Measuring Currents

– a short guide for the Harbour Master

OCEANWISE | WHITE PAPER

Accurate, real-time current measurement ensures safety is never compromised due to an incorrect assessment of the environmental conditions.

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Introduction

This paper looks at the importance and value of reliable and real-time current information, such as speed and direction (or set and drift in nautical terminology), as a tool to aid safer and more efficient port and harbour operations. It provides a guide on how to best to approach the collection and distribution of relevant currents measurements to support safe, operational decision-making.

Who this is for

This guide is designed for Harbour Masters and others responsible for managing or overseeing the navigational, safety, operational and development activities of a port, harbour or coastal terminal.

Currents in ports, harbours, estuaries and bays are a result of a number of factors:

- **Tides** – by the daily natural flood and ebb movements
- **Storms** – wind-driven flows and barometric pressure
- **Floods** – increased outflows in estuaries and river mouths
- **Density differences** – caused by temperature, salinity or turbidity
- **Other events** – such as seiching, earthquakes, tsunamis

What we mean by currents

A current describes the movement of a body of water flowing in a definitive direction, as a result of a mixture of external forces (see box). Currents occur primarily in a horizontal direction but can vary considerably with time, depth and location.

Real-time accurate tide, wind and currents data, from a network of sensors, provides a clear picture of the evolving situation, both above and below the water surface, for those making critical operational decisions.

The increasing pressure on Ports and Harbours to be able to handle larger vessels with demanding turnaround schedules to ensure global trade continues, is creating the requirement for more metocean data to gain a full understanding of the operational environment.

Having a complete understanding of your marine environment gives confidence in decision-making, improves operational efficiency and safety, as well as maintaining the commitment to work towards improved environmental performance and sustainability.

Why you need to measure currents

Ports and harbours are dynamic environments where the interplay of wind, tides and currents can significantly impact vessel manoeuvrability, navigation, dredging, berthing, construction and development.

Understanding and measuring currents is of paramount importance to ensure safe maritime operations as well as maximising their efficiency.

Currents monitoring is becoming increasingly important as harbour masters and maritime pilots face the challenge of manoeuvring ever-increasing vessel sizes through narrow channels, whilst ensuring safety standards are maintained.

Both wind and currents have an impact on vessels, particularly larger vessels. Monitoring changing wind conditions is common practice in ports. However, it is not yet common practice to monitor real-time current variability.

Bridging this data and knowledge gap with real-time currents data helps with establishing fit-for-purpose, evidence-based risk assessments and procedures. This requires real-time, accurate tide, weather and currents data which provides a clear picture of the evolving situation.

There are multiple factors which influence the movement of water bodies and thus current speed and direction throughout a tidal cycle.

A network of sensors will give accurate knowledge of the conditions not only above the surface but also below, providing operational support to those making critical decisions.

Data from current sensors can be fed into third-party software for the application of Dynamic Under Keel Clearance (DUKC) calculations. This can play a significant role in determining whether a vessel can transit safely or not.

More accurate and reliable currents data provides ports with a comprehensive understanding of their operational environment, resulting in greater confidence in the decision-making process.

For example, ports can use this information to confidently update operational thresholds. This has commercial benefits which can see increased cargo loads or increased vessel movements within a tidally restricted port, and all without the need to undertake a lengthy and expensive capital dredging project.

With >80% of the global trade volume being transported by sea and the UK handling 458 million tonnes of cargo in 2022, enhancing our understanding of the environment we operate in to ensure effective decision-making and establish climate-resilience is critical.

Ref: UNCTAD, 2020 and British Ports Association Circular 229.

Why you should consider investment in measuring currents

Charted currents information is not enough

Traditionally, tidal diamonds on navigational charts or tidal predictions have been used to account for the movement of waterbodies in coastal environments. However, these are very time and location specific, for example currents predictions may not be available for critical turning or swinging points. There can also be major directional and speed changes across short distances, horizontally but also vertically through the water column, and real-time differences caused by other environmental conditions. Having in situ real-time currents measurements gives a clearer understanding of how representative of actual conditions the charted or predicted data is.

