SUSTAINABLE INFRASTRUCTURE
Key approaches and practices to integrating dredging in sustainable development

IADC SAFETY AWARDS 2023
Recognising and encouraging the development of safety innovations

SAND AS A RESOURCE
SETTING OUT IADC’S BEST PRACTICES TO CONDUCT RESPONSIBLE DREDGING PROJECTS
For hundreds of years, dredging has been used to shape and manipulate the interface between land and water in order to support a variety of human activities, including navigation, coastal protection, flood risk management as well as residential development. Read the full article on page 6 that presents the concept of sustainability in relation to dredging projects.
SUSTAINABILITY

Integrating dredging in sustainable development
Describing the approaches and practices that are key to using dredging and dredge material to create more sustainable solutions and infrastructure.

ENVIROMENT

Sand as a resource
An article adapted from IADC’s paper by the same name in response to the 2022 United Nations Environmental Program report, “Sand and sustainability: 10 strategic recommendations to avert a crisis.”

EVENTS

Upcoming courses and conferences
Check out the many networking opportunities including PIANC COPiDEC X in Manila and IAPH World Ports Conference in Abu Dhabi.

SAFETY

Submissions for IADC’s Safety Awards 2023
Review of all nine submissions in the running for this year’s awards, each one aiming to improve routine processes and situations encountered in the dredging industry.

BOOK REVIEW

WEDA’s role in sustainable development
White paper on how the dredging industry contributes to our communities’ resilience, sustainability, and adaptation in response to climate change.
This summer saw sweltering temperatures and raging storms that ignited wildfires and caused flooding around the world. Tropical storms drove fast-spreading wildfires on the island of Maui causing devastation and loss of lives. Typhoon Doksuri slammed into south-eastern China’s Fujian province displacing more than a million people. Black summer fires were among the worst in Australia’s history and Canada battled its worst-ever fire season. In Europe, thousands of people were evacuated as fires burned across Greece. In Spain, temperatures soared 15 degrees above normal values. Slovenia suffered heavy rain and devastating flooding, while Norway and Denmark were hit by severe storms. As the human-caused climate crisis accelerates, scientists are clear that extreme weather events will only become more frequent and more intense.

Signs of the market’s growth is encouraging. The Dredging in Figures 2022 report shows an increase in turnover compared to 2021 and the 2023 turnover is expected to be even higher. More and more equipment is being engaged on projects globally.

Companies within our industry are well aware of the need to conduct sustainable projects and investments in technology continue to be made with this goal in mind.

This issue of Terra et Aqua includes a host of articles all focused on the ways to create more sustainable solutions and infrastructure. In 2022, the United Nations Environmental Program (UNEP) formulated ten recommendations that show the path towards the sustainable use of sand. IADC has taken these recommendations to heart and has elaborated from the perspective of the dredging industry on UNEP’S call to action and recommendation number 7 “Establish best practices and national standards, and a coherent international framework”. How the global dredging industry uses sand in a responsible manner is described in a new paper “Sand as a resource. Best practices to conduct responsible dredging projects”, published by IADC earlier this month. An article, adapted from this paper, can be found on page 18.

Technological advancements come from the body of research carried out across our industry and IADC was greatly saddened to learn of the death of Cees van Rhee this July. Since 2007, Cees was Professor of Dredging Technology at the Department of Maritime & Transport Technology at TU Delft in the Netherlands. A former employee of Van Oord, he had an unwavering sense for practical research that contributed to the efficiency of our industry. Cees was amiable, always easy to connect with and ever supportive of IADC activities. A frequent author and contributor of articles for Terra et Aqua, he published several articles over the years, the first back in 2002. On behalf of IADC, I would like to offer our deepest condolences to Cees’ family, friends and colleagues.

Frank Verhoeven
President, IADC

In memoriam – Cees van Rhee (1959-2023).
INTEGRATING DREDGING IN SUSTAINABLE DEVELOPMENT

The International Association of Dredging Companies (IADC) aims to inform the world about the fundamental need for dredging as well as advocating for an industry that makes the world a safer, better and more sustainable place to live. Adapted from the second chapter of the book, Dredging for Sustainable Infrastructure (2018), this article presents the concept of sustainability in relation to dredging projects. It describes the approaches and practices that are key to using dredging and dredge material to create more sustainable solutions and infrastructure – a modern way of thinking about dredging.

The broad context
A dredge is a tool. For hundreds of years this tool has been used to shape and manipulate the interface between land and water in order to support a variety of human activities, including navigation, coastal protection, flood risk management, as well as residential, commercial, agricultural and hydro-power development. The use of dredging to achieve these purposes has always been guided by an understanding of the costs and benefits of applying the tool. However, in the last few decades the understanding of what constitutes costs and benefits has evolved substantially beyond the direct monetary costs of using the tool and the direct monetary benefits of what the tool was used to create.

This evolution was aided by the environmental movement over the past five decades, where the costs (in a broad sense) of applying the tool was expanded to include the negative environmental impacts that can be associated with dredging. Environmental regulations were put in place in an effort to minimise negative impacts on ecosystems caused by dredging activities, and for the last few decades dredging has been at the centre of a conflict, where the water meets the land, between groups supporting development and the environment. However, attitudes and approaches are changing.

The environmental regulations that have been put into place over the last 50 years to eliminate, reduce, or control the impacts of dredging on the environment, have produced a range of outcomes, both positive and negative. It is undoubtedly true
that such regulations have helped to reduce negative impacts on the environment, in general. However, it is also true that the amount of environmental benefit produced by these regulations has not been systematically quantified, nor have the environmental, social and economic costs of such regulation been fully assessed (e.g. related to trade-offs and transferring impacts within the system).

Today, a paradigm shift is being embraced – a move toward a holistic approach for integrating values for people, planet and profit.

The growing focus on sustainability  

The international focus  
An increasing amount of attention is being given to the concept of sustainability as an approach to informing social, environmental and economic development. In 2015, the United Nations (2015) published its SDGs, as a part of “The 2030 Agenda for Sustainable Development” (see Figures 1 and 3). These 17 SDGs encompass a very broad range of interests, values, and objectives.

As a means for developing water resources infrastructure, the relationship of dredging to each of the 17 SDGs varies. For example, the use of dredging to construct efficient and productive navigation infrastructure is directly connected to SDGs 2, 6, 7, 8, 9, 10, 11, 14, and 15. As a tool used to provide coastal protection and infrastructure supporting flood risk management, dredging clearly supports SDGs 1, 3, 6, 9, 11, and 13, among others. In the future, one of the opportunities that should be addressed by the dredging and water infrastructure community is to incorporate these goals into the infrastructure development process, while effectively communicating how such projects support the SDGs.

The organisational focus  
An example of organisational focus and application of sustainability in relation to dredging and infrastructure can be seen in the Environmental Operating Principles (EOP) of the United States Army Corps of Engineers (USACE). The USACE dredges approximately 250 million m³ of sediment annually (including permits for dredging issued through its regulatory programme). This level of dredging supports a network of nearly 40,000 km of navigation channel and the associated ports, in addition to flood risk management and ecosystem restoration projects. In 2002, the USACE developed and published its EOP, which were subsequently updated in 2012.

These principles were developed and disseminated by USACE as a means of advancing its stewardship of air, water and land resources while protecting and improving the environment. These principles have been communicated within USACE and codified as a part of an agency regulation so that each of the more than 30,000 employees of the agency “understand his or her responsibility to proactively implement the EOP as a key to the Corps mission.” (Bostick, 2012). The USACE EOP recognise the relationship of infrastructure development to the three pillars of sustainability, the importance of considering the long-term, life-cycle implications of agency actions, and the essential need to openly engage the stakeholders and interests affected by its projects and programmes.

The sector-specific focus  
In 2013, the dredging sector itself, through the actions of the World Organization of Dredging Associations (WODA) (which includes the CEDA, the Eastern Dredging Association

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**UNITED NATIONS’ SUSTAINABLE DEVELOPMENT GOALS**

**Goal 01:** End poverty in all its forms everywhere.

**Goal 02:** End hunger, achieve food security and improved nutrition and promote sustainable agriculture.

**Goal 03:** Ensure healthy lives and promote well-being for all at all ages.

**Goal 04:** Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all.

**Goal 05:** Achieve gender equality and empower all women and girls.

**Goal 06:** Ensure availability and sustainable management of water and sanitation for all.

**Goal 07:** Ensure access to affordable, reliable, sustainable and modern energy for all.

**Goal 08:** Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all.

**Goal 09:** Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation.

**Goal 10:** Reduce inequality within and among countries.

**Goal 11:** Make cities and human settlements inclusive, safe, resilient and sustainable.

**Goal 12:** Ensure sustainable consumption and production patterns.

**Goal 13:** Take urgent action to combat climate change and its impacts.

**Goal 14:** Conserve and sustainably use the oceans, seas and marine resources for sustainable development.

**Goal 15:** Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss.

**Goal 16:** Promote peaceful and inclusive societies for sustainable development, provide access to justice for all and build effective, accountable and inclusive institutions at all levels.

**Goal 17:** Strengthen the means of implementation and revitalise the Global Partnership for Sustainable Development.

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**FIGURE 1**
The Western Dredging Association (WEDA), published its principles of sustainable dredging (see Figure 4). The WODA principles reflect the importance of using dredging to create value across the three pillars of sustainability, considering the system-view of projects, including the ecosystem and natural processes operating within the system, and the role of engaging stakeholders (including project proponents, regulators, and the broader array of interests relevant to a project). Publication of the WODA principles has sparked a range of discussions and actions within the dredging sector in efforts to seek a balance between the economic development that is supported through dredging and environmental considerations and regulation.

