The role of continuous monitoring as a decision support tool: A Dublin Port deployment.

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Background

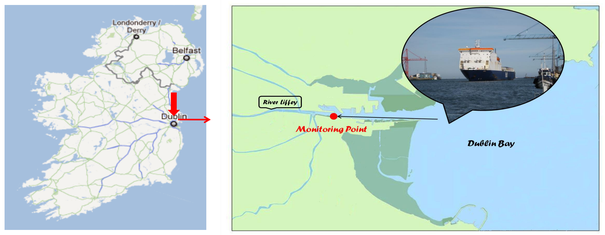
The growth of population in the coastal areas and the ever increasing density of marine transport translates into an elevated pressure on these water bodies. Effective monitoring is inherently hard to achieve using grab sampling regimes and low frequency sampling. Emerging sensor technologies and high frequency monitoring can provide additional information on the variability of pollutants as well as early detection of special events. As a result, the ability to characterize dynamic and hydrologic properties at adequate temporal and spatial scales has greatly improved.

MESTECH has deployed an autonomous portable water quality monitoring system in Dublin Port. The system is ideal for applications where a rapid response is required as it is deployable in under 30 min, and its size and portability allow it to be used to collect data from hard to access or remote locations.

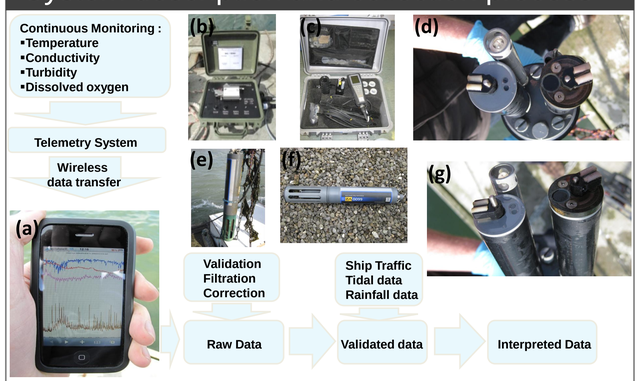
Site and System Description

Site location and description

Dublin Port is located on the Lower Liffey Estuary (macro-tidal estuary highly salinity stratified). Constantly changing and dynamic water body (anthropogenic activity, tidal flushing, WWTP discharges, fresh water inflow).



System description and collection process



Scheme 1. Data collection, analysis and interpretation, (a)- real time data visualisation in the field using smart phones, (b)- telemetry system, (c)- YSI Pro-Plus hand held sensor used for on-site validation, (d), (e), (f), (g)- YSI 6 series sonde.

Results: Collected Data

Entire collected data set

Deployment period (7 months):
1st Oct. 2011-1st May 2012;
Frequency of Sampling:15 min;
Depth: 2,5 m from the water surface.

Four turbidity events recorded: 1,2,3 were attributed to heavy rainfall and no. 4 was attributed to an increase in primary production (Fig. 1).

Table 1. Data Output from the multi-parameter sonde. N- samle size. Specific Conductance (µScm^{1}), Conductivity (mScm^{-1}) , Depth (m) and DO saturation (DO %) are not shown in the table.

Parameter	N	Range	Minimum	Maximum	Mean
Temperature (°C)	20401	11.90	3.20	15.10	8.62
ODO (mg L^{-1})	20401	9.03	5.16	14.19	9.56
Turbidity (NTU)	20401	95.00	0.20	95.20	5.38
Salinity (ppt)	20401	14.05	16.95	31.00	30.35
Total	81604				

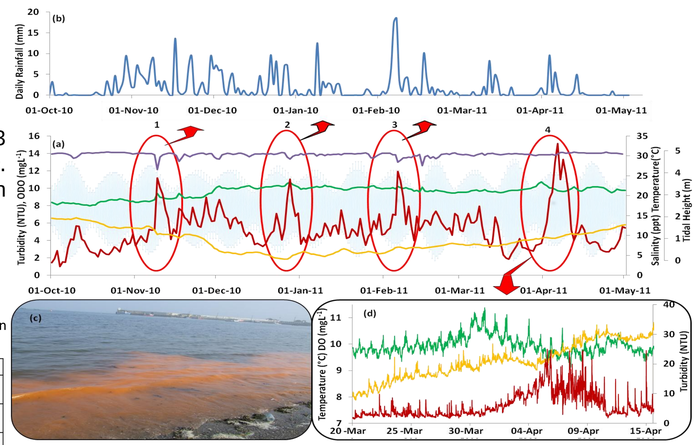


Fig 1. Averaged data set for the seven months deployment period and major events in this period.
(a) Plot of daily averages : Turbidity (NTU), ODO (mgL^{-1}), Salinity (ppt) , Temperature (°C) and Tidal Height (m)
(b) Daily rainfall averages.
(c) Picture taken by the Skerries Coast Guard on 19th of April showing an algal bloom.
(d) Time series of DO, temperature and turbidity raw data from the 20th of March until 15th of April.

