Realising operational value from environmental data.

Systems for rapid response and preventive environmental management at ports.

envirosuite

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Visualisation showing movements of the global merchant fleet over the course of 2012, visualised by www.kiln.digital

1. INTRODUCTION

Environmental constraints have become more burdensome and costly while ports continue to strive to grow economic output.

With increased environmental regulation come vast amounts of environmental data collected for compliance purposes. There is a strong emphasis on using such data to compare past performance to regulatory benchmarks, driven primarily by environmental licence requirements. At the same time, there is an increasing trend towards collecting real-time data and centralising storage in corporate systems. **There is a general assumption that automating data acquisition and displaying data will simply lead to value;** however, there is little guidance on how environmental data can help drive improvements in operational performance or deliver least-cost improvements in environmental performance.

This paper provides examples of how real-time or forecast environmental data are now being used to support operational decisions to manage airborne dust, metals and combustion products at bulk handling, container and tourist ports around the world. It shows how environmental incidents can be avoided or mitigated through timely, targeted decision-support driven by readily available data.

Port areas that were once well-separated from communities face increasing and intensifying residential and commercial development. At the same time, community and regulatory expectations about environmental quality continue to increase.

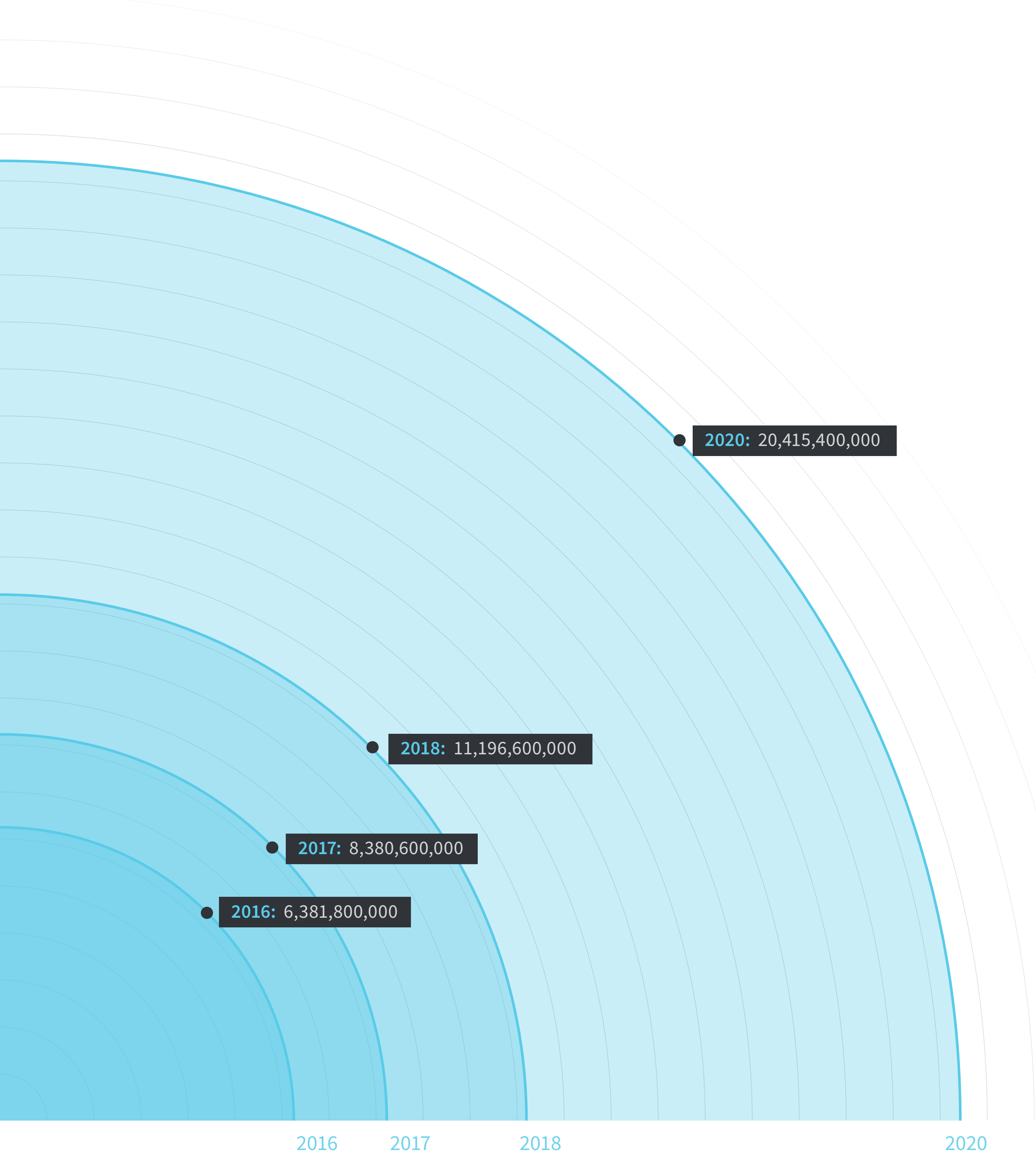
When unfavourable weather conditions occur, particulate matter (and associated toxic substances) can sometimes be released into the atmosphere to impact upon nearby communities.

Products of combustion - such as sulfur dioxide, oxides of nitrogen and particulate matter - which are the focus of considerable regulatory attention - are also released in significant amounts by both tourist and commercial ships that are at berth or transiting through port areas.

The challenge is particularly serious for ports handling large volumes of materials such as coal, iron ore or metal concentrate. Often transferred on-site or stored in large stockpiles ahead of being loaded onto vessels, the materials are at the mercy of prevailing weather conditions.