Also, the recently published technical report “Sustainable ports: A guide for port authorities” (PIANC, 2014), from the port sector illustrates this shift towards an integrated and sustainable approach. This guide is a joint report of The World Association for Waterborne Transport Infrastructure (PIANC) and International Association of Ports and Harbors (IAPH). It defines a sustainable port as “... one in which the port authority together with port users, proactively and responsibly develops and operates, based on an economic green growth strategy, on the Working with Nature (WwN) philosophy and on stakeholder participation, starting from a long-term vision on the area in which it is located and from its privileged position within the logistic chain, thus assuring development that anticipates the needs of future generations, for their own benefit and the prosperity of the region that it serves.”

With regards to sustainable dredging it states the following aims: The Green Port goals related to sustainable dredging are primarily to keep the port’s nautical access open, clean and safe. At the same time, the goals aim to:

- manage integrated dredging activities to create opportunities for improving environmental quality and at the same time creating or enhancing ecosystems;
- manage dredged material according to the philosophy of minimising quantity, enhance quality, reuse with or without
pre-treatment and long-term beneficial placement; and

• understand the local (and surrounding) environment and search for opportunities to use the natural processes including hydraulics, hydrology, geophysical, vegetation, benthos, etc., to maximise the efficiency of the dredging in both the short and long term.

Applying the concept of sustainability to water infrastructure development

The concept of sustainable development is based on the premise that the design for an action (in this case a development project that involves the use of dredging) will be informed by a full consideration of the values and costs of the proposed action across the three pillars of sustainability: society, environment and economy (see Figure 5).

The concept of sustainable development recognises the need to consider the full range of benefits and impacts related to human actions and the distribution of these benefits and costs across the social, environmental and economic domains. The relationships among these value domains are reflected by the goal to take actions (e.g. develop projects) that will balance the distribution of benefits and costs so as to produce socially equitable, environmentally acceptable, and economically viable outcomes. This balance is achieved through active and consistent engagement with the stakeholders who will be affected by the proposed project, including government authorities, private sector interests, local/regional/national members of the public, and the special interest groups and perspectives that are relevant to the project.

In order to aid our discussion of sustainability in the context of infrastructure development and dredging we propose the following operational definition (in line with the definition proposed by Brundtland et al., 1987): “Sustainability is achieved in the development of infrastructure by efficiently investing the resources needed to support the desired social, environmental, and economic services generated by infrastructure for the benefit of current and future generations.”

Here, we use the word infrastructure to refer to the diverse range of structures, features, and capabilities that are developed through the use of dredging (e.g. navigation channels and waterways, ports and harbours, levees and dykes), and nature-based infrastructure, such as islands, beaches and dunes, wetlands, reefs.

In view of the processes, variability and extremes associated with climate change, there is renewed motivation to consider the long-term sustainability of water infrastructure.
and many other forms of habitat. In practical terms, the sustainability of an infrastructure project is increased by:

- increasing the overall value of the project through the range of services it provides;
- reducing costs associated with the project, where the word costs is being used in the broadest sense to include all of the monetary and non-monetary (e.g. environmental impacts) costs and resources consumed by the activity; and
- balancing the distribution of the value and costs among the social, environmental and economic domains over time.

**Some practical implications for dredging**

The importance of vision and value creation

For the vast majority of the history of dredging, the nearly exclusive focus of the activity was to generate the economic benefits produced by infrastructure. The incorporation of environmental and social factors (the other two pillars of sustainability) into the decision-making and governance process is a relatively recent development, mostly concentrated within the last 50 years. During the last few decades, significant technological and operational advancements have been made that have improved the dredging process in relation to the environment. That said, one of the biggest opportunities for increasing the overall sustainability of the water infrastructure sector is for project proponents, dredging contractors, and other stakeholders to invest more time and energy in up-front visioning to identify ways of creating more project value across all three of the pillars of sustainability. Such visioning will not diminish the importance of generating economic benefits from infrastructure, rather, it is more likely to reveal opportunities for creating additional economic value. By devoting more effort to identifying and developing positive social (e.g. recreational, educational, community resilience) and environmental (e.g. ecosystem services, habitat, natural resources) values, dredging and infrastructure projects will be able to avoid unnecessary conflicts with stakeholders while simultaneously developing a larger number of project proponents, advocates and partners.

Adapting projects to nature, rather than the reverse

Dredging is used to change or manipulate the physical structure of the environment to produce a feature or a function that nature did not and would not create on its own. For centuries, ports and waterway networks have been produced by creating a design for these systems and then imposing that design on the natural environment, with mixed results. Traditionally, designs were evaluated for their engineering performance and impacts on nature. Uncertainties related to performance and impacts were acknowledged to varying degrees. In the past, engineering was focused more on hydrology than ecology. In this historical approach, the engineering design and economic costs were dominant factors and effects on nature were secondary considerations. However, important lessons have been learned. Effects on nature and impacts in the coastal zone and rivers were underestimated or partly ignored in many cases. Lack of knowledge regarding sediment processes and the relation of these processes to local and regional geomorphology resulted in negative effects on engineering performance (e.g. higher than expected sedimentation in channels and reservoirs, erosion and scour around structures) and ecosystems (e.g. loss of habitat).

The ability to project long-term performance and effects was complicated by uncertainties. Hard structures, separating fresh and salt water and wet and dry areas (e.g. revetments, breakwaters, dams, walls, dikes etc.), were common engineering solutions, in order to manage the hydraulics. Rivers were trained and dams were built to facilitate navigation, manage high water and flooding, and generate energy. In many cases these solutions have disrupted sediment processes, which have given rise to long-term effects and current, ongoing engineering and ecological challenges (e.g. shrinking reservoir capacity due to sedimentation, shoreline erosion, loss of coastal landscapes and habitats, etc.). Past engineering projects have certainly delivered major economic, safety and human welfare benefits. As time has passed and the infrastructure projects have “begun to show their age”, the adverse effects associated with these projects have become more and more visible, casting at least a partial shadow over the realised benefits produced by their construction. In view of the processes, variability and extremes associated with climate change, there is renewed motivation to consider the long-term sustainability of water infrastructure.
Nature can be a stubborn and uncooperative collaborator when she is not adequately considered and consulted during the process of design. Winds, waves, and tides deliver force, water, and sediment against the products of our design with endless energy, which prompts us to spend our effort, time, and money reacting to nature’s onslaught. We have learned the lesson countless times that taming nature can be an expensive proposition. Integrating the concept of sustainability into our infrastructure projects will help us identify opportunities to cooperate and collaborate with natural processes, rather than seek to control and counter them. Working in this way we will adapt the port to the coastal ecosystem, the ship to the river, the local community to cycles of low and high water.

PIANC’s WwN philosophy incorporates this approach to navigation infrastructure development and the Building with Nature (BwN) programme in the Netherlands (De Vriend and Van Koningsveld, 2012, www.ecoshape.org) and the Engineering with Nature (EwN)® initiative in the United States (Bridges et al., 2014. www.engineeringwithnature.org) are implementing these practices across a wide range of water infrastructure projects. The opportunity and need to more directly incorporate nature into our infrastructure development process can be viewed at two different levels: the scale of the system the project is part of and the means of constructing and operating the project. Our infrastructure projects are part of a system (e.g. an ecosystem), and the projects will both affect and be affected by the processes operating within that system. The more we are able to take these processes into account over the full life-cycle of the project, the more sustainable the project can be. The more we use construction and operational methods, including dredging, that intentionally incorporate natural processes and materials, the more sustainable the project can be.

The new nature–based design philosophies draw attention to the opportunity and need to enhance natural capital, over the short and long term. As the concepts, techniques and tools supporting ecosystem services are implemented as a part of infrastructure practice, we will be able to communicate about sustainability more effectively within our project teams and with the broader community of stakeholders interested in our projects.

Taking the long view
Water infrastructure projects, due to the amount of investment they require, are long-term propositions. While the state of scientific and engineering practice continues to advance, there will continue to be uncertainties regarding the behaviour of natural and engineered systems over the long-term. Nevertheless, pursuit of sustainable infrastructure requires taking a broad and long-term view of a project’s life cycle. Taking this broad, system view is necessary in order to determine whether the project can be expected to be sustainable over the long term, i.e. that the total value of the project over the three pillars of sustainability is judged to be sufficient in relation to the investment required to create that value. Performing such sustainability analyses could mean that some proposed projects will not be built, or that existing...
projects will be decommissioned and abandoned in favour of more sustainable projects. Some ports or waterways, for example, which cannot be efficiently sustained over time due to the effects of physical processes, coastal conditions, sedimentation, environmental impacts, etc., would receive reduced levels of investment in favour of ports and waterways situated in a more sustainable condition. When investment decisions are being made on the basis of the overall sustainability of the project, then we will know that the concept of sustainability has been successfully incorporated into the governance of infrastructure systems.

Three guiding principles of dredging for sustainability

Principle 1
Comprehensive consideration and analysis of the social, environmental and economic costs and benefits of a project is used to guide the development of sustainable infrastructure – Dredging is but one component of an infrastructure project, and any one piece of infrastructure functions as a part of a larger network of infrastructure as well as the surrounding ecosystem. Therefore, understanding the full set of costs and benefits of a project requires taking a system-scale view of infrastructure and the functions and services that infrastructure provides.

The costs (in the broad sense) of a project include all the resources, material, and negative impacts associated with executing the project and/or producing and operating the system over time. Likewise, the benefits generated would include all the values, services, and positive outputs generated by the project and/or system over time. Defined in this way, costs and benefits will include both monetisable and non-monetisable quantities.

