

THE BUILDING WITH NATURE PROGRAM: HOW TO ENABLE BROAD APPLICATIONS OF NATURE-BASED SOLUTIONS

E.M.M. van Eekelen, EcoShape / Van Oord Dredging and Marine Contractors, The Netherlands

Building with Nature (BwN) responds to the need of aligning the interests of economic development and care for the environment around hydraulic infrastructure development. This is accomplished by working with the natural system in such a way that society's infrastructural needs and the interests of stakeholders are met, while at the same time creating new opportunities for nature. Since 2007 the EcoShape consortium is developing and mainstreaming this way of thinking. The first Building with Nature innovation program ran from 2008-2013 and was focused on demonstrating that Building with Nature works via a combination of fundamental research and development of design rules and expertise on the basis of existing projects as well as new pilot projects. EcoShape and partners have currently established a second Building with Nature program in which we aim to bring the BwN approach and concepts another step further. As in the first program we do this by implementing and learning from BwN pilot applications in a broad range of environments.

The main knowledge themes addressed in the new program include systems understanding, nature based design of the BwN concepts, business cases and governance. As the strength of BwN is in utilizing and/or providing ecosystem services, a thorough understanding of the local system is a first necessity to 'assess suitability' of potential BwN concepts. Next, design of concepts requires knowledge and tools to 'engineer' the ecosystem services that are used and/or provided as part of the solution. The development of a business case for BwN concepts requires proper valuation of the (ecosystem) services delivered and insight in the beneficiaries of those services. Finally, governance aspects that promote or hinder the realization of BwN concepts need to be identified.

The current scope of the new program adds up to over 37 mln € and is funded 'bottom-up' via a diversity of subsidies, research grants, project development funding as well as a significant cash and in kind contribution from partners of the EcoShape consortium. Currently, the pilot applications in the new program are supported by monitoring programs and scientific research and cover a hybrid flood defense in the pilot Houtribdijk (Lake Marken), two sandy strategies for flood safety along the Dutch coast (pilot Sand Motor Delfland and the Hondsbossche and Pettemer sea defense), sustainable rehabilitation of mangrove coasts in Indonesia, salt marsh development in the Wadden Sea near the harbours of Harlingen and Delfzijl and some smaller-scale pilots in the urban setting of Dordrecht and Rotterdam.

Next to a short, more general introduction of the BwN principles, the presentation will focus on the pilots and concepts as tested in the current program, with focus on the sustainable harbour development pilots. To conclude some recent developments within the BwN II program will be highlighted as well as a preview on future developments.

SUSTAINABLE AND ENERGY EFFICIENT DREDGING VESSELS

E.C. van der Blom, Royal IHC, The Netherlands

Sustainability is a major topic in the global dredging industry and it has become an important driver in Royal IHC's research & development programs. As a developer, designer and builder of dredging vessels and equipment, Royal IHC is well aware of the environmental footprint of these vessels. Especially for complex dredging vessels, like trailing suction hopper dredgers, research & development now focusses on reduction of the environmental footprint, next to improving production performance and cost effectiveness.

Reduction of exhaust gas emissions is one of the main challenges. Since 2015 strict SO_x emission regulation is in place for Emission Controlled Areas (ECA's), limiting the level of SO_x emission to 0.1%. Strict limits for NO_x emissions and CO₂ emission are expected in the future. Emission regulation will have impact on vessel design and vessel operations. Both vessel owners and vessel designers are confronted with tough questions and considerations. Costly measures are needed, whether it is the installation of exhaust gas after treatment, the application of new types of engines or switching to other types of fuel.

An option that looks very promising is Liquefied Natural Gas (LNG). LNG reduces exhaust gas emissions drastically. SO_x emissions and Particulate Matter (PM) are almost eliminated with LNG. NO_x emissions are reduced by approx. 80% and CO₂ emissions by approx. 20%. Compared to other emission reduction measures, LNG is a very environmentally friendly solution that can meet the strictest emission levels. Unlike other options, LNG provides ship owners with earn back potential on their investment, making it an economical viable option. This has led to the development of the worlds' first LNG powered Trailing Suction Hopper Dredgers. Right now, Royal IHC is building 3 LNG powered Trailing Suction Hopper Dredgers for its customer DEME. These vessels range from the midsized 8.000 m³ hopper dredger 'Scheldt River' and small sized 3.500 m³ hopper dredger 'Minerva' to the large 15.000 m³ hopper dredger 'Bonny River'. The design challenges that come with the integration of LNG in a trailing suction hopper dredger will be presented.