Currents can vary with depth

Most currents predictions and historical data usually only provide information on surface currents. There can be significant differences in currents speed and direction through the water column, which may affect deeper draft vessels or activities such as diving and dredging.

Port and channel developments

Deepening or widening a channel, or development of new port facilities, can change the current flows in the harbour environment and impact on operations. A sustained and managed currents measurement program will provide detailed insight into these changes and support safer navigation.

When a port wants to expand and develop its facilities, then the impact of the development and capital dredging project on the current flows needs to be assessed. This requires a baseline historical dataset to assist the physical and more commonly computer modelling. The collection of this data can cause considerable delays. If a routine and well managed currents measurement programme is already in place, then this data is already to hand.

The impact of floods and storms

Changing weather conditions can impact predicted tidal flows. Floods will increase outflows in estuaries, and ocean storms can strengthen wind driven currents resulting in increased water levels and tidal surges which may cause over-topping and flood events.

Ports are on the climate change frontline in terms of dealing with and coping with the effects of climate change. With increasing frequency of extreme meteorological and changing sea-level events, such as present day 1 in 100-year storms predicted to occur annually by 2100 along global coastlines*, it is important to have a full picture of the marine environment to strengthen future resilience, and promote safer operations through informed decision-making.

Real-time currents measurements will contribute to a true picture of the prevailing conditions and provide insight on the impact of such events on the port environment.

**UN Conference on Trade and Development report, 2020*

Reassurance and decision making

Harbour masters, pilots and other operational personnel are making critical decisions based on prevailing environmental conditions. Having accurate and relevant real-time measurements of currents accessible at the point of decision can give that additional confidence and ensure safety is never compromised due to an incorrect assessment of the environmental conditions.

"A challenging job, made more difficult by unexpected changes on the day, was able to be managed easily and effectively by having data available in a dynamic format."

Mark Green, Pilot

How to best approach measuring currents

Investment in a sustained currents measurement programme can provide enormous benefit and value to a port and its customers, users and stakeholders. However, careful planning is required to ensure that the data obtained is fit-for-purpose and is readily available to those who need it.

You will need to consider all potential users of the currents data, and then consider sensor location and deployment.

Who will be needing and using the data?

- To maximise the benefit of your investment, and the value of the data, you will want to ensure that the needs of all port users are considered. This will include maritime pilots, vessel traffic managers, dredging companies, surveying contractors, engineers and others.

What data do they need?

- Do they need just currents, or other data as well? A complete environmental monitoring system with sensors measuring critical metocean data types such as wind, tide, waves, will give them a complete picture of the operating environment.
- What are the key locations? Depending on the complexity and size of the port/harbour, multiple stations are likely to be required.
- In addition to location, you need to decide if you need just surface currents data, or data through the water column as an average and over what depths or a combination. This will depend on the types of vessels that use the port, and other operations in the port.

When do they need it?

- Those involved in operational decision making will need easy access to real-time data.
- This data will also be used alongside forecast data for both landside and marine planning.
- Historical currents data will be required for modelling purposes and hindcast analysis to assist operational reviews and development planning to ensure a port can meet future trade demands such as larger vessel sizes.

How will they access the data?

- You will need to consider the systems users will be using to view the data.
- These may be other specialised systems such as Portable Pilot Units (PPUs), Vessel Traffic Systems (VTS), where the data will be integrated and combined with other data sources.
- This will require data formatting and processing, and possibly system integration. You may need to consider data sharing platforms, such OceanWise's Port-Log data sharing platform.

How will you get the data to where it's needed

- Reliable and fast data transfer from the sensor is vital, especially for real-time data for decision making. Your options will be very much dependent on cost and availability of suitable networks.
- Data can be transmitted via LAN/mobile network and there are now applications using AIS to transmit metocean data strings which can also be received by vessels via compatible Electronic Chart Display and Information Systems (ECDIS).

