Marine transport infrastructure development in Moreton Bay: Dredging, monitoring and future directions

Abstract

Marine infrastructure development throughout southeast Queensland is fast-paced, with the ongoing expansion of our major ports and harbours, airports and road infrastructure. Our cities and regional centres continue to expand along the Queensland coastline and into the marine environment through dredging and land reclamation. These activities are managed from an environmental protection perspective at the local, State and Commonwealth government levels. Here we examine the maintenance and capital dredging works undertaken by the Port of Brisbane Pty Ltd (PBPL), Department of Transport and Main Roads (DTMR) and Brisbane Airport Corporation (BAC), which are necessary for maintaining ports and marina infrastructure, roads and runways. A variety of methods has been adopted over the past few decades for managing potential marine environmental impacts from these dredging activities. This chapter explores the different monitoring tools implemented by the PBPL, DTMR and BAC for managing potential impacts from port and harbour maintenance, capital works programs and operational activities. We consider the regulatory environment and how this influences port and harbour works, road and airport infrastructure development within the Bay. We also explore new technology and approaches to monitoring and the areas of future research and investigation to help contribute towards a sustainable future for Moreton Bay.

Keywords: ports, dredging, transport, marine, Gold Coast, turbidity, light, seagrass.

Introduction

Early development

Regional exports of coal, rural products and manufactured goods into and out of the Brisbane River began in the mid to late 19th century. The first exports from Ipswich and Brisbane were timber from local forests, where the product was transported down river and across Moreton Bay to Dunwich on North Stradbroke Island (Fig. 1).

The development of two oil refineries at the mouth of the Brisbane River in the 1960s boosted the local economy and the first container terminal was built in the late 1960s. The Port of Brisbane was formed in the mid-1970s and the Port of Brisbane Authority Act 1976 was introduced and the first contract awarded to the Port in 1977 (1).

Air travel was first established in Brisbane in the early 1920s, when a site at Eagle Farm was chosen for development of a government aerodrome (Fig. 2). This aerodrome was used by the Royal Australian Air Force in World War II and formally established as the principal airport for Brisbane in 1947.

Figure 1. Left: Brisbane's first exports in the late 19th century. Right: Recent image of the Port of Brisbane (images from Port of Brisbane (2)).

Figure 2. Left: Eagle Farm Airfield in 1925. Right: Brisbane Airport (domestic terminal)

today (3).

A new international terminal was built in the 1990s and today Brisbane Airport Corporation Pty Ltd (BAC) owns and operates two major terminals (domestic and international) accommodating 35 airlines flying to 84 domestic and international destinations and is the third largest airport in Australia (3).

Shipping channel maintenance

The Port of Brisbane is a major source of import and export into and out of southeast Queensland. Approximately $50 billion worth of international cargo is shipped each year and 33.2 million tonnes of trade goods. The Port of Brisbane is managed and developed by the Port of Brisbane Pty Ltd (PBPL) under a 99-year lease from the Queensland Government. It is Queensland's largest multi-cargo port and the closest major container port to export markets in Asia, where more than 30 shipping lines service the Port of Brisbane (4).

To maintain its shipping channels, the Port of Brisbane Pty Ltd (PBPL) has undertaken annual maintenance dredging in and around the Port, where the dredge material is either deposited in the Fisherman Island reclamation areas, or in the Mud Island Dredge Material Disposal Area, which is a designated offshore disposal site (Fig. 3a). Dredging at the Port of Brisbane has occurred since 1862 due to siltation and sediment buildup and the need to bring in deep draft vessels.