Also other sustainable innovations developed by Royal IHC will be presented. Research on fuel saving started with extensive measurements of operational profiles of dredging vessels. This led to thorough understanding of the power consumption of drive trains in different phases of the dredging cycle. Based on this insight, drive train designs can now be configured and optimized for minimal fuel consumption. It also led to the development of 2-speed propulsion, saving fuel when sailing in partial load conditions. Fuel saving potential is also pursued by minimizing hull shape resistance of dredging vessels and by optimizing dredging processes using intelligent dredging automation.

Another development to be presented is the airless overflow. Trailing suction hopper dredgers often generate turbidity as a result from overflow activities. Royal IHC has developed an airless overflow system, that reduces the amount of air entrapped in the overflow stream and thereby reducing the size of the overflow plume.

ECOSYSTEM SERVICES: TOWARDS INTEGRATED MARINE INFRASTRUCTURE PROJECT ASSESSMENT

Annelies Boerema, University of Antwerp, Belgium

The ongoing need for navigation in the context of a still growing world population and global world trade as well as climate change challenges are major drivers of the dredging sector. Consequently, there is a permanent need for marine infrastructure projects due to growth and this is especially so for people living in low lying delta areas. However, nowadays, dredging companies are operating in an increasingly complex world – not only are projects getting more complicated from a technical point of view but there is also a growing environmental awareness amongst project proponents, legislators and dredging contractors. Companies are taking ownership of their responsibilities (environmental awareness in this case) by promoting the design and implementation of more sustainable solutions. However, developing and designing solutions alone is not good enough. To enable broad implementation and ensure effective realization, these solutions should be widely accepted by clients, project financers and other stakeholders. To that end, the benefits of these solutions or approaches should be taken into account in the evaluation method that is being utilized. This is where the concept of ecosystem services (ES) comes into play.

To enable the design of more sustainable dredging and marine infrastructure works and their efficient, safe implementation and realization in environmentally sensitive areas, the concept of ES has become increasingly important as a tool for integral evaluation of project effects (whether benefits or negative impacts) and achieving broad public support. The concept of ES aims at classifying, describing and assessing the value of natural resources and ecosystem services in terms of benefits for society, such as provision of food and other resources and air and water quality regulation. Though these benefits are always delivered, project stakeholders (including developers, financers, governments) do not always perceive them as a full “economic good”. An ES assessment can provide quantifiable information and data that can be included in a traditional cost-benefit analysis of projects. Thus, monetary valuation of ES can be utilized to make a full environmental cost-benefit analysis and weigh the investment cost with not only technical profits, but also environmental and socio-economic benefits. An ES assessment also allows for a better comparison between project alternatives – not just scenarios that mitigate negative effects but also the ones that positively contribute to the environment – delivering ecosystem services. Furthermore, qualitative assessment can be done for ES when monetary valuation is not straightforward possible. In this way other considerations can be added to the evaluation such as habitat and biodiversity targets.

While classic environmental impact assessments focus on the potential negative effects of a dredging project on nature, taking an ecosystem services perspective allows to look at both the negative effects as well as new opportunities that may arise as secondary benefits to society. By targeting a variety of ecosystem services from the conceptualization phase of a project and optimizing its design for additional benefits, innovation efforts shift away from ‘avoiding damage’ to ‘creating opportunities’. Taking ecosystem services into account from the designing phase of a project allows to generate added value that might otherwise be missed out on, avoid destruction that is impossible to mitigate and create support from different stakeholders.

THE CO₂ BALANCE OF DREDGING PROJECTS, AN ECOSYSTEM APPROACH

Jasper Fiselier, RoyalHaskoningDHV, The Netherlands

Dredging produces vast amount of CO₂ emissions. So far reducing the carbon footprint of dredging projects mainly looked into the possibilities of reducing the emissions by the equipment used, with a focus on dredging schemes that are more efficient, or using dredging vessels that are more fuel efficient. A reduction in the order of 10 to 20% may be within reach, most of it is a win-win since fuel reduction will also reduce costs.

