currents, chemical, biological and lithodynamic processes);
- oceans and seas as sources of food and energy;
- mineral resources under sea (including crude oil and natural gas);
- sea transport including waterways, ships, ports and port management;
- protection of the sea environment;
- seas and oceans for recreation and sports; and
- maritime policy of coastal states (legal aspects, organisation of maritime administration and rescue).

The congress is open to all interested parties. Parallel to the congress, an exhibition will be organised for national and international suppliers, contractors and consultants.

For further information please contact:
Seas and Oceans Congress Secretariat:
att: Dr inż. Jaroslaw Guziewicz
Wyższa Szkola Morska
Ul. Waly Chrobrego 1/2
70-500 Szczecin, Poland
tel. +48 91 434 42 26, ext. 329
tel./fax +48 91 489 4003
email: icso@wsm.szczecin.pl
www.wsm.szczecin.pl

International Seminar on Dredging and Reclamation

Place: **Singapore**
Date: **October 9-13, 2000**

In cooperation with the National University of Singapore (NUS) and the Applied Research Corporation (ARC), International Association of Dredging Companies is pleased to organise, for the fifth time, an intensive, one-week seminar on dredging and reclamation.

The last course, held in February 1998, met with such enthusiastic response, that IADC, building on this success, has decided to present this seminar again in 2000. The costs are US$ 2950, which include six nights accommodation at the conference hotel, breakfast and lunch daily, one special participants dinner, and a general insurance for the week.

The seminar includes workshops and a site visit to a dredging project. Highlights of the programme are:

Day 1: **Why Dredging?**
The Need for Dredging/Project Phasing
Day 2: **What is Dredging?**
Dredging Equipment/Survey Systems (includes a Site Visit)
Day 3: **How Dredging?**
Dredging Projects
Day 4: **Preparation of Dredging Contract**
Day 5: **Cost/Pricing and Contracts**

Representatives of port authorities, companies, and individuals interested in attending are requested to complete the preliminary registration form below as soon as possible and prior to September 15, 2000, and return to:
IADC Secretariat, Duinweg 21,
2585 JV The Hague, The Netherlands
tel. +31 70 352 3334, fax +31 70 351 2654
e-mail: info@iadc-dredging.com

(please print)

Name ....
Title ....
Company ....
Address ....
....
Tel. .... Fax ....
E-mail ....

Please send this form and your deposit by cheque or credit card for US$ 500 in order to guarantee your place at the seminar. Upon receipt of this form and your deposit your place in the seminar is confirmed. We will then send you further detailed information, final registration forms, and an invoice for the correct amount.

Without your deposit we cannot guarantee your place and accommodations at the seminar.

- ☐ A Cheque is enclosed.
- ☐ Please charge my credit card:
- ☐ American Express ☐ Eurocard/Master Card ☐ VISA ☐ Diners Club

Account no.: |__|__|__|__|__|__|__|__|__|__|__|__|__|__|__|__|__|__|

Expiry date: |__|__|__|__|__|__|

Signature .... Date ....

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Through their regional branches or through representatives, members of IADC operate directly at all locations worldwide.

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