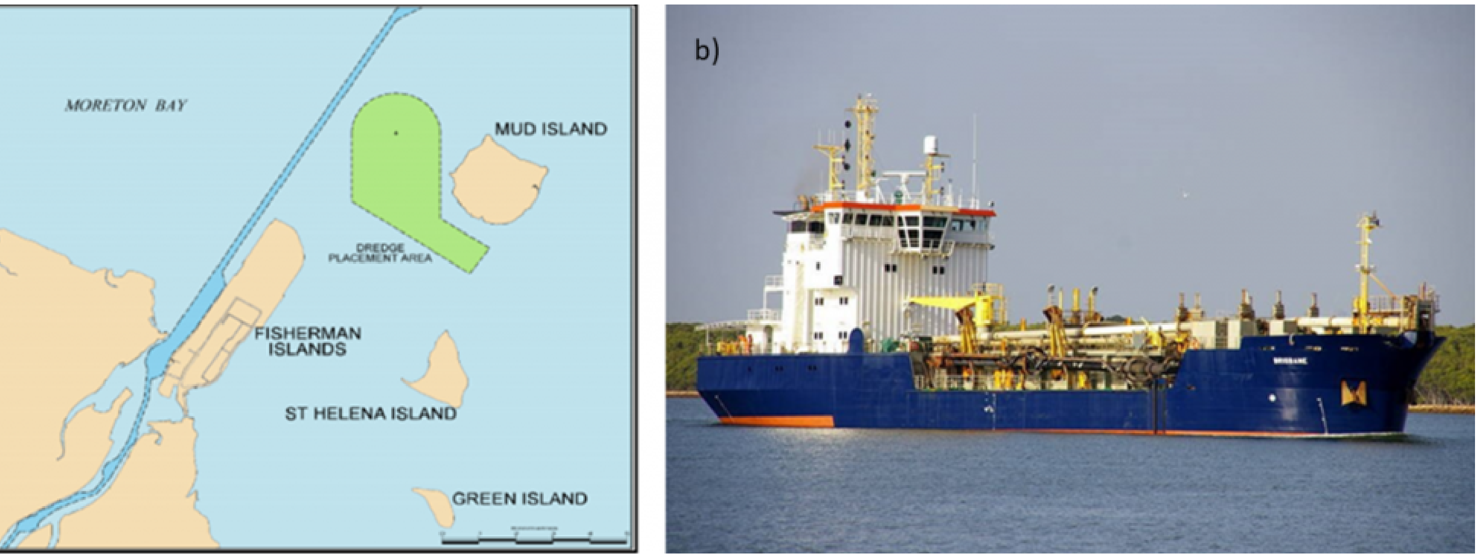

Figure 3. *a) Mud Island Dredge Material Disposal Area (5). b) Port of Brisbane Pty Ltd trailer suction hopper dredge, Brisbane (image from Dredgepoint.org).*

PBPL are responsible for maintaining the declared depth of 14 m below lowest astronomical tide level for 90 km of navigational shipping channel from Bribie Island, southwards inside Moreton Island, across Moreton Bay and into the Brisbane River as far as the Hamilton Reach. To this end, maintenance dredging is carried out between Fisherman Island and the Hamilton Reach of the Brisbane River and within the channels of Moreton Bay (6).

Each year the trailer suction hopper dredge (TSHD), *Brisbane*, removes up to 1 M m^3 of sediments from the Port's berths and shipping channels (Fig. 3b). These works are undertaken to maintain the shipping channels into the Port of Brisbane. These channels are in naturally deep areas of the Bay, which minimises the extent of dredging required.

Figure 4. *Proposed Port of Brisbane Limited Cruise Terminal (7).*

Periodically, larger capital dredging works (areas not previously dredged) occur at the Port. PBPL is constructing a new $100 M cruise ship facility at the mouth of the Brisbane River, which will require localised dredging to be undertaken. These works will accommodate cruise vessels more than 270 m in length. There was no dedicated cruise facility in southeast Queensland able to accommodate mega-cruise ships.

The new facility is considered the ‘missing link’ in Brisbane’s tourism infrastructure. This facility aims to ensure the city can attract and support the world’s largest cruise ships and act as an important gateway to the south-east Queensland region (4). The contracts for construction of the wharf and terminal facilities were awarded in early 2019 and the new cruise terminal is scheduled to open in late 2020 (Fig. 4).

Brisbane Airport Expansion

A large infrastructure project recently completed by the Brisbane Airport Corporation (BAC) was the New Parallel Runway project (Fig. 5). This project involved the dredging of 11 M m^3 of sand from the Bay and reclamation of 360 ha of soft marshland.

Dredge material was transported onto the site over a 4-year period and the weight of the sand is being used to create a solid base for the runway. The sand was extracted from the Bay's Middle Banks by the Jan de Nul Group's TSHD, ***Charles Darwin***.

Figure 5. *New Parallel Runway Project (3).*

In addition to the large-scale projects throughout Queensland that involve maintenance and capital dredging works, the Department of Transport and Main Roads (DTMR) has committed to a $30 million, 2-year extension of the Marine Infrastructure Fund from July 2016, for additional facilities and upgrades to existing facilities (8), which include boat ramps, jetties and seawalls.