The carbon foot print of marine projects depends however also on the impact a project has on the primary production and sedimentation processes in the coastal system. Primary production produces organic carbon that can be sequestered with the sedimentation of fines in sand pits and in blue carbon wetlands, such as salt marshes. These ecosystem based impacts can be a substantial or even overriding factor in the carbon footprint, especially on the longer term. A further reduction in the carbon footprint of a marine project can therefore be achieved by integrating blue carbon wetlands into the design, for example by using them as part of a protection schemes, or by furthering conditions that will stimulate their growth. Also the form and location of the sand pit may influence its potential to sequester (organic) carbon due to sedimentation of finer particles.

However, coastal systems are essentially open systems, and marine projects do not only impact and alter the area of the sand pit and the project area, but will influence a far larger part of the coastal system. Organic carbon that is produced by algae may be sequestered in the sand pit or the salt marsh that forms part of the project, but may, without the project taken place, have been sequestered in another salt marsh or other part of the coastal system. So the contribution of a salt marsh made possible by a project, is never 100% of the (organic) carbon that is sequestered by a growing salt marsh.

In order to assess the carbon balance between a coastal system with and without the project one may need to consider a myriad of factors that influence primary production and the formation of organic carbon as well as regional sedimentation patterns. In order to simplify the related complexity, we focus on a limited number of most relevant factors. The first is the availability of (mineral) fines that are needed to safely store organic carbon in sediments, since sand alone allows too much oxygen and the decay of organic matter. Fines are in principle limited, in an absolute sense, since only so many tons flow down rivers or are produced by coastal erosion. Fines are also limited in a relative sense, since various sedimentation areas compete with one another. The second limiting factor is phosphorus which is needed for primary production. There are other nutrients, such as nitrogen, and minerals needed, such as potassium and iron, but phosphorus is in most coastal seas the most limiting.

The carbon balance therefore depends on the most efficient use of phosphorus to produce

organic carbon and of the most efficient use of fines to sequester organic carbon. If a salt marsh or a sand pit is the most efficient in this sense, their use as part of a marine engineering project, will contribute positively to the carbon footprint and the carbon balance. The coastal sea can in principle be seen as a combination of sedimentation zones that have different ability in sequestering organic carbon in an efficient way. Unfortunately many studies into CO₂ footprints of blue carbon wetlands seldom look into sedimentation processes in relation to fines, TOC and phosphorus. This relation is also often an unknown for sand pits and other parts of the coastal system and wider open sea.

So, summarizing, a carbon footprint can be assessed on three different levels. The first level is that of combustion related CO₂ emissions by dredging equipment. The CO₂ emission of dredging equipment is well-known. In the long term maintenance may play an important role, especially where soft defenses that need nourishment form part of a marine project. In this case the long-term nourishment needs may form the largest uncertainty.

The second level is including the (organic) carbon that is sequestered by the sand pit and blue carbon wetlands, made possible or perhaps also directly impacted by the project. The carbon sequestration of blue carbon wetlands is fairly well known, but that of sand pits is not studied. In the long-term, the long cyclic sequestration of (organic) carbon is only possible if the long-term fate of pits and wetlands are known. Predicting their status over a longer period is quite challenging.

The third level includes all off site impacts on primary production and fine sediment sedimentation and its consequences for (organic) carbon sequestration. As indicated, these are largely uncharted waters, and more research into the whereabouts of fine sediments, phosphorus and (organic) carbon is needed.

As part of the Ecoshape program, a first tool is being developed whose aim it is to produce a carbon footprint based on all three levels. The presentation will briefly describe the architecture of this tool and some primary results from several marine engineering projects. The aim is to identify dredging strategies and marine engineering designs that have smaller carbon footprints.

NATURE CONSERVATION AND INDUSTRY IN HARMONY: CASE STUDIES FROM THE UK

Steve Gilbert, Conservation Programme Manager, RSPB, United Kingdom

Despite historical instances of conflicts between the dredging and excavated materials industries and nature conservation organisations, there are in fact many opportunities for collaboration between these interests for the benefit of both. In recent years the RSPB, a major UK non-governmental conservation charity, has been a partner in several innovative projects delivering multiple benefits, including environmental outcomes. These have involved the use of dredged materials from river based campaigns, but also excavated materials arising from current or proposed major infrastructure projects.

Two case studies will be described from the RSPB's experience in the UK, namely the Cliffe Pools Project in Kent and Wallasea Island Wild Coast in Essex. Both projects, which are still in the process of delivery, have involved joint working by the RSPB and commercial partners.