While traditional economic analysis can be used to develop an understanding of the more readily monetised costs and benefits, for other values within the social or environmental domains different methods should be used to develop credible evidence about costs and benefits. Finally, one of the key opportunities for increasing the overall sustainability of water infrastructure is to seek opportunities to increase the total value of projects by identifying and developing benefits across all three of the pillars of sustainability.

Principle 2
Commitments to process improvement and innovation are used to conserve resources, maximise efficiency, increase productivity, and extend the useful lifespan of assets and infrastructure – Innovations in technology, engineering, and operational practice provide opportunities to reduce fuel and energy requirements related to dredging and the operation of infrastructure. These same innovations can provide the means to reduce emissions (including greenhouse gases and other constituents) and conserve water and other resources.

By reducing the consumptive use of resources associated with dredging and infrastructure the sustainability of projects is enhanced. In addition, using better technologies or improvements in operational practice in order to extend the useful lifespan and functional performance of an asset (e.g. a navigation
Stakeholder engagement can produce opportunities to increase the overall value of a project.

Such engagement will provide important information about the values of interest to stakeholders and how those values can be generated by the project, in respect to the three pillars of sustainability. Furthermore, early engagement can help identify project partners who are interested in making contributions or investments toward particular values the project could produce (e.g. partnering with an NGO to perform ecosystem restoration as a part of the project). Pursued in this manner, stakeholder engagement can produce opportunities to increase the overall value of a project and to diversify the benefits produced across all three pillars of sustainability. This approach to stakeholder engagement is different to the historical use, which has been more focused on reducing conflicts over project costs, which in the context of this discussion includes the negative impacts associated with a project (whether social, environmental or economic). For example, stakeholder engagement has been used as a means to proactively engage environmental interests concerned about port infrastructure, flood protection and dredging in order to minimise the risk of project delays and litigation. The information and knowledge that is produced through active and robust stakeholder engagement provides a basis for increasing the overall sustainability of the project.

When the information leads to actions that increase overall project value, sustainability is enhanced. When these actions lead to reducing total project costs (including all monetary costs and non-monetary impacts), while producing the same level of benefit, the result is a more sustainable project and system. Likewise, actions that increase project value (in terms of social, environmental, and economic benefits) for the same (or lower) costs result in a more sustainable project.

Traditionally, dredging projects have been focused on a narrow set of functions and outcomes (e.g. land reclamation, port basins and channels, coastal development, flood protection, pipeline trenches). A design was made and the effects on the environment and other functions were assessed, where possible mitigated, and, if needed, compensated. Stakeholders entered the project process...
late, during the permitting stage, where they were informed about the design, with limited opportunity to influence the design. This approach has frequently led to conflicts, project delays and frustration, for the developer as well as stakeholders. Increasingly now, more and more projects are developed in a manner that is more inclusive of stakeholder perspectives. At first, the focus on stakeholders was driven by aims to reduce the risk of project delays and lengthy procedural conflicts, but more recently this approach has evolved to include the mind-set of co-creation. In this mode of stakeholder engagement, values are created not only with regard to the primary motivation for the project (e.g. a particular set of economic outputs), but also to address stakeholder interests and values. This approach leads to value-added design and innovation, which will produce projects that are beneficial in regard to people, planet and profit (Elkington, 1997).

The practical contribution of dredging companies

Environmental impacts can have consequences that affect other marine users. The livelihood of local fishing communities may be affected by decreased fish stocks due to prolonged turbidity or deterioration of their fishing grounds. Coastal communities may be deprived from inhabitable land, cultural sites and natural wealth due to erosion or salinisation. Addressing these impacts is a requirement for project permits in many countries. Below are examples of dealing with these impacts.

**Quantity of sand extracted**

Between 1990 and 2023, dredged sediments were placed onto intertidal habitat to achieve both habitat restoration and coastal protection objectives at Horsey Island on the eastern coast of England. Sand and silt from capital and maintenance dredging at the nearby ports of Harwich and Felixstowe was used to create a mix of habitats including mudflats, marsh and a shingle spit to be used by nesting birds. The project has demonstrated that the environmental benefits can persist over decades. More case studies were collected by the CEDA Working Group on the Beneficial Use of Sediments.

**Loss or degradation of marine habitats inside the dredging zone**

For the extension Maasvlakte 2 of the Port of Rotterdam, 220 mln m³ of sand was Extracted between 2009 and 2013. The maximum extraction depth was 20 m below seabed, which is tenfold of the traditional limit. This reduced the directly impacted area from 110 km² to 11 km². Two sandbars mimicking natural sand waves were left behind after extraction to increase habitat heterogeneity. This is one of the optimisations researched in OR ELSE (recommendations for Ecosystem-based large-scale sand extraction) a consortium of 21 partners funded by the Dutch NWO programme.

**Nature-inspired design**

In Atafalaya River (USA), Dredged sediment is placed in the middle of the river, just upstream a natural shoal, and contributes to the formation of an island. In 10 years, a 35 hectare island was created that hosts a rich wildlife habitat with access for recreation and a better aligned navigation channel. Also prohibiting sand extraction in vulnerable habitats, has an inevitable impact on the livelihood of local communities. Even if these activities are illegal, they provide the means for survival of many of the local population. Any change in regulation to protect the environment should therefore be accompanied by measures to provide local employment.

**FIGURE 9**

Atafalaya River (USA).
These stakeholder impacts can be mitigated with the right regulations and ESIA procedure in place. In most projects, these regulations and procedures are beyond the scope and responsibility of contractors, but they can exercise due diligence and leverage and assist project owners with that responsibility.

A dredging project is short-lived and requires large deployment of human resources and equipment, often in little-developed areas. Yet it contributes significantly to the local economy in the form of:

- salaries for local workforce;
- local expenses (office, housing, transport, catering);
- local purchases and subcontracts (fuel, civil construction, fabrication, equipment rental); and
- tax revenues (import duties, royalties, withholding tax, corporate tax, personal income tax on salaries).

The local content in the project budget can be improved by different incentives:

- onboarding and awareness training of local workforce with focus on health and safety, environmental care, diversity, equality and respect;
- training of local workforce when gaps are identified between required and available skills;
- selection and training of local suppliers based on labour and human rights, biodiversity, emissions, waste management and business ethics;
- advertisement of supply opportunities in local media;
- unbundling of contracts into units that are tailored to the local market; and
- engagement in local community projects.

Examples of these contributions are:

**Stakeholder engagement**

Port Philip channel deepening project, Melbourne, that involved the removal of 23 mln m³ of sediment of which 3 mln m³ was contaminated, was met with strong and continued opposition. The client and contractor formed an alliance contract to share responsibilities and risks, and also the communication effort, leading to successful completion of the project. Stakeholder acceptance of the project was a result of the accurate and transparent public communications which included public consultations, public hearings, a dedicated website, a 24-hour toll-free telephone number, weekly press conferences, media releases, mailing lists, signage around the bay and notices to mariners. A vessel tracking system and online video data was used to prove that the operations proceeded in accordance with the environmental management plan.

**Rebuilding villages after a flood**

Around 70,000 people suffered from coastal flooding and erosion hazards in Demak, Indonesia and entire villages have been swallowed by the sea. Many people have experienced a major loss in income, reaching up to 60–80% in some villages. Also, the agri- and aquaculture sectors which are key economic engines in Indonesia have suffered multi-billion
Continuing with responsible dredging projects is key to sustainable development.

dollar losses. A project was launched to support the villagers through Building with Nature. The strategy for the area was to restore the sediment balance and through that, the mangrove habitat by constructing permeable brushwood dams, in the near future, these dams will be overgrown by the mangrove forest. The results of the current BwN activities in the Demak district are encouraging. Sediments are indeed being trapped, restoring the coastal sediment balance and the mangrove habitat locally. The first mangrove seedlings have naturally established.

Sustainability for dredging practice: From philosophy to action
Dredging is connected to several SDGs, such as those related to navigation, coastal protection, and flood risk management. The dredging industry is increasingly recognising the need to incorporate these goals into the infrastructure development process and communicate how projects align with the SDGs.

Climate change continues, energy transition is a fact, the growing world population calls for more sustainable cities and the need for food will increase. The demand for dredging will only increase, therefore, continuing with responsible dredging projects is key to sustainable development. The industry will continue to advocate for sustainability and promote dredging for sustainable infrastructure along with conducting more research on the topic to better projects that truly contribute the UN Sustainable Development Goals.

Summary
A dredge is a tool, an increasingly important tool for creating and sustaining value produced by water infrastructure. This article establishes the principles for integrating dredging in sustainable development. It outlines the philosophies and concepts of sustainability, and their application to water infrastructure projects focusing on practical issues for dredging.

References


On 5 September 2023, IADC published a paper by the same name in response to a 2022 United Nations Environmental Program (UNEP) report “Sand and sustainability: 10 strategic recommendations to avert a crisis”. In this report, UNEP calls for actions to set the global sand agenda in addressing environmental needs alongside justice, equity, technical, economic and political considerations. IADC’s paper highlights the dredging industry’s best practices for optimal use of scarce sand resources. This article is a condensed version of that paper.

“Sand, gravel, crushed stone and aggregates (hereinafter sand resources) are the second most exploited natural resource in the world after water, and their use has tripled in the last two decades to reach an estimated 40-50 billion metric tonnes per year, driven by factors such as urbanisation, population growth, economic growth, and climate change.