DTMR has undertaken recent maintenance and/or capital dredging programs at Cabbage Tree Point and Cabbage Tree Creek. These involved dredging between 10,000 m^3 and 50,000 m^3 of material from the seabed. Other projects include the Manly Boat Harbour public channel deepening and maintenance dredging, and Raby Bay (east) maintenance dredging projects (Fig. 6)

Figure 6. *Small maintenance dredging locations in southeast Queensland (image from Google Earth Pro).*

There are small to medium-Local Councils that undertake routine maintenance dredging programs. For example, Redland City Council recently commissioned a 5-year dredging program in Aquatic Paradise, involving the removal of approximately 180,000 m^3 of sediment (Fig 6). These works were completed by the PBPL dredger, ***Brisbane*** to ensure ongoing vessel access into this canal estate.

Gold Coast Waterways and the City of Gold Coast undertake routine maintenance dredging and beach nourishment activities. Gold Coast Waterways recently completed maintenance dredging at Biggera Creek and Tipplers Passage and Cabbage Tree Point in the Gold Coast Broadwater (Fig 6).

The City of Gold Coast recently completed the Northern Beaches Shoreline Project (NBSP), which involved offshore dredging and beach re-nourishment along the coastline from North Burleigh to Main Beach. The works by RN Dredging were completed in the second half 2017 and enhanced the condition of beaches for a wide variety of uses including the 2018 Commonwealth Games (Fig. 7).

As evidenced by these small, medium and large-scale projects throughout southeast Queensland, dredging plays an important part in maintaining our shipping channels, waterways and coastline, as well as provides a valuable resource (i.e. sand) for infrastructure development. However, how these works are managed from an environmental protection perspective remains a key issue.

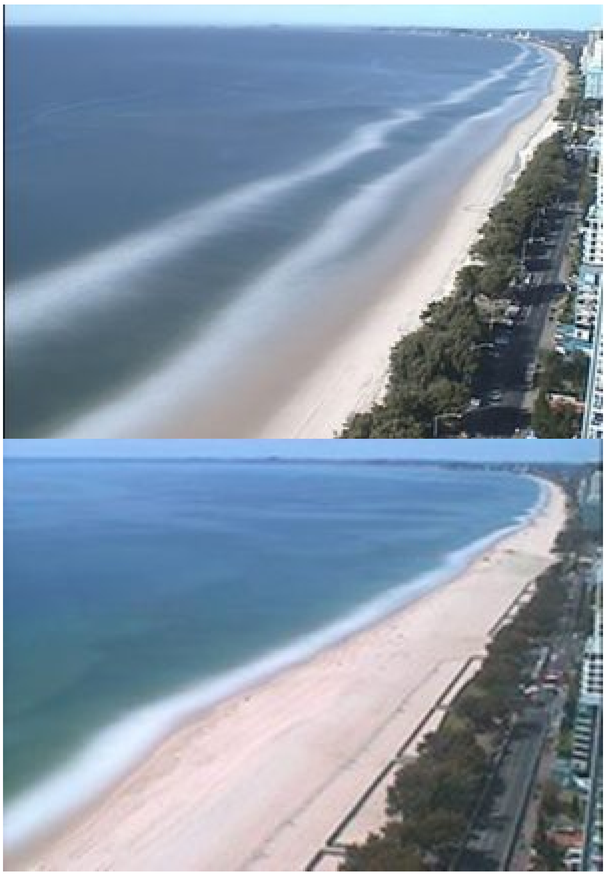

Figure 7. Before (left) and after (right) beach nourishment works at Narrowneck (image

from City of Gold Coast website).

Environmental management of dredging

The dredging works described above are guided by the various State and Commonwealth Acts, Regulations and Guidelines; namely the Commonwealth Environmental Protection and Biodiversity Conservation Act 1999, the Commonwealth Environment Protection (Sea Dumping) Act 1981 and Queensland Environment Protection Act 1994 (EP Act).

In Queensland, dredging and land reclamation activities require an Environment Authority (EA) (under the EP Act), as they are traditionally classed as environmentally relevant activities (ERA) and a Tidal Works permit. The EA and Tidal Works permit have a series of environmental management monitoring and mitigation measures (i.e. water quality monitoring) that the proponent (persons/company/government body that undertakes the dredging) needs to follow to manage the environmental risks associated with each respective project.

For large scale projects such as the New Parallel Runway, the environmental responsibilities employed and reported by the Brisbane Airport Corporation included demonstrating that the sand was uncontaminated in accordance with the National Assessment Guidelines for Dredging (NAGD) and contained negligible levels of fine clay/ silts.