At Cliffe Pools, a former cement industry extraction site, an ambitious habitat restoration project is dependant upon the import and landscaping of large volumes of excavated materials. A long standing partnership between the RSPB and Boskalis Westminster has led to significant enhancement of the site through the deposit of river dredgings, but much more is required and, in an initiative also involving partnership with neighbouring landowner Brett, opportunities are being investigated to source suitable excavated materials from major infrastructure projects such as the Thames Tideway Tunnel. Around six million tonnes/2.5 million cubic metres is required in total.

The Wallasea Island project involves the transformation of 670 hectares of arable farmland to coastal marsh by major landform changes and the removal of seawalls. Between 2011 and 2015, in partnership with Crossrail, over three million tonnes/1.25 million cubic metres of excavated materials were brought onto the site by way of a temporary jetty to raise the land and create lagoons and other habitats. Further materials will be required in the period to 2025 to complete one of the largest projects of its type in Europe.

The RSPB will continue to work with new and existing commercial partners in the dredging and excavated materials sector to deliver further large-scale conservation projects.

DREDGING IN PORTUGUESE PORTS: A CHANGING PARADIGM

Luís Ivens Portela, LNEC, Portugal

Commercial ports play a significant role in Portuguese trade, having handled 80 million tonnes of freight in 2014 and accounting for 57% of exports by weight. In order to maintain and improve operating conditions, ports regularly require maintenance and capital dredging. The volume of material dredged from Portuguese ports (including fishing ports) has been estimated at about 5 million m³ year⁻¹. At the turn of the 21st century, the main options for the disposal of dredged material were marine and estuarine disposal (primarily fine sediments; 45%) and commercial use (sand; 46%), with smaller percentages of other options such as port development (4%) and coastal nourishment (4%). However, practices in the management of dredged material have been evolving since then.

Over the past 30 years, environmental regulations have had a major impact on dredging. Milestones include the introduction of legislation on environmental impact assessment (1990) and dredged material assessment and disposal based on contamination (1995). Although subject to criticism, these regulations have improved access to information and encouraged port authorities to address existing problems. To comply with the new regulations, ports have developed multiannual dredging plans, sediment characterization programmes and, in some cases, water and ecological monitoring programmes. The new regulations were particularly effective at raising awareness about fine sediment contamination and the need to eliminate active sources of contamination.

Coastal protection is a more recent challenge. Dredging requirements often result from the infilling of navigation channels by longshore transport. For a long time, Leixões was the only port to consistently relocate sandy dredged material within the nearshore zone, but since 2006 there is a push to make the practice more widespread. At the Port of Aveiro, coastal nourishments have amounted to 4 million m³ in 2009-2015, following an EIA process, and an additional 2 million m³ are expected in 2017 under a protocol with the Environment Agency. At the Port of Lisbon, nourishments amounted to 3.5 million m³ in 2007-2014. It is believed that the relocation of sandy dredged material within the coastal system may have a significant effect in attenuating erosion in the most critical areas.

Clearly much has been achieved so far, as ports increasingly recognize their responsibility towards the environment. But much work still lies ahead. To make dredging and dredged material management more environmentally sustainable, it must also be as cost-effective as possible. More advanced and efficient strategies and technologies are needed, along with a greater focus of environmental measures and requirements on those aspects that maximize benefits and minimize costs to society.

Coastal erosion and sediment management in Portugal

Celso Aleixo Pinto

(Senior Technician – Portuguese Environment Agency)

About 20% of Portuguese's sandy coastline (circa 42% of the total length of 987 km) experiences erosion, with retreat rates in some locations ranging between 6 to 8 meters per year. Since 1958 about 1220 ha (\approx area of 1700 football fields) of inland disappeared due to erosion.

Coastal erosion causes in Portugal are both natural and anthropogenic, namely: interventions at river basins (e.g. dam construction, dredging in river basins), coastal engineering structures (e.g. downdrift erosion due to presence of jetties, groins and breakwaters), sea level rise and changes in storminess and wave climate.

Damage and loss of land, property and infrastructure is widespread, increasing risk for local communities, leading to the adoption of several coastal protection measures in order to reduce the impacts of coastal erosion.

Hard structures, such as groins, breakwaters, seawalls and rock armour were extensively used during the 1970's and 1980's, leading to the armouring of significant parts of the Portuguese shoreline. Until a few years, the assessment of possible response strategies to coastal erosion has mainly focused on hard protection measures that, despite the positive effects to protect and mitigate risk for local communities, not managed to solve the global problem of sediment deficit. Simultaneously, there has been increasing awareness of the benefits of "soft protection" measures, such as beach nourishment, and in the last 10/15 years the number of projects and volumes placed in the nearshore, dry beach and dunes increased significantly.