OceanWise Telemetry

OceanWise are experts in marine telemetry and have helped develop products for the unique requirements of the harsh marine environment.

We are able to handle the process of recording and transmitting the outputs of marine sensors such as wind, currents and tidal data, so that it can be viewed, used and disseminated by those who need it.

Data is configured to work seamlessly with environmental monitoring systems, including our widely used Port-Log.

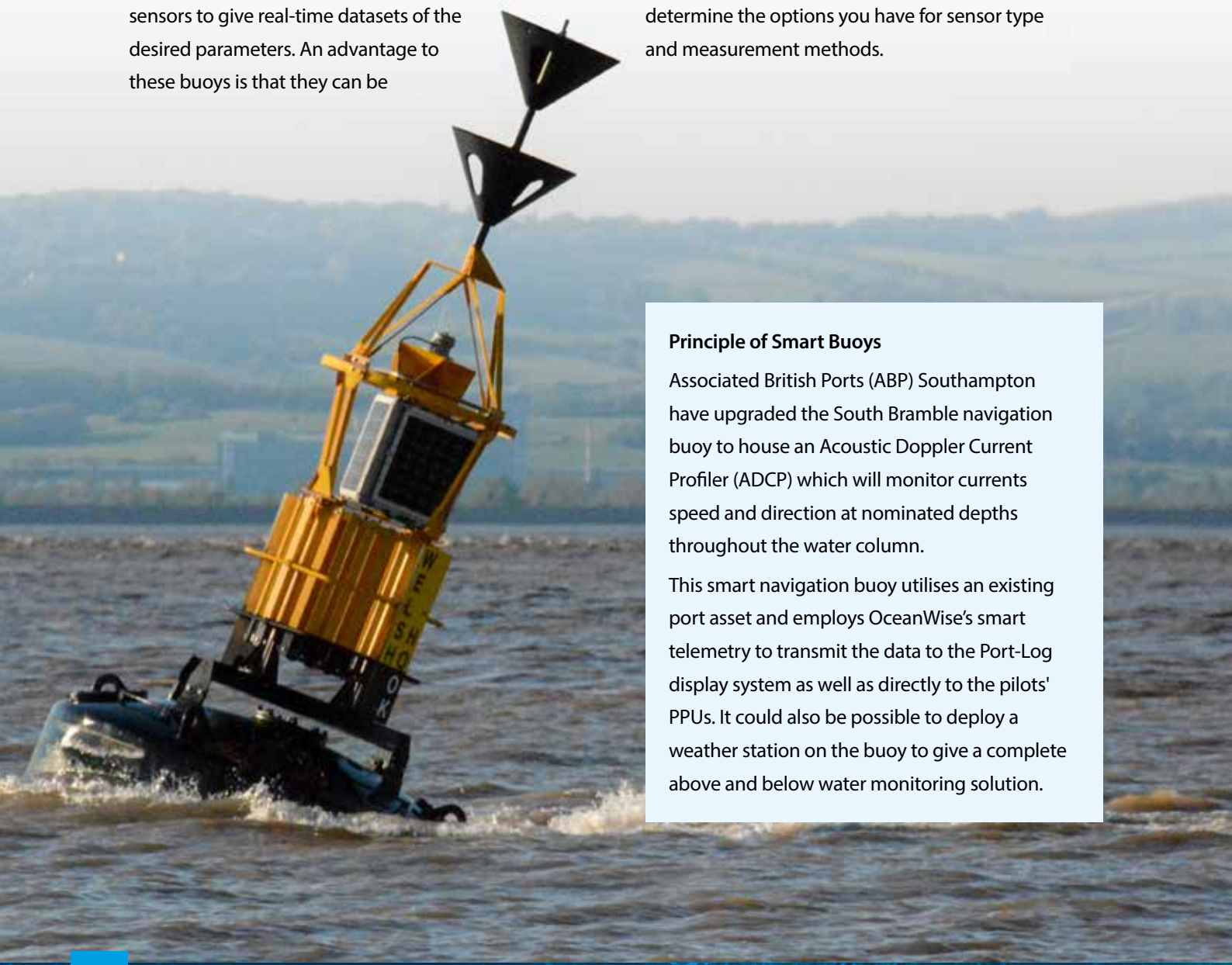
Sensor positioning and deployment

Deciding where to locate currents sensors to get the most out of the data for operational purposes requires local knowledge to identify unique environmental conditions and currents variability. You will need to decide on the critical points where you want currents data collected. This could be critical manoeuvre points in a channel, or approaches to a dock for example.

Current sensors can be located on the quayside, on piers, or on buoys (navigation or specific monitoring buoys). Consider if there are any existing navigational buoys where sensors can be deployed, rather than using a new dedicated buoy.

Alternatively, smart environmental monitoring buoys can be equipped with the required sensors to give real-time datasets of the desired parameters. An advantage to these buoys is that they can be moved to differing locations around a harbour to either update or confirm existing tidal diamonds, or collect additional currents data in between the existing tidal diamonds to build a more detailed picture. Smart buoys provide more flexibility, but do not give a long-term record at a single point.

The depth intervals for measurements will also determine the options you have for sensor type and measurement methods.



Principle of Smart Buoys

Associated British Ports (ABP) Southampton have upgraded the South Bramble navigation buoy to house an Acoustic Doppler Current Profiler (ADCP) which will monitor currents speed and direction at nominated depths throughout the water column.

This smart navigation buoy utilises an existing port asset and employs OceanWise's smart telemetry to transmit the data to the Port-Log display system as well as directly to the pilots' PPUs. It could also be possible to deploy a weather station on the buoy to give a complete above and below water monitoring solution.

How to get the most out of currents measurement data

Data management

You will be building a valuable archive of information, so it is important that you protect this investment. You will need to consider how the data will be stored and managed, and made easily accessible by those who need it now and in the future for analysis and planning.