Sand is the key raw material in concrete, asphalt and glass that built our infrastructure. It is also used for land reclamation as well as flood protection in coastal areas, part of the efforts to protect eroding coasts and address climate change impacts such as sea-level rise and increasingly severe storms. Satisfying a growing sand demand without transgressing planetary boundaries represents an important and insufficiently recognised sustainability frontier.” (UNEP, 2022)

Global sand consumption
For hundreds of years, dredging activities have shaped the interface between land and water to support a variety of human activities including navigation, coastal
protection, flood risk management, as well as residential, tourist, commercial, agricultural and industrial activities. The use of dredging to achieve these purposes has always been guided by an understanding of the costs and benefits (CEDA/IADC, 2018).

The increasing tension between human development and planetary resilience urges us to rethink the way we work and live. The dredging sector is no exception. It uses sand as a building block to create infrastructure projects for social and economic development. At the same time, the increasing quantities extracted and its impacts on environment and society raise concerns.

The dredging industry has an important part to play in addressing these concerns. Operating globally, dredging contractors are working within a wide variety of physical, environmental, social, and legal conditions. Their first-hand experience can serve as a guide to formulate recommendations for responsible use of sand resources.

The dredging industry has measures at its disposal on both project and operational levels. On a project level, impacts can be reduced before the construction starts, with nature-inclusive designs, alternative materials and by using sand in such a way that it contributes to a more sustainable world. Other impacts can be reduced during the implementation of the project – on an operational level – by adapting working procedures and technology and applying mitigation measures.

Nonetheless, global sand consumption is the sum of the activities of many local parties, each having their own motives and drivers. There are no dominant players (Holms, 2023). The dredging industry is keen to turn this issue around but cannot do it in isolation. It is the shared responsibility of suppliers, contractors, project designers, project owners and authorities.

Societal concerns about sand consumption
Dredging projects are usually part of larger-scale socio-economic development schemes that impact a significant portion of society. It is therefore not surprising that societal concerns about sand consumption have been raised in several recent publications and that the issue has been thoroughly studied by international institutions such as the United Nations Environmental Programme Finance Initiative (UNEP FI) and working groups, such as the joint Group of Experts on the Scientific Aspects of Marine Environmental Protection (GESAMP) and the International Council for Exploration of the Sea (ICES). In the following paragraphs these concerns are thematically summarised.

Environmental concerns
When sand is extracted from active riverine and marine ecosystems, the activities can disturb both local and regional systemic functions and underlying chemical, biological, ecological, hydrological, hydrodynamic and morphological processes.

Local effects include the removal of habitats and marine organisms, and the introduction of abnormal stress levels. Suspended sediments may result in smothering benthic species and disturbing fish that rely on visual cues for predation.

Regional effects include changes in current and wave patterns, sediment transport and soil permeability that can lead to coastal and river erosion, salinisation of coastal aquifers and groundwater reserves, shrinking deltas, threats to freshwater, fish stocks, biodiversity, land-use changes and air pollution.

The impact of the activities and therefore the concerns about them vary depending on location, affected ecosystems and stakeholders. Finding consensus about the conditions under which sand extraction can be allowed and about the measures to accompany the activities is always a delicate balance that requires thorough understanding of natural processes and the ecosystem services provided by both the project and environment. These are the prerequisites of an effective Environmental and Social Impact Assessment (ESIA).

Socio-political concerns
The degree to which sand mining is regulated exhibits a huge range across the globe. Many countries have strict regulations for sand extraction, and this creates a fair and level economic playing field.

At the other end of the spectrum, reports indicate that sand extraction is undertaken illegally in both riverine and coastal areas in some 70 countries (Peduzzi, 2014). Such illegal markets are often controlled through coercion and violence, with disregard for property rights, liveable wages, safe working conditions and health risks (Brown, 2019).

Bringing practices in line with regulations will contribute to more environmentally sustainable supply chains but can also disturb the local social balances. Interference in existing informal markets without accompanying social measures may lead to loss of income, disruption
Socio-economic concerns

The increasing demand for sand is driven by the growth of the global population, welfare and the associated need for housing, transport infrastructure and climate adaptation measures. In areas where sand is scarce and extraction is unregulated, inequalities and shortcomings in decent work standards may be exacerbated by this growth trajectory. Stark levels of inequality can be found when looking at the distribution of benefits (e.g. jobs, revenues) and environmental, social, and economic impacts resulting from these developments (Lamb, 2019). Large discrepancies along the value chain may occur, leaving those dependent on the industry and natural resources impoverished, without improved social and economic advantages (WWF, 2021; John, 2021).

Environmental effects, such as changing hydrodynamic conditions, may affect a variety of other ecosystem services and thus negatively impact livelihoods that people in affected communities depend upon, such as fishermen, sea farers and farmers (WWF, 2021; Aliu, 2022). These aspects are all part of an effective Environmental and Social Impact Assessment (ESIA).

Project level approaches to responsible dredging

To make optimal use of scarce sand resources, interventions are required before the operational phase. It is during project preparation that the required quantities and qualities of sand are determined and the ecosystem functions are incorporated into the project scope. Decreasing negative impacts and increasing positive contributions can be done with different strategies in every stage of the project.

Quantity of sand extracted

Sand deposits that are accessible and eligible for extraction are considered to be finite, non-renewable resources. Even though sand is formed continuously by weathering and erosion processes of rock and accumulation of inorganic remains of marine organisms, only a fraction is readily accessible (Padmadal, 2014).

The issue of depleting sand resources is not visible to the same extent in every region. For developed countries that have a large infrastructure budget but limited sand deposits such as Singapore, Florida and Israel, the issue is pressing. It is even more pressing for developing countries where the lack of sand deposits lead to uncontrolled excavation and destruction of crucial ecosystems. This, for example, is the case at Cabo Verde’s beaches (Vieira, 2021). These countries are faced with rising aggregate prices, which push them towards illegal and environmentally detrimental practices. Transitioning towards reduced sand consumption by promoting alternative materials, construction techniques and infrastructure concepts is a very challenging task.

Other countries, such as the Netherlands, Germany and India have seemingly infinite quantities of sand available for centuries to come, despite the large quantities consumed. For developed countries that can afford the significant costs, international transport from countries with abundant resources can be a solution, but it is not an option for many developing countries. Moreover, countries that are geologically blessed with large sand deposits are more and more inclined to keep this strategic resource for their own future generations.

While the focus of this paper is on the impact of sand extraction, infrastructure projects require other primary materials such as gravel, rock and cement. It is important to note that the availability, sourcing and/or impact of using these materials deserve equal attention. In some cases, a design that uses more sand and less concrete or rock may therefore be a more sustainable option.

The quantity of sand extracted from marine resources can be reduced by using alternative sources, such as sediments extracted during capital and maintenance dredging works (CEDA, 2019). Prerequisite is that the quality of the material – that can be mud, clay, silt sand, or rock – fits its potential use, that a suitable recipient is nearby and that the time schedule of the two projects fit (USEPA/USACE, 2007; PIANC, 2009).
In an ideal scenario, there are recharge plans in place (with required consent) for vulnerable and suitable sites so that sediments of all types can be used effectively and quickly when they are available [ABPmer 2016]. Although other alternative materials are available, such as crushed rock, quarry dust, fly-ash and metal slag, they do not play a significant role as a sand alternative.

**Example**
Between 1990 and 2023, dredged sediments were placed onto intertidal habitat to achieve both habitat restoration and coastal protection objectives at Horsey Island on the eastern coast of England. Sand and silt from capital and maintenance dredging at the nearby ports of Harwich and Felixstowe were used to create a mix of habitats including mudflats, marsh and a shingle spit to be used by nesting birds. The project has demonstrated that the environmental benefits can persist over decades [USEPA/USACE, 2007]. Case studies such as this one were collected by the CEDA Working Group on the Beneficial Use of Sediments (CEDA, 2023).

**Local effects of sand extraction**
When sand is extracted from marine deposits, sediment layers are removed that have different ecosystem functions, such as hosting nutrients and benthic fauna and flora in the top layer. Exposing older geological strata with different composition alters living conditions. The most poignant manifestations of habitat destruction are found in countries lacking sand resources. This deficiency combined with a high demand for aggregates often leads to destruction of vulnerable ecosystems and illegal economies.

Dredging in or near sensitive sites with high natural or cultural value is only feasible with extensive monitoring, adherence to strict limits and adequate supervision. These sites can be protected by defining marine conservation areas, setting up a marine spatial plan and enforcing compliance. This is applicable to areas with living coral reefs, coastal wetlands and other habitats with high biodiversity or endangered species and similarly to sites with historical or cultural importance, including indigenous values.

Habitat and biodiversity losses are best tackled in the conception and design phase of a project. In this early project phase, abundance and biodiversity can be inventoried. With this knowledge, the sand extraction zone with the lowest impact can be selected and mitigation, compensation and restoration measures can be included in the project scope. Loss of substrate or alteration of seabed composition can be transformed into the creation of a habitat that is regionally in decline, rare or specifically targeted for valuable or endangered species.

When an area is approved for sand extraction, authorities monitor dredging activities in order to ensure that extraction remains within the boundaries of the licenced area. In many countries, the representative on board of the dredger has been replaced by a black box computer system that is installed before the vessel arrives on site. The system transmits the drag head’s location and production data in real time without the interference of the crew or computer systems on board. Due care has to be taken that vessels do not inadvertently carry species that are considered invasive exotics at its destination. For this reason, international and local regulations may require cleaning of hull, water intakes and ballast tanks before the start of a voyage. Such regulations also apply to dredging vessels.

**Regional effects of sand extraction**
Extraction of sediments results in a local depression of the seabed. This changes local bottom friction and may have an impact on local hydrodynamics. Currents and waves may be less attenuated on their way to the coast when the seabed is deepened. Waves encountering a depression in the seabed at specific angles may refract or reflect in a different direction and hit previously sheltered coastlines.