About $\frac{3}{4}$ of the sediment sources for beach nourishment came from regular maintenance dredging made by Port Authorities, reinforcing the importance of this activity in coastal erosion management.

This work presents an overall perspective of coastal erosion in Portugal and protection strategies adopted. A retrospective of beach nourishment practice is shown as well as the ongoing and future strategy of coastal protection based on a recent framework of integrated sediment management policy.

Strategies for sustainable sediment management: the case of Port of Antwerp

Agnes Heylen, Port Authority Antwerp, Belgium

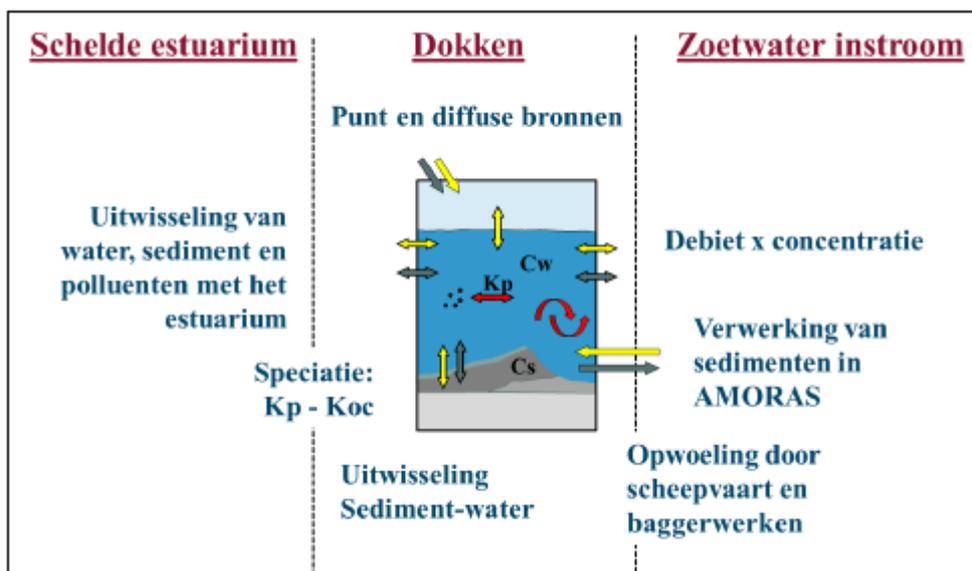
To meet the demands of an expanding harbor, the Port of Antwerp need to perform maintenance and capital dredging works in her area.

The dredging demands of our expanding harbor are compiled in a business development plan, the so called nautical vision 2020. It's partly as a result of the latest Scheldt deepening that also in the port area an access for vessels with a larger draft should be guaranteed. As a result, the extra volume due to capital dredging works, that will arise the next few years is estimated at $12 \cdot 10^6$ m³.

Due to historical industrial activities (e.g. shipyards, oil refineries, tank storage) a part of these sediments are polluted. As the sediments are partly the result of maintenance and capital dredging activities, the port will be confronted with both sandy and silty material.

The timely and well-defined vision 2020 provides the Port with the opportunity to move as a function of the dredging activities in a more proactive and sustainable way. A number of actions are set up: among other things an extended qualitative mapping of the sediment quality is performed, as well as the construction of site specific sediment risk assessment. The purpose of the presentation is to zoom in on both of these projects. Both projects were carried out in collaboration with different stakeholders.

The project **Ecodocks**, carried out by the Antwerp University, implies the construction of a mathematic site specific risk model where both distribution (mainly to the river Scheldt) and ecotoxicology are calculated. This is mainly based on our own data collection, as well as on literature (e.g. Kd-values).



A large set of data are collected in order to have a mathematical idea on the turbidity influence of sailing/maneuvering, dredging activities and lock movements, in order to calculate the potential distribution of pollutants.

In the project **mapping** 294 samples were taken in the port area in order to have an idea of the current sediment quality and moreover on the evolution in sediment quality since 2002. Evolutions in time, parameters and location will be discussed.

Additionally, information will be given on the latest developments of the plant AMORAS, the large mechanical dewatering installation in the port area where investments have been carried out for better representation of today's challenges.

Also, attention will be given to the progress the Port has made in reusing the produced filter cakes and the large lots of natural dried sediments, and the challenges it has faced.