This involves a disciplined approach to data management, that should include a documented data management policy.

Data management

Data management is the development, execution and supervision of plans, policies, programmes and practices that control, protect, deliver and enhance the value of data and information assets. Data is now widely considered to be the second most valuable asset an organisation possesses after its employees. With data volumes multiplying every few months, it is critically important that organisations value and manage this asset through its life-cycle including its collection, quality assurance, quality, ingestion, curation, archiving and use.

Maintenance and calibration

To ensure that you continue to get accurate data with minimal downtime, you will have to ensure you budget for servicing of the sensors, and regular maintenance.

A key issue here is to identify who has responsibility for the system. Systems can be complex and problems may occur due to a variety of reasons. You need to ensure who is responsible for each component - the sensors, communications, data processing, and the display software - so that problems can be identified and resolved quickly.

To minimise the risk of downtime, it is best to establish a routine servicing and calibration schedule. In high marine growth environments it is recommended that the sensors are cleaned 6 monthly at least to avoid biofouling on the sensor face which would result in spurious data. Sensors can also be fitted with biofouling agents or guards to help extend the time between maintenance periods.

References and other useful resources

UNCTIA, 202 and British Ports Association Circulate 229

DAMA International Body of Knowledge (DM-BOK)

MEDIN (Marine Environmental Data and Information Network)

'Why Data Management Matters to Ports and Harbours' OceanWise Whitepaper

Smarter environmental and conservancy management – a short guide for the Harbour Master - OceanWise Whitepaper

UN Conference on Trade and Development report, 2020

If you need help to get a better understanding of current measurements in your port, then please contact us.

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OceanWise provides applications, services and tools that enable safer and smarter management of marine operations.

OceanWise offers a range of training and consultancy services worldwide to support the understanding and implementation of Data Management, Data Policy, Data Strategy and Data Governance.

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