In rivers and deltas, the tidal flow is in dynamic equilibrium with bottom level, shape and roughness. When sand is extracted from these systems, the equilibrium is disturbed and this may lead to increased tidal amplitude (flood risk) and increased flow (change of habitat conditions). When impermeable layers are removed, salt water may infiltrate into nearby coastal areas.

All these issues can be identified through modelling during the planning and permitting
phase of a project. Modelling of coastal zones outside the dredging area is however not a standard requirement for a dredging permit. A marine special plan may define exclusion zones for dredging in highly dynamic zones such as reefs, sandbanks, river beds, beaches and beach foreshores.

Example
Since 2021, the extraction depth limit of 5 metres in the Belgian Continental Shelf was replaced by a limit based on scientific principles. The limit ensures the preservation of the surface sediment characteristics, the structure of the sandbanks, a maximum use of sand from mobile structures and limited impact on hydrodynamic conditions. The implementation of this new reference level led to a reduction of less than 2% of available quantity, while the extraction area was reduced by 25%, excluding the ecologically most valuable areas (Degrendele, 2021).

Regulations and due diligence
Restricting sand extraction to responsible practices inevitably comes down to regulation and enforcement, which can be carried out in several ways. Next to local, national and regional legislation, financial institutions can be held accountable for the impact of the projects they are funding (e.g., by the IFC performance standards (IFC, 2012)). Project owners can reward contractors for their efforts with a competitive advantage. Prequalification criteria can include company-level compliance with requisite minimum environmental and labour standards.

The management of sand resources is necessarily a task of the competent authority. Income from sand concessions can be used for monitoring, assessing the quantity and quality of the resource and drafting a responsible sand resource strategy and marine spatial plan.

Still, the contribution of the dredging industry to a safe and healthy work environment for its employees and its supply chain is essential. Responsible companies promote a safety culture in company-wide programs, organise mandatory courses for their employees, which enable them to recognise signs of modern slavery and conduct due diligence on subcontractors and suppliers. These initiatives are recorded in a register that can be consulted by clients during their due diligence.

Example
The Safety Culture Ladder (SCL) is a certified assessment method for measuring safety awareness and conscious safe and healthy acting in companies, with an emphasis on safety culture. The higher the safety awareness, the higher the assigned ladder step. Steps range from ignorance about safety to full integration of safety in the business processes. Since 2022, the SCL is mandatory for project owners that have undersigned the Dutch construction governance code (Van de Minkelis, 2022).

Stakeholder engagement
Stakeholders can be defined as “any” group or individual who can actively affect or be affected by the project development (Freeman, 1984). As such, stakeholders can be anything from individuals affected by a project through to large-scale NGOs whose organisational goals are related to aspects of the project.

Connecting with all relevant stakeholders and partners as part of any project planning and design is key to unlocking positive potentials.
Through systematic and equitable involvement across partners and stakeholders, a comprehensive system perspective can be derived, and local voices equitably heard. Infrastructure projects operate across the boundaries of physical, ecological, and socio-economic domains. A multitude of interests and backgrounds are involved in the successful development of such projects. Thoughtful management of these interests – as well as combining them in a specific design – contributes to project success (Biernaux, 2021). Effective incorporation of interests can only be achieved by careful engagement of stakeholders. Key for the organiser is to be attentive to the incitement of the public by project opponents with misinformation and covered funding.

There are several ways to engage stakeholders in a project:

- **Public consultation as part of an ESIA process** helps to identify societal concerns and impacts on local communities.
- **Citizen participation in project capital** incorporates the stakeholder’s agenda into the project objectives.
- **Design process based on co-creation** where working group sessions of stakeholders decide on focus and phasing of the project within the physical and economic boundaries set by the project team.
- **Real-time access to a monitoring platform** related to the dredger’s activity and environmental parameters.
- **Periodic newsletters and grievance procedures.**

**Example**
Port Philip channel deepening project, Melbourne, Australia, that involved the removal of 23 million m³ of sediment of which 3 million m³ was contaminated, was met with strong and continued opposition. The client and contractor formed an alliance contract to share responsibilities and risks, as well as communication efforts. Stakeholder acceptance of the project was a result of the accurate and transparent public communications, which included public consultations, public hearings, a dedicated website, a 24-hour toll-free telephone number, weekly press conferences, media releases, mailing lists, signage around the bay and notices to mariners. A vessel tracking system and online video data was used to prove that the operations proceeded in accordance with the environmental management plan. These joint efforts led to successful completion of the project (Biernaux, 2021).

**Nature-inspired design**
An infrastructure project is part of a system. It affects and is affected by the processes operating within that system. The concept of ecosystem services supports this very notion. Ecosystem services are benefits that humans derive from nature. Ecosystems generate human welfare because they produce goods and services that humans can use directly or indirectly (through the use of other goods or services). Examples of indirect forms of use are “nutrient recycling” and “fish nurseries”, which result in “clean water” and “fish production”, respectively (Reed, 2005; TEEB, 2010).

The more ecosystem processes are taken into account over the full life-cycle of a project and the more natural processes and materials are incorporated into the project, the more sustainable a project can be. These practices are commonly referred to as Nature-inspired Design (NID) or Nature-based Solutions (NbS). In practical terms, the sustainability of an infrastructure project is increased by:

1. Increasing the overall value of the project by increasing the range of services it provides;
2. Reducing costs associated with the project, where costs include all monetary and non-monetary (e.g., environmental impacts) costs and resources consumed by the activity; and
3. Balancing the distribution of the value and costs among the social, environmental, and economic domains over time.

For more than a decade the dredging industry has invested in nature-based solutions and has developed multiple initiatives such as

Example
In the Atafalaya River (Louisiana, USA), dredged sediment was placed in the middle of the river, just upstream of a natural shoal, and contributed to the formation of an island. In 10 years’ time, a 35 hectare island was created that hosts a rich wildlife habitat with access for recreation and a better aligned navigation channel (Suedal, 2015).

Adaptive management
Alternative building methods and concepts add risks and uncertainties on top of difficult-to-predict natural processes, climate change and the effects on environmental and socio-economic receptors. Adaptive management addresses these uncertainties by incorporating flexibility and robustness, and allowing decision-making based on continuous data/information that is acquired during the project.

In the early stages of the project, project goals on environmental, social and economic levels are defined. The preferred strategy is then selected and implemented based on an inventory of alternatives.

As the project proceeds, goals are translated into warning indicators that are monitored and evaluated continuously. These indicators are the basis of adjustments in design, construction, maintenance and monitoring.

Example
During the dredging works at Teluk Rubiah in Lumut, Malaysia, continuous water quality monitoring was combined with hindcast plume modelling to safeguard the nearby sensitive receptors. Based on the forecast, the dredging schedule was adapted, resulting in a zero exceedance of trigger levels and ahead-of-schedule completion of the project. The setup also allowed the contractor to avoid the necessity of 14 km silt screen (Savioli, 2013).

Early Contractor Involvement
The involvement of contractors and specialist suppliers is from time to time solicited by project owners prior to setting construction phase contracts. Contractors have expertise on construction methods, the availability of equipment and alternative materials, the implications of design for the ease and safety of construction, the resilience and sustainability of the constructed works.

FIGURE 7A/B/C
Atafalaya River (USA).
and the cost and time required to provide the designed works (PIANC, 2022). Early Contractor Involvement (ECI) is a tool to introduce sustainable project approaches such as the beneficial use of sediments. While ECI has many benefits, prior knowledge and equal treatment of tenderers is a concern that needs to be addressed.

**Procurement process**

The procurement process is decisive for prioritizing within different objectives and risks associated with infrastructure projects and natural processes (CEDA, 2019b). It can therefore contribute to more sustainable practices.

A wide variety of procurement principles are used:

- **Prequalification:** a first selection of candidates based on setting minimum standards for safety, financial stability, experience and competences.
- **Competitive dialogue during tender:** meetings are organised between the client and tenderers where concepts and strategies can be checked and adjusted.
- **Design and build:** the contractors, using their experience and capabilities, can optimise the project design reconciling the project objectives.
- **Risk allocation:** stakeholder communication, complaint handling and nuisance mitigation can be allocated to the contractor scope.
- **Qualitative, non-monetary award criteria:** these criteria value proposals that benefit nature and society, and mitigate risks and impacts.

These requirements are demanding and sometimes at odds with the competitive character of the tender process. Strict requirements can lead to exclusion of a number of smaller, local contractors that cannot comply, which can result in the disturbance of the local market. Additional requirements should therefore be accompanied by incentives for local contractors to upgrade their equipment and working methods.

**Example**

Most Economically Advantageous Tender (MEAT) (Alhola, 2012) and Best Value Procurement (BVP) (Storteboom, 2017) are two tender systems where price is only part of a valuation system that also includes safety initiatives, risk management, stakeholder engagement, innovation, emissions, etc.

**Socio-economic contribution**

Environmental impacts can have consequences that affect other marine users. The livelihood of local fishing communities may be affected by decreased fish stocks caused by prolonged turbidity or deterioration of their fishing grounds. Coastal communities may be deprived of inhabitable land, cultural sites and natural wealth as a result of erosion or salinization. Addressing these impacts is a requirement for project permits in many countries. This is usually done under “Areas of Operations” in an ESIA.

However, prohibiting sand extraction in vulnerable habitats also has an inevitable impact on the livelihood of local communities. Even if some of these activities may be illegal, they provide the means of survival for many communities. Any change in regulations to protect the environment should therefore be accompanied by measures to provide alternative local employment.