Finally, the goal of the presentation is to give examples of the sustainable actions in relation to the nautical accessibility on the river Scheldt that were carried out in the last years, together with the Flemish authority responsible. The Port remains the main stakeholder.

The examples will emphasize the pairing of nautical accessibility and morphological issues, as well as issues of climate change in the Natura 2000 area.

INNOVATIVE SOLUTIONS FOR MANAGING CONTAMINATED SEDIMENTS: APPLYING LESSONS LEARNED FROM U.S. SEDIMENT CLEANUP PROJECTS

R. Gardner, Anchor QEA, LLC, USA

In the United States (U.S.) fewer and fewer projects receive approval for open water disposal of dredged sediment. In many regions, landfill disposal is an expensive, sometimes cost prohibitive, alternative to open water disposal. As such, beneficial use has become an increasingly desirable option for sustainable sediment management.

In recent decades, dredged sediment has been used as a valuable resource in a wide range of projects including aquatic habitat restoration, land reclamation, levee construction, and landfill closures. However, new science is altering our understanding of acceptable risk levels for soils and sediment, which is limiting the potential for these uses. Sediments that were once approved for such beneficial use are now often characterized, regulated, and disposed of as waste. Progressive policies that support and promote beneficial uses of dredged sediment are needed to achieve a sustainable approach to sediment management. These policies must not only consider science and environmental aspects, but also need to factor economic and social considerations. Innovative management solutions, based on lessons learned in the cleanup of contaminated sediment sites, may help breakthrough these barriers to beneficial use.

Several guidance documents (e.g., SMOCS and various publications by the U. S. Army Corps of Engineers and U.S. Environmental Protection Agency) have been developed and provide a range of solutions for managing dredged sediment from navigation projects and environmental cleanup projects. The presentation will focus on lessons learned from completed navigation and environmental dredging projects initiated to support more sustainable management of contaminated sediment and overall toxics reduction. Various case studies will be discussed including the Poplar Island habitat restoration and dredged material management project in Chesapeake Bay, Maryland, U.S.

Beneficial use of dredged material under existing European and international legislation

Helmut Meyer, Federal Waterways and Shipping Agency, Germany

Dredging is essential for the maintenance and development of ports, harbors and waterways for navigation, remediation and flood management. This generates large volumes of dredged material. Historically the most common dredged material management approach employed in many countries has been disposal at sea.

Therefore the protection of the seas in issues of dredged material placement on the high sea, in coastal waters, and in the inner waters is regulated in the international conventions on the protection of the marine environment (London Convention 1972 for assessment of dredged material, Ospar Convention 1992 for management of DM, Helsinki Convention 1992 for disposal of dredged spoils). The conventions were ratified by the many countries and are therefore national law.

In the framework of these conventions on marine environmental protection, special directives for the ecologically acceptable placement of dredged material in the respective conventions areas have been passed (London 2000, Ospar 2004, Helsinki 1992). Such regulations have to be observed in all operations of waterway maintenance, development, and remedial actions.

Furthermore the EU developed and adopted regulative and technical directives with effects on dredging : the management plans of the EU-WFD and the action plans on the river basin 2010, the daughter directive on environmental quality objectives for priority substances of the EU-WFD 2008, the Marine Strategy Directive 2008, the European Directive on Flood Protection 2007.

However over the last few decades not only the acceptable environmental placement of dredged material has been an issue. There also has been an increasing recognition dredged materials are resources that can be used to provide benefit in environmental and engineering programs conserving primary resources such as mined sand and gravel. There are many possibilities for increasing the use of dredged material whilst also identifying the constraints, e.g. from legislation, that restrict such use.

More recently there have been considerable advances in knowledge about the natural environment and its processes and dynamics which has facilitated innovative uses of dredged material. Attitudes towards the environment have become more proactive where environmental considerations, nature-based approaches, value engineering and win-win solutions (i.e. benefits / value for all parties) are increasingly considered as an integral part of dredging projects from an early stage.

Integrating Adaptive Environmental Management into Dredging Projects

This presentation, prepared on behalf of the Central Dredging Association (CEDA) Environment Commission, outlines concepts of integrating adaptive management (AM) for the enhancement of the environment into dredging activities (inclusive of placement / disposal / reclamation). Dredging projects are often permitted with license conditions or regulations based on an assessment of the potential environmental effects. For those dredging projects where the environmental outcome can, with less certainty, be assessed, a sequence of more intense and targeted monitoring, impact assessment and management actions might be implemented. This sequence of activities is understood as 'adaptive management', although various ways of implementation may exist.