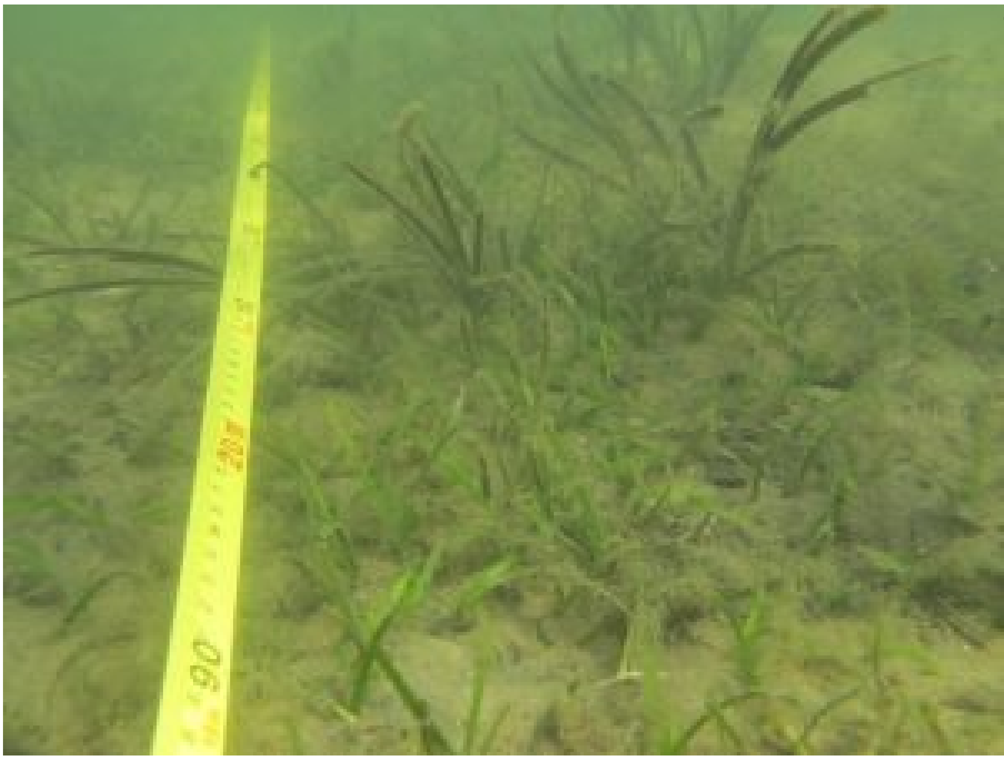

Figure 8. *Habitat surveys are used in some cases to demonstrate impacts of dredging on sensitive communities such as this seagrass (Zostera spp) meadow.*

The Brisbane Airport Corporation (BAC) implemented a continuous, real-time monitoring program to ensure that project-specific water quality criteria were not exceeded. In accordance with best practice, temporary sediment ponds were constructed by BAC to manage suspended sediments and turbidity in return waters. The water was contained on site within the primary reclamation bund and tail water ponds and was then released back into the Kedron Brook floodway via the airport's new major drainage system. No water was released until it met the agreed water quality discharge requirements. This approach is now standard practice for managing return waters from onshore disposal and dewatering activities.

For smaller-scale dredging projects in southeast Queensland, the dredging contractor or the proponent who has contracted the dredging works, is required to undertake an acceptable form of monitoring of dredge plumes to ensure that they are contained and do not either extend beyond the agreed dredge plume footprint or negatively impact sensitive marine communities. This generally requires qualitative observational monitoring, but can also involve collection of turbidity and other physico-chemical parameters at set distances from the dredge and disposal site.

In some instances, and where there is a medium to high risk of impact to the marine environment due to the presence of sensitive species (e.g. seagrasses), the Environment Authority or Tidal Works permit will also specify a requirement for habitat surveys before and/ or after dredging to demonstrate that dredging has not impacted the environment (Fig. 8).

Current Monitoring Methods and Novel Approaches

Given the location of the major transport infrastructure to the Bay, there should be a continued emphasis on monitoring and managing impacts to sensitive marine communities, particularly in western Moreton Bay. The chief tools used for monitoring water quality in marine waters throughout southeast Queensland are telemetered fixed site instruments, which report on physico-chemical parameters such as pH, dissolved oxygen (DO), temperature, turbidity, suspended solids, light attenuation and salinity/ conductivity in real time.