These stakeholder impacts can be identified and mitigated with appropriate regulations and ESIA procedures in place. Although in most projects, these regulations and procedures are beyond the contractor’s scope and responsibility, contractors can exercise due diligence and apply leverage and assist project owners with that responsibility.

A dredging project is short-lived and requires large deployment of human resources and equipment, often in little-developed areas. Yet it has the potential to contribute significantly to the local economy in the form of:

- salaries for the local workforce;
- local expenses (office, housing, transport, catering);
- local purchases and subcontracts (fuel, civil construction, fabrication, equipment rental); and
- tax revenues (import duties, royalties, withholding tax, corporate tax, personal income tax on salaries).

The local content in the project budget can be improved by different incentives:

- Onboarding and awareness training of local workforce with a focus on health and safety, environmental care, diversity, equality and respect.
- Training of local workforce when gaps are identified between required and available skills.
- Selection and training of local suppliers based on labour and human rights, biodiversity, emissions, waste management and business ethics.
- Advertisement of supply opportunities in local media.
- Unbundling of contracts into units that are tailored to the local market.
- Engagement in local community projects.

**Innovation and contribution**

Knowledge and best practices to increase sustainability in dredging projects are not written in stone. They develop with changing conditions, with learning by doing, with scientific knowledge and with public focus. Knowledge and best practices require a strategy to develop and to disseminate them to the stakeholders.

**Development strategy**

Many countries and regions have research and innovation funds to encourage scientific institutions and industry to develop new goods and services with the aim to increase competitive advantage and employment. Research and innovation funds can be a tool for authorities to:

- stimulate co-operation between local players in order to create sector-specific communities and local supply chains;
- stimulate the inclusion of small and medium-sized enterprises as they seldom have the means to innovate on their own;
- create programmes where industry, scientific institutions and authorities work
together to ensure that the solution is endorsed by everyone;
• develop performance metrics; and
• facilitate demonstration projects with tangible results that are accessible to potential clients.

Dissemination strategy

The task of dissemination is shared by industry, sector organisations and scientific institutions. The target is to:

• inform all workforce about new developments. Innovation is usually in the hands of a small group that is not necessarily linked to the operational division of the company;
• educate students in order to create a workforce knowledgeable about the potential, the challenges and limits of existing and developing solutions; and
• inform stakeholders, clients and licensing authorities about the pros and cons of existing and alternative solutions.

There is a wide variety of information channels depending on the target public: newsflashes, reports, courses, seminars, publications, websites, Wikipedia pages and data platforms.

Example

A maritime consortium is conducting research funded by the Dutch government into methanol as an energy step towards zero-emission shipping (MENENS). The consortium, which includes ship owners, shipyards, suppliers of specialist maritime equipment and knowledge institutions, retrofits six different vessel types to test the viability of methanol fuel systems. The programme builds on earlier feasibility studies like the Green Maritime Methanol Consortium. The dredging industry is keen to be part of this research, because it has specific needs that differentiate them from the rest of the shipping industry, such as a volatile load-curve and operations close to populated areas (Veldhuis, 2022).

Conclusions

This article responds to UNEP’s call (UNEP, 2022) to contribute with best practices and presents a wide range of initiatives the dredging industry has taken to counteract concerns and impacts related to sand extraction and reclamation. These contributions include initiatives on both project and operational levels.

Key takeaways are:

• Performing and adhering to an Environmental and Social Impact Assessment are key to finding consensus about conditions and requirements for sand extraction.
• Impact mitigation and nature-inspired design start with monitoring and understanding the physical and ecological processes involved.
• Dredging in or near sensitive sites with high natural or cultural value is only feasible with extensive monitoring, adherence to strict limits and adequate supervision.
• Beneficial use of dredged sediment from capital and maintenance dredging projects is an alternative to sand extraction.
• Stakeholder engagement addresses concerns and unlocks potentials.
• Adaptive management counters risks and uncertainties associated with dredging projects.
• Appropriate procurement processes are able to prioritise project objectives.
• Large marine infrastructure projects entail opportunities to involve the local socio-economic community.
• Incentives for investment in innovation, safety culture and impact mitigation measures encourage improved practices.
• Transparency about activities, with publicly available monitoring data and warning triggers, helps to maintain focus on impacts and to obtain project acceptance.

The dredging industry is committed to help build a better future and continues to:

• contribute to the understanding of the ecosystems by exchanging information and know-how with knowledge institutions and scientific communities, by encouraging research and participating in joint research programmes;
• invest in innovations that increase sustainability and biodiversity, reduce accidents and impacts, and improve operational excellence;
• contribute to new and upcoming standards and regulations; and
• engage in dialogue with a wide group of stakeholders to ensure that the public’s concerns are addressed and projects benefit the entire society.

Knowledge and best practices to increase sustainability in dredging projects are not written in stone. They develop with changing conditions, with learning by doing, with scientific knowledge and with public focus.

Summary

The path towards sustainable use of sand is set out in the 10 recommendations formulated by UNEP (UNEP, 2022). Keeping pace on this path requires the combined efforts of authorities, project owners, stakeholders, project designers and industry. When all actors contribute within their field of competence and responsibility, opportunities can be seized to significantly reduce negative impacts on environment and society and to increase positive contributions.

The dredging industry has an important part to play in seizing these opportunities. Operating globally, dredging contractors are working within a wide variety of physical, environmental, social, and legal conditions. Their first-hand experience can serve as a guide to formulating recommendations for responsible use of sand resources. Every stage of a project presents opportunities to increase the sustainability of sand extraction. This article presents best practices for optimal use of scarce sand resources, on both project and operational levels.
Jan Fordeyn

Jan studied naval architecture and started working at Jan De Nul in 1994. Since 2007, he has helped develop projects around the world that fall outside the classic canon of marine construction and whose result relies on the symbiosis of different disciplines. For that purpose, he maintains close relations with experts, consultants, universities and manages innovation projects.

Tom Janssens

With an MSc in electromechanical engineering from the Ghent University in Belgium, Tom joined the DEME Group in 1993 as a project engineer. During his career, he has worked on various multi-disciplinary marine construction projects and has been involved with all aspects of rock revetment works, as well as complex environmental remediation projects for DEME’s environmental division. Since 2012, Tom is responsible for DEME Building Materials (DBM) specialised in the licensing, extraction, transport, processing certification and supply of marine aggregates for the European construction industry. In 2015, he joined the board of ZEEGRA, the Belgian federation of importers and producers of dredged sea aggregates, where he became chairman in 2021.

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Sjon Kranendonk

Sjon Kranendonk studied civil engineering and joined Van Oord in 1990 as a production engineer in the estimating and engineering department. He has worked on dredging projects all over the world, including major reclamation projects in Hong Kong and Dubai. In 2003, he became head of the production department, responsible for soil investigation and interpretation, working methods, dredger design and R&D for the dredging business unit. Since 2022, Sjon has worked as MT member in the operations department of the dredging and infrastructure business unit, responsible for the production and research for dredging projects executed by Van Oord worldwide.

Thomas Vijverberg

Thomas has a background in civil engineering with specialisation in coastal engineering/morphology (fine sediments). After his graduation, he worked for Royal HaskoningDHV as a consultant from 2008-2016 before joining Boskalis. Thomas is currently deputy manager at Hydronamic, Boskalis’ engineering department and is also responsible for the morphology, environmental and social impact team. In addition, he is one of the course leaders of the Dredging for Sustainable Infrastructure course for IADC.
SAFETY
When individual employees, teams and companies view everyday processes and situations through a continuous lens of safety, they can each contribute to making all aspects of operational processes, whether on water or land, safer. For the 2023 Safety Awards, IADC’s Safety Committee received nine submissions. Each one is assessed on five different categories: sustainability; level of impact on the industry; simplicity in use; effectiveness; and level of innovation.

Affirming the importance of safety
Dredging activities can be risky operations with hidden dangers among heavy machinery. In response, the dredging industry proactively maintains a high level of safety standards. A representative of contractors in the dredging industry, IADC encourages its own members, as well as non-members participating in the global dredging industry, to establish common standards and a high level of conduct in their worldwide operations.

IADC’s members are committed to safeguarding their employees, continuously improving to guarantee a safe and healthy work environment and reducing the number of industry accidents and incidents to zero.

Recognising advancers of safety
IADC conceived its Safety Award to encourage the development of safety skills on the job and reward individuals and companies demonstrating diligence in safety awareness in the performance of their profession. The award is a recognition of the exceptional safety performance demonstrated by a particular project, product, ship, team or employee(s).

In total, nine submissions were received. Each one aims to improve routine processes and situations encountered in the dredging industry. The winner will be announced during IADC’s Annual General Meeting in Barcelona, 13-15 September 2023.
Dredging contractor safety award submissions

**SAFETY BAR ON HYDRAULICALLY OPERATED WATERTIGHT SLIDING DOORS BY JAN DE NUL**

In accordance with Safety Of Life At Sea (SOLAS), vessels are equipped with hydraulically operated watertight sliding doors (WTSDs). To prevent persons being crushed between a moving watertight sliding door and the doorframe, Jan De Nul is installing a safety bar on the doorframe of its hydraulically operated WTSDs. The safety bar is activated by pressure and upon activation the door reopens. The system is also equipped with an alarm so the bridge is alerted when the safety bar has been activated.

The first vessel equipped with this safety feature is the Trailing Suction Hopper Dredger Sanderus, Jan De Nul’s fourth Ultra-Low Emission vessel (ULEv). By installing the safety bar, Jan De Nul is going beyond the standards set by the International Marine Organization (IMO), in that an additional safety layer is provided to protect personnel on board. The feature can be implemented on all dredging vessels with similar doors facing similar hazards.