AM can be an efficient and cost-effective management process in dredging projects, it helps to achieve goals by addressing uncertainty and by incorporating adaptivity in decision-making as the project develops. AM in dredging projects represents a "modern" approach and has the potential to become good practice in the future, although is not likely to become good practice for all kinds of dredging projects. The need for integrating AM in dredging projects is already becoming recognised, but will probably increase in future.

Innovations in environmental management of large marine infrastructure projects

Boudewijn Decrop, IMDC, Belgium

During large dredging and marine infrastructure projects, pre-defined environmental quality objectives (EQO) are to be respected. In the recent past, environmental awareness and by consequence environmental legislation has become stronger. As a result, dredging contractors and dredging consultancy have been faced with the challenge to implement better control mechanisms for environmental management purposes. To this end, pro-active adaptive environmental management has been developed, or EcoPAM.

EcoPAM combines field monitoring, satellite imaging, numerical modelling and operational forecasting. Real-time field monitoring of water quality parameters allows for issuing an early warning in case signals are registered that EQO's will potentially be breached. Satellite images serve for baseline studies and incident analysis with respect to turbidity thresholds and sediment plume monitoring. Numerical models allow for feasibility-stage analysis of sediment plume and pollutant dispersion during hypothetical dredging scenarios. Moreover, during project execution numerical modelling allows for predictions of marine currents and plume dispersion up to 5 days in the future. This allows for operational forecasting of potential EQO breaching and subsequently for pro-active adaptation of the dredging scenarios.

These tools are brought together in a web-based system in which the different data streams are visualised and analysed. Satellite images and plume modelling results are consulted in a map viewer with different layers. Monitoring time series can be consulted and project-specific automatic warning systems can be implemented.

Contractors and environmental consultants can therefore rely on a single, online system for most aspects of environmental management of a marine infrastructure or port construction project.

Sustainable nourishment of a dark sand beach

João Godinho, (at the time of the project with Dravosa), Spain

As an island in the middle of the ocean, La Palma is subject to Atlantic's swell, and it's capital city is very exposed. This project aims to find a sustainable way to create an infrastructure that protects the city and creates an attractive beach, fully integrated on the island's environmental conscious philosophy.

A surveyor's point of view, on a dynamic dredging project featuring some of the most efficient technologies on the industry.

Data, the new oil

P. de Looze, HAL Maritiem, The Netherlands

Sustainability means 'the quality of non being harmful to the environment or depleting natural resources, and thereby supporting long-term ecological balance'. But in practice, this word used most of the time in an economic interest in state of an ecological interest.

This results in high investments to place more sustainable systems, but how sustainable are those systems? How you manage this system?

Sustainability is a combination between awareness and competitions.

In dredging industry it's important to get insight of the performance:

- During design of a vessel
- During operations of the vessel
- During operations on a project.

Therefore, HAL Maritiem and several other companies developed a ship monitoring and maintenance system to get insight into the proces to be more sustainable.

Because: Data is the new oil!!

STRATEGIES FOR REDUCING DREDGING IMPACTS ON PORT DEVELOPMENT: THE PORTSMOUTH DESIGN & CONSTRUCT CASE

J. Fernandes, Boskalis, The Netherlands

Capital dredging of the Portsmouth harbour, berth pocket, turning circle and approach channel is required to allow for the seaborne access of the new Queen Elizabeth Class aircraft carriers.

Dredging operations are needed in close vicinity of sensitive stakeholders particularly, the historical heritage of old Portsmouth, the recreational marinas and docks of the Port and the protected Ramsar area.

Strategies to mitigate the social, economical and environmental impacts of the works on those assets were created in close cooperation with the Client and successfully implemented:

- (i) Management strategy to deal with the structures in the narrows consisting of a risk assessment, gap analysis and demonstration of the overall slope stability after dredging
- (ii) Overall dredging strategy using combination trips, maximizing the cycle period, with no overspill through overflow within the harbour and continuous turbidity monitoring at the access channel
- (iii) Design of dredged slopes ensuring no encroachment into the Ramsar area by surveying prior to dredging and considering additional safety in design

Boskalis was awarded the design & construction contract after a competitive dialogue procedure during which the proposal of these strategies were key for the successful outcome.