Elsewhere in Australia other approaches are used, some of which might be applied in the Moreton Bay context. For example, the Port of Melbourne (PoM) in 2008 and 2009 looked at ‘cutting edge’ statistical analysis methods to better understand short-term biological response to dredging and increased turbidity and generated 6-hourly Exponentially Weighted Moving Average and 2-week moving average control charts for turbidity (9). This provided an early warning trigger and assisted the Port in ensuring that seagrass light requirements were maintained throughout the project.

The traditional method of measuring sedimentation using sediment traps and taking water samples for measuring suspended sediment concentrations (SSC) has also been upgraded in recent years with the adoption of *in-situ* instruments which monitor optical backscatter. This is because sedimentation monitoring with sediment traps does not provide monitoring data over time frames that are relevant to the affected organisms (10).

Taking water quality measurements and waiting for the laboratory to report on SSC is also unrealistic in terms of reporting timeframes and trying to monitor potential changes in organism and ecosystem response. Other recent technological advances in measuring suspended sediment concentrations *in-situ* includes the Laser In Situ Scattering Transmissometer-Stream Lined profiler (LISST-SL), which is designed to provide real-time data on sediment concentrations and particle-size distributions.

In addition to real time water quality monitoring, there has also been a change in the type of parameters monitored. The mining company BHP, in Port Hedland in 2011, focussed on active light monitoring, to better understand how seagrasses responded to turbidity and sedimentation. Application of lethal, sub-lethal and non-measurable change (% surface irradiance (SI) thresholds) compared to the dredge plume modelling outputs, was used to define the Zones of High Impact, Moderate Impact and Influence for corals and seagrasses (11).

A shift to monitoring incident light on the seabed was also adopted by Gladstone Ports Corporation (GPC) in 2013 and 2014, for monitoring potential impacts to seagrass from dredging, where GPC used telemetered benthic photosynthetically active radiation (BPAR) monitoring and applied a PAR limit over a 14-day rolling average to manage light availability to seagrass (12). This approach was again utilised on the INPEX Ichthys Project in 2014, where the company adopted a 28-day moving average of benthic PAR to assist in understanding seagrass and coral responses to dredging activities (13).

In summary, what has been learnt by transport-related entities from dredging and land reclamation activities is the need to better understand, in ‘real time’, how the marine species and communities respond to increases in suspended solids concentrations in the water column.

Opportunities and Constraints

There are a number of new infrastructure projects proposed in the near future along the Moreton Bay foreshore, which include: the Brisbane Cruise Ship Terminal; Toondah

Harbour; and Manly Boat Harbour Channel Deepening, amongst others. One of the key challenges for managing the marine environment, considering this new infrastructure, includes gaining a thorough understanding of the sensitive marine organisms present in the Bay. In addition, understanding the threshold tolerances of these species and implementing monitoring programs that allow the dredge contractor/dredge proponent to respond quickly to any negative biological responses will also be a key challenge for the future.

There is also the need to better understand the type of dredge plant and the potential impacts from dredging and disposal activities. Cutter suction dredges and trailer dredges tend to be the preferred method of dredging in Queensland. However, these dredges have the potential to generate significant turbidity during disposal of dredge material to beaches as part of beach nourishment activities, especially when there is a high silt content.

The regulators who are preparing the Environment Authority or writing the Tidal Works permits, as well as the proponents who are undertaking these works, should consider undertaking a thorough evaluation prior to dredging of the type of equipment available and the potential impacts to the environment. This is highly relevant to the smaller dredging projects up to 50,000 m^3, where a bucket, clam shell or auger dredge may be the more appropriate equipment, as they are relatively efficient up to this dredge volume, do not generate as much excess water and therefore generate less turbidity during both dredging and disposal activities.

Another important area of investigation for transport development would be on the fate and remobilisation of sediments in the Bay. Understanding of how the finer sediments present in the lower estuaries are recycled and whether this material influences ecosystem function is essential. This understanding is important to gain a better appreciation of how the ecosystem responds to change, and whether it is from natural or anthropogenic sources, such as dredging activities.

Future research and investigation that helps contribute towards a sustainable future for Moreton Bay, may include undertaking sediment transport modelling to better enhance our understanding of the fate of sediments and how they are recycled in the environment, which are either naturally deposited in Moreton Bay from catchment inputs or deposited at Mud Island from dredge material disposal activities.