Due to the nature of its design, the system makes the watertight door intrinsically safe without having to rely on human factors. The basic design makes it easy to install, maintain, use and prevent misuse (for example, using the safety bar to open the door instead of using the door handle).

During vessel familiarisation, crew are informed about the specific function of the safety bar and the consequences when it is activated. Additional specific familiarisation for bridge officers to deal with an alarm upon activation of the safety bar is also provided. In addition, posters and signs that include the safety bar are to be posted at every doorframe. The maintenance programme of the watertight sliding door is to be amended to include the monthly testing of the safety bar.

The installation of the safety bar also implies a deviation from the standard operating modes described in SOLAS, namely “local control” and “central close”. A third operating mode is introduced, “central close with safety bar activated”. Approval of relevant Classification Societies and Flag State to obtain an equivalence for the safety bar is required.
PEEPHOLE INSPECTION ON CSD DREDGE PUMP BY DEME

While performing dredging works on the parts of the Ok Tedi River in Papua New Guinea, DEME faced a problem: the dredge pump and booster of its Cutter Suction Dredger (CSD) kept constantly getting clogged up with large amounts of timber, tree roots and other materials. As a consequence, the pump inspection hatch had to be opened and closed up to 22 times per day, as there was no other way to check if the pump was blocked. To avoid this inconvenience, DEME team came up with a simple but efficient solution: installation of a peephole that allows effortless inspection of the pump. With this design, the crew are able to carry out an inspection of the pump with the advantage of literally being able to see “through” the pump.

Installation was pretty straightforward. The pipe was fitted with a 2-inch ball valve with an end plug or cam coupling with endcap. The peephole was placed on the inspection pipe during a maintenance day. A spare inspection pipe was equipped with the peephole too. It is important to mention that an inspection tool (a small mirror or camera) is needed for proper use of the installation. A freshwater hose must also be accessible when opening the ball valve in case some sand is present and needs to be flushed away.

The installation of the peephole has greatly improved safety working conditions for DEME’s crew. Opening the inspection hatch requires significant physical effort and heavy hammering above shoulder height, which can lead to various injuries. Those potential risks have now been reduced due to less hammering on the wingnut when opening and closing the inspection hatch and less risk of pinch points occurring while closing it. This solution has also helped minimise general physical exhaustion caused by the job and produced the knock-on effect of improved morale.

After a couple of times performing the inspection this way, the crew grew confident in the efficiency of the new approach. As a result, the peephole is now used as a standard method to inspect the pump for blockages.
BARGE MOORING SYSTEM
BY VAN OORD

Barge mooring has several high-risk moments in general, including vessel-to-vessel transfer and connecting vessels. For the execution of a turbine installation project located off the coast of New York, Van Oord had to design a barge mooring system in order to supply the turbine components to the Wind Turbine Installation Vessel (WTIV) “Aeolus”. The approach for Van Oord was to incorporate some safety sensitive topics into the development of this design. For instance, access to the barge and the connecting and disconnecting of lines are risky activities that are to be kept to a minimum but also need to be operated safely.

Van Oord opted for a method in which the feeder barge with the components moors against a jacked up WTIV. To do so, the system requires compensation for tidal, waves and barge loading conditions in order to make sure the barge remains securely moored against the Aeolus during the complete unloading of the barge in offshore conditions.

This method of fixed mooring the vessel eliminates a number of safety concerns. During the entire operation a lot of crew have to transfer to and from the barge. Due to the decision of mooring the vessel fixed to the Aeolus, this transfer can be done utilising a fixed gangway, eliminating the issue of boat-to-boat transfer. The gangway consist of a staircase tower with a conventional gangway in order to enter the barge, the gangway step over accounts for the barge motions by a simple mechanical connection.

The full entry is enclosed by railing and can therefore be considered as any normal flight of stairs. This both eliminates the need for training and improves the use of the system even for people with little offshore experience. With a stair tower and conventional gangway from the jack up to the barge, the risk of incidents is therefore reduced.

Mooring the barges is done by centralised and remotely operated winches. The mooring lines are only brought under tension when there are no personnel in the area. These winches are operated by a docking master who has full control and overview of the operation due to its elevated vantage point on board the Aeolus. In order to connect the lines, the barge remains stationary at a safe distance when the main crane of the Aeolus lifts crew and lines on board to connect to the barge. Once connected, the winches take over the control of the barge and bring her alongside after which the tugs are disconnected.

To disconnect the barge from the Aeolus, a remote system has been designed in order to reduce interaction between mooring lines and crew. This disconnection system uses hooks normally operated by tugs. These hooks have a “remote controlled quick release”, dropping the hook in order to release lines. The automated barge release system has been designed to release the barge once operations are completed without interference of people to disconnect the wires. Therefore not only increasing safety and reducing the likelihood of accidents but also reducing the operational lead time.

TERRA ET AQUA

SAFETY
SAFETY OBSERVER ROLE ON BOARD BY BOSKALIS

Boskalis has developed a learning-by-doing programme to develop safety leadership on board its trailing suction hopper dredger, Oranje. Named the NINA “Expedition”, the programme aims to raise the level of safety by each month giving the role of “safety observer” to a different crew member.

The role of the safety observer is to directly report unsafe situations/tools/equipment to the Dredge Master and/or the 2nd Mate. The idea is that they discuss the situation directly to find a solution. Other crew members can also inform the safety observer about unsafe situation and incidents. The Dredge Master and/or 2nd Mate will report any action in the monthly work order under Nina Expedition.

In addition, every week the safety observer will choose a safety toolbox from the NINA (No Injuries, No Accidents) safety toolbox and acting as the trainer, discuss the topic with the other crew members.

By making the safety observer a well-known and recognised role on board, it will help in the engagement of all crew members, regardless of rank, nationality or gender, to join the safety conversation and to be heard.

The programme has been running for over a year on board the Oranje and is proving very successful. It has created a sense of leadership among the entire crew as well as recognition and appreciation for the role by all.

USING MOBILE DAVIT TO TAKE SOIL SAMPLES FROM A HOPPER BY DEME

According to legal regulations, while performing dredging operations, soil samples from a hopper have to be taken on a regular basis, but this task certainly comes with a number of safety risks as it is carried out during the filling of the hopper. Personnel performing sample collection experience additional pressure on arms and shoulders and face the risk of falling into the hopper.

DEME has decided to eliminate potential risks by designing a mobile davit, which can be positioned in five different locations around the hopper. This lightweight davit of just 30 kg has a working load limit of 125 kg and an integrated winch. This simple appliance brings considerable benefit of performing the job efficiently, but without running risks of physical strain.

The davit is very easy to use due to being lightweight, it can even be stored in a handy travel bag. Not only is it compact, but also it is low maintenance and relatively corrosion free since it can be stored inside the vessel when not in use. The davit can be ATEX certified for zone 2 and 22.

The only installation necessary is the placement of small pedestals, which are welded onto the deck in the locations where the davit is to be used. It is definitely an easy solution that reduces potential threat of dangerous situations, near misses and possible injuries.
With a complex project involving a short offshore installation period and numerous modifications taking place on different vessels, Boskalis’ project team turned to VR technology. Early on in the project they decided to have operational models created in virtual reality (VR) of the new equipment and various locations involved. This way, safety critical operations were tested and discussed upfront during design reviews, HAZIDs and familiarisations, without the need to expose personnel to risks, such as working at height or possible delays to the project incurred during acceptance tests. The models were able to apply different weather states including daylight or actual current predictions and allowed movement as a pedestrian or operator across the models.

To reduce the exposure of personnel to new and potentially dangerous operations and environments, VR models can be created to test those in a safe setting. As in video games, the user can walk through models to check access, egress, work spaces and line of sight. This way the setup or placement of equipment can already be optimised during the planning phase. Stakeholders, including less familiar decision makers, can use VR models to better discuss operations, prevent misunderstandings and experience different scenarios at minimal cost and no operational risk.

The models (PC game or VR) integrated vessel, equipment, weather, current and location data into a total of five different safety critical environments.

Stakeholders were able to immerse themselves into the same environment to view and feel what the actual situation would be like, e.g. the installation of new equipment at a height of 22-50 metres. Traffic management and operational setup were adapted based on the observations gained while using the site model. In addition, design improvements were applied to new equipment based on user experience and line of sight simulated.

Identifying safety critical operations early on and deciding which new or complex environments might benefit from the creation of a VR model helps stakeholders to acknowledge the risks involved. Shared experiences help common understanding and promote a proactive and inclusive review of operations. In case of incidents, existing models could be used to replicate the actual scenario and support investigations.

Once created and tested, the VR environment is very easy to use and feels like a video game. This supports the engagement of the personnel in the project environment and opens up the conversation about operations in the VR model versus reality. After models were created, they were also used for auxiliary products, such as a game for a school programme and derived inputs to project videos. The model can be downloaded and played on any PC or uploaded to a VR headset for an immersive VR experience.
Van Oord’s new build trailing suction hopper dredgers Vox Ariane, Vox Apolonia and Vox Alexia are all powered by LNG. For Van Oord and for the dredging industry, LNG as a fuel is still relatively new, so it was and still is important to educate crew and the organisation on the overall design and in particular on the safety aspects and safe operations of the gas system.

Since the gas system consists of several different suppliers, no single supplier can provide a training that will cover the entire system. Therefore, a vessel specific LNG training was setup in-house to provide a comprehensive overview of the gas system, combining all aspects from different system suppliers into one. The goal, to better prepare the crew with the system specific knowledge for safe operations of the LNG fuel supply and how to conduct safe LNG bunkering operations.