Turbidity and Ship Traffic

Ferries coming in and out of Dublin Port have a pronounced effect on turbidity readings by resuspending river bed material and creating an artificial vertical mixing of the water body (Fig. 2).

Higher amounts of sediments are resuspended by the arriving ships due to the turnover procedure (Fig. 3, 4).

Tidal cycle has a major impact on the amount of sediments resuspended.

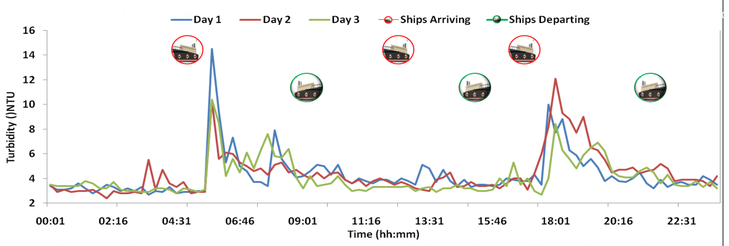


Fig 2. The impact of P&O ferries activity in Dublin port on the turbidity readings small time. The arrival and departure times of P&O ferries and the turbidity readings for 3 different days.

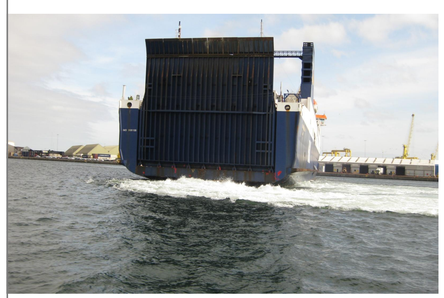


Fig 3. Turbulence caused by the turn-over manoeuvre. Causes displacement of river bed material and artificial mixing of the water column.

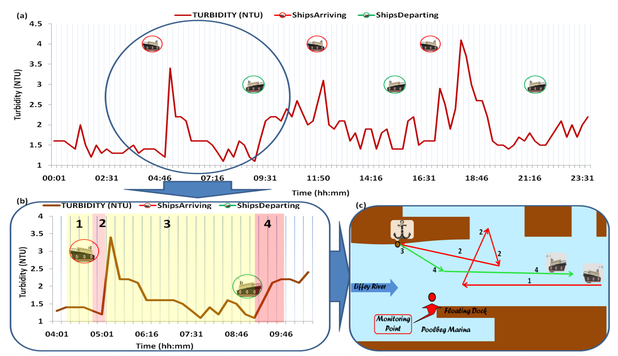


Fig 4. Explanation for the different effects on turbidity of the arriving and departing ferries.
(a)-Plot of arriving and departing ferries and the sensor response for a random day.
(b)-The effect of a single arrival and departure on turbidity and the time stages: 1-arrival recorded by Dublin Port Authority, 2-time needed for the turnover manoeuvre and mooring, 3-docking time, 4-departure.**(c)**-Graphical representation of the observed ferry pattern: ⬅ arriving ship, ➡ departing ship, numbers on the arrows representing the time stages from Fig. 4 b.

Summary of findings

In a constantly changing environment influenced by so many factors continuous monitoring has overcome the limitations of grab sampling regimes.

A primary production event was identified in April using simple physicochemical parameters like DO, turbidity, temperature and salinity.

Ship traffic within Dublin Port has a pronounced effect not only on the daily turbidity readings but also on the entire averaged turbidity data set (same pattern, Fig. 5, Fig. 2).

The turnover manoeuvre within the channel carried out by the arriving ferries accounts for most of the sediments resuspension. Sediments accumulated during the night settling period are resuspended early in the morning after the arrival of the 1st ferry causing a sudden increase in turbidity and a possible enrichment of the water column with pollutants (heavy metals, nutrients, pesticides, PAHs , faecal coliforms).

Continuous monitoring should be employed for exploratory purposes in such challenging environments as it has the potential to be used as a decision support tool to aid in the development of future effective monitoring programs.

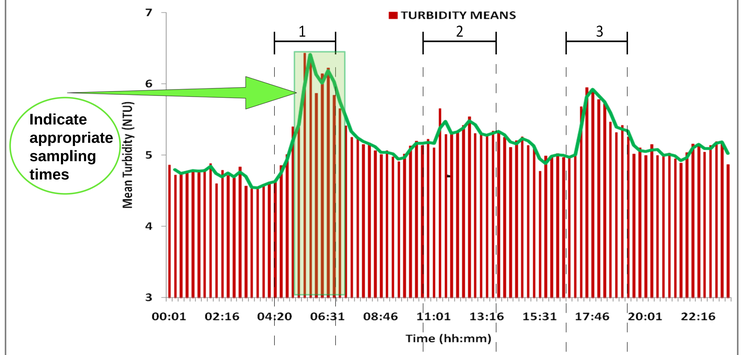


Fig 5. Average turbidity values for the entire data set at each sampling time during the course of 24 hours; ⊢ Time periods for the arrival of the ferries over the deployment period.

Acknowledgements

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