The setup of a vessel specific LNG system training is meant to provide a good knowledge base for the (future) crew to operate the system and reduce the risks of safety incidents due to improper handling, unfamiliarity and/or other errors. The training is also intended to alleviate any doubt and scepticism that the crew might have towards the safety of the gas system.

For each group of new crew members joining the three vessels, the LNG training is given prior to actual operations. Training is refined to include new details and insights into practical operation of the gas system. With the LNG training already in use on all three vessels, LNG system project engineers or experienced ship crew can provide the training for new crew members. The classroom based training is followed by a walkthrough of the system along with a practice session in operating the system. In addition, the training slides are always available on board for quick reference by the crew.

After each training, the crew highlighted that they feel more comfortable and confident in operating the gas system safely. After more than one year of gas operations on the three vessels there has not been any near misses or accidents.
Boskalis has introduced new water boxes for sand fill areas, greatly improving the safety for its sand fill workers. The water boxes have been designed, calculated and constructed in such a way that the risk of implosion due to soil pressure is eliminated.

Using an adjustable platform on the outside of the water box, it is possible to remove or add planks to regulate the water level within the sand fill area. A feature that is highly appreciated by the workers as this way of working eliminates the risk of drowning and suffocation.

Durable construction can be used on different sand fill heights just by easily adding or disconnecting box sections to the bottom section. The design is basically a “plug and play” setup and can easily be transported to a work site where workers can receive instruction on how to handle the water box safely. Used in many projects around the world, this type of water box is currently being use on the Manila International Airport project.
Statistics published by the European Harbour Masters committee indicates that 95% of personal injuries are caused by ropes and wires, and 80% of them happen during mooring operations.

Performing works on board dredging vessels involves regular usage of mooring ropes, which under tension always create the risk of snap back effect. Making personnel aware of the possible risks and designating snap back zones is a standard practice, but it does not take away the risk of snap back occurrence and consequently possible injuries, while eliminating the snap back effect reduces the threat of injuries completely.

DEME has conducted market research of various available mooring ropes and considered the pros and cons of each type. As a result, it has been concluded that although mooring rope with Dyneema fibres poses no snap back risk, it has disadvantage of not having sufficient working stretch. By contrast, standard mooring rope provides acceptable stretch, but produces snap back effect when it breaks.

With the appearance of a rope, held within the heart of a 12-strand mooring line, if the outer, load-bearing construction breaks, the SBA absorbs the snap-back forces, transforming them from a potentially deadly snap to a much safer slump.

The innovative design of this mooring line combines all the desired characteristics DEME was seeking: sufficient stretch and most importantly, no risk of snap back. In addition, this type of high modulus polyethylene (HMPE) mooring line weighs 60% less than a traditional mooring rope and has lower dimensions meaning that it can not only be handled by one person, but it also requires less storage space on deck and on the winch.

The mooring rope, which has been lab tested and certified by DNV GL, not only offers major safety benefits by removing the risk of snap back effect, but also provides financial advantages. It reduces costs due to its prolonged life span (compared to the alternatives), which removes the need for frequent renewal.
UPCOMING COURSES AND CONFERENCES

Dredging and Reclamation Seminar
9-13 October 2023
Hotel Holiday Inn and Suites Makati
Manila, Philippines

About the seminar
Since 1993, the IADC has regularly held a week-long seminar developed especially for professionals in dredging-related industries. These intensive courses have been successfully presented in the Netherlands, Singapore, Dubai, Argentina, Abu Dhabi, Bahrain and Brazil. With these seminars, IADC reflects its commitment to education, encouraging young people to enter the field of dredging and improving knowledge about dredging throughout the world.

For whom
The seminar has been developed for both technical and non-technical professionals in dredging-related industries. From students and newcomers in the field of dredging to higher-level consultants, advisors at port and harbour authorities, offshore companies and other organisations that carry out dredging projects. Attendees will gain a wealth of knowledge and a better understanding of the fascinating and vital dredging industry.

In the classroom
There is no other dredging seminar that includes a workshop covering a complete tendering process from start to finish. The in-depth lectures are presented by experienced dredging professionals from IADC member companies. Their practical knowledge and professional expertise are invaluable for in the classroom-based lessons. Among the subjects covered are:

- the development of new ports and maintenance of existing ports;
- project development: from preparation to realisation;
- descriptions of types of dredging equipment;
- costing of projects;
- types of dredging projects; and
- environmental aspects of dredging.

Site visit: seeing is believing
Practical experience is priceless and it sets aside this seminar from all others. There will be a site visit to a dredging yard or a dredging project of an IADC member to allow participants to view and experience dredging equipment first-hand to gain better insights into the multi-faceted field of dredging operations.

Networking
Networking is invaluable. A dinner where participants, lecturers and other dredging employees can interact, network and discuss the real, hands-on world of dredging provides another dimension to this stimulating week.

Certificate of achievement
Each participant will receive a set of comprehensive proceedings and at the end of the week, a certificate of achievement in recognition of the completion of the coursework. Full attendance is required to attain the certificate.

For more information and how to register visit https://bit.ly/IADC-events.

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engineers, scientists, planners and decision-mak-ers for the exchange of knowledge and ideas. The event provides an excellent avenue in the dissemination of new products and solutions to challenging concerns, especially in developing countries, in ports and harbour engineering, coastal zone management, inland waterway transport, dredging and other related areas.

**IAPH World Ports Conference 2023**
31 October - 2 November 2023
Abu Dhabi, United Arab Emirates
www.worldportsconference.com/index.html

Energy transition will be one of the main themes of IAPH 2023. The annual conference will bring together leading ports, their customers and stakeholders as well as regulators in a world-class interactive event to imagine and deliver a future where ports lead in energy transition, data collaboration, reputation management and business innovation.

The three-day conference will feature a mix of panel discussions, one-to-one conversations, hands-on workshops and specialised working events to showcase unique, practical insights from business leaders who have engaged in successful and sustainable cross-industry collaboration. Its goal is to ensure that attendees from various backgrounds understand how best to create genuine trust, boost transparency and increase reliability both internally and externally.

**Dredging for Sustainable Infrastructure Course**
12-14 December 2023
Abu Dhabi, United Arab Emirates

How to achieve dredging projects that fulfil primary functional requirements, while adding value to the natural and socio-economic systems. This is just one of the questions addressed during the 2.5-day course (organised with the support of NMDC) that is based on the philosophy of the book, *Dredging for Sustainable Infrastructure*.

Experienced lecturers will describe the latest thinking and approaches, explain methodologies and techniques, and demonstrate through engaging workshops and case studies, how to implement the information in practice.

During the course, participants will learn how to implement the sustainability principles into dredging project practice, through answers to the following questions:

- What is the role of dredging in the global drive towards more sustainable development?
- How can water infrastructure be designed and implemented in a more sustainable and resilient way?
- How can the potential positive effects of infrastructure development be assessed and stimulated as well as compared with potential negative effects?
- What equipment and which sediment management options are available today?
- A brief introduction to the question, “What knowledge and tools are available to make sound choices and control a project?”

For more information and how to register visit https://bit.ly/IADC-events.
How the dredging industry contributes to our communities’ resilience, sustainability and adaptation in response to climate change.

The white paper recently published by the Western Dredging Association (WEDA) is a living document that describes the preliminary steps in WEDA’s Sustainability Initiative. In 2015, the United Nations (UN) established Sustainable Development Goals (SDGs), which WEDA has used as the organising framework for this paper. There are 17 SDGs and at first glance, one could wonder what those have to do with WEDA and its dredging and marine construction missions. Look more closely at the targets within each SDG and the connections between WEDA and the SDGs become obvious.

The call to action is a request for WEDA members to provide information and case studies on their past and present projects, policies, and actions that contribute to our communities’ resilience, sustainability and adaptation in response to climate change. To facilitate members contributing examples of their projects and activities pertaining to each of the UN SDGs, WEDA has developed a submission form, which can be found as an appendix to the paper. Through this form, members can submit their information and further WEDA’s goal to support sustainability in general and sustainable dredging specifically.

The white paper builds on earlier statements by the World Organization of Dredging Associations (WODA) in 2016 and 2022 that emphasised the need for the dredging industry to recognise and address climate change by implementing sustainable methods of operations.

Example of an SDG
Goal 3 of the UN’s SDGs is to ensure healthy lives and promote well-being for all at all ages. One of its targets (number 3.9) is by 2030 to substantially reduce the number of deaths and illnesses from hazardous chemicals and air, water and soil pollution and contamination.

A project in Rensselaer, New York to remove contaminated sediments and remediate and restore the Hudson River via dredging adjacent to the former BASF Corporation dye manufacturing plant is a good example of SDG 3, target 3.9. It demonstrates how sustainable dredging has positive impacts that can reduce environmental pollution and promote healthy lives.

The WEDA Sustainability Initiative continues
Using the UN SDGs as a framework as mentioned above, the paper goes on to ask: What are WEDA and its members doing to advance specific UN SDGs? Given those long-term goals, the follow-up question to be addressed via WEDA’s Sustainability Initiative is: What can WEDA and its members do to improve their sustainability efforts?

The exercise of developing this white paper revealed how often the dredging industry is already involved with projects that support the socio-economic and environmental goals of the UN SDGs. By adding case studies to this living document, WEDA will continue to make clear how much the dredging industry is at the forefront of innovative, sustainable development.

Authors: Burton Suedel, Jason Raimondi, Marsha Cohen and Russell Hyatt
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IADC stands for 'International Association of Dredging Companies' and is the global umbrella organisation for contractors in the private dredging industry. IADC is dedicated to promoting the skills, integrity and reliability of its members as well as the dredging industry in general. IADC has over one hundred main and associated members. Together they represent the forefront of the dredging industry.

www.iadc-dredging.com