Although weather conditions can affect the impacts of emissions on communities by several orders of magnitude, ports are often limited by the quality of information that they receive. It is common for environmental management to be based on management plans that do not take into account changeable, local weather conditions. When management plans do consider dynamic weather, they are based on coarse, region-wide forecasts that do not represent local conditions accurately. Outcomes are inconsistent, with control being applied when it is not needed, or vice versa.

Environmental performance monitoring data has been aimed historically at managing environmental compliance obligations - a necessary objective. Reporting is focussed on what happened in the past: historical statistics and trends. Manual processing is required by on-site staff and subject matter specialists to understand and communicate the significance of impacts. By the time an interpretation of the data has been received, the opportunity to take action to avoid incidents, or reduce those impacts, is lost.



Gartner predicts there will be 20 billion devices connected to the internet by 2020

(Gartner 2017)

The last decade has seen explosive growth in the number of devices connected to the internet, and this is predicted to continue.

Category	2016	2017	2018	2020
Consumer	3,963.0	5,244.3	7,036.3	12,863.0
Business: Cross-Industry	1,102.1	1,501.0	2,132.6	4,381.4
Business: Vertical-Specific	1,316.6	1,635.4	2,027.7	3,171.0
Grand Total	**6,381.8**	**8,380.6**	**11,196.6**	**20,415.4**

The Internet of Things (IoT) is widely publicised these days. At its most fundamental level, the IoT refers to the connection of devices to the internet. Implied in this idea **there appears to be general acceptance that connecting devices to the internet will naturally lead to the generation of value for businesses.**

Yielding value from the connection of devices is not a natural progression. In our experience of implementing systems for real-time and pro-active management at ports and other industries, a number of important factors determine whether value will be generated for a business.

Avoiding a small fraction of events (less than 10%) can reduce total impacts significantly and be the difference between compliance and non-compliance.

It is important to consider how information is to be used. Responding to, or avoiding, incidents requires data that must be presented in ways that differ from the needs of compliance assessment and reporting. If we examine how certain events can lead to non-compliance, we can find that in many cases it is determined by relatively few events (see Figure 1 and Figure 2).

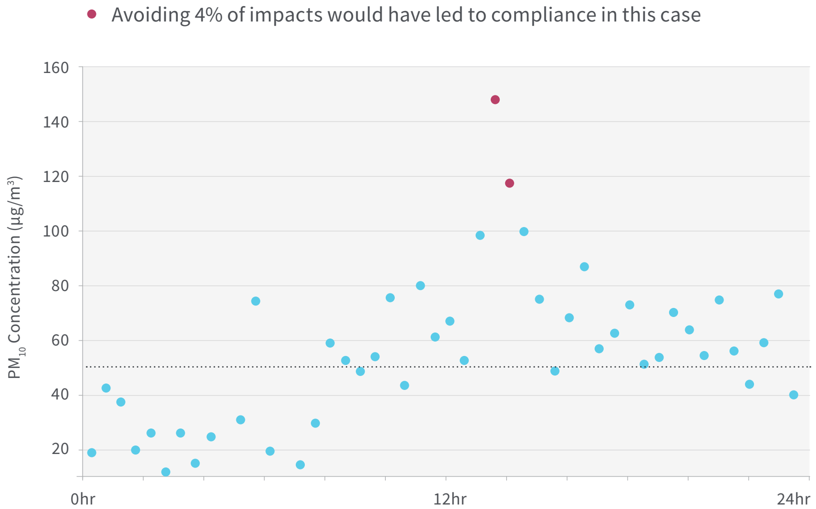


Figure 1: Typical contributions of peak events to overall impact for a port's air quality monitoring program.

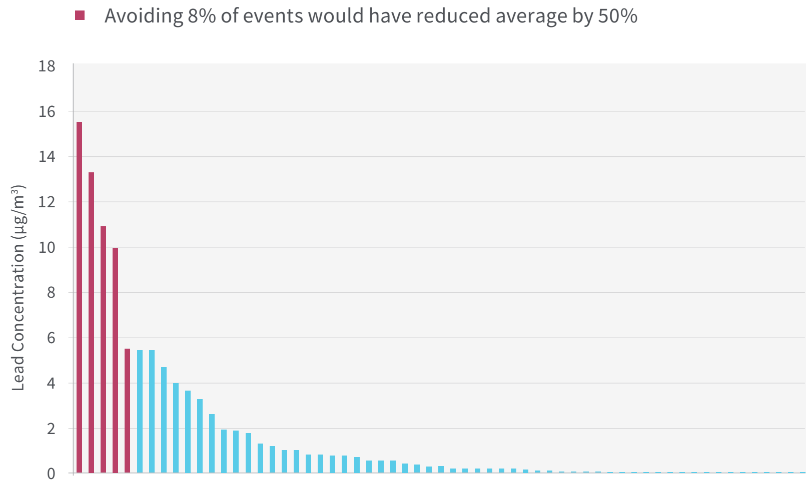


Figure 2: Typical contributions of peak events to overall impact for material handling, transfer and open area impacts.

Therefore, if the particular issues that are responsible for non-compliance are very short-term events, lasting minutes or hours, then specific forms of data will be needed.

Spot triggers or alerts linked to 'instantaneous' values are best when a rapid response is needed above all else. Real-time instruments can exhibit volatile short-term patterns and do not always accurately represent what is happening from an operational point of view. Basing alerts on short-term triggers can lead to some false alarms, but will guarantee rapid response when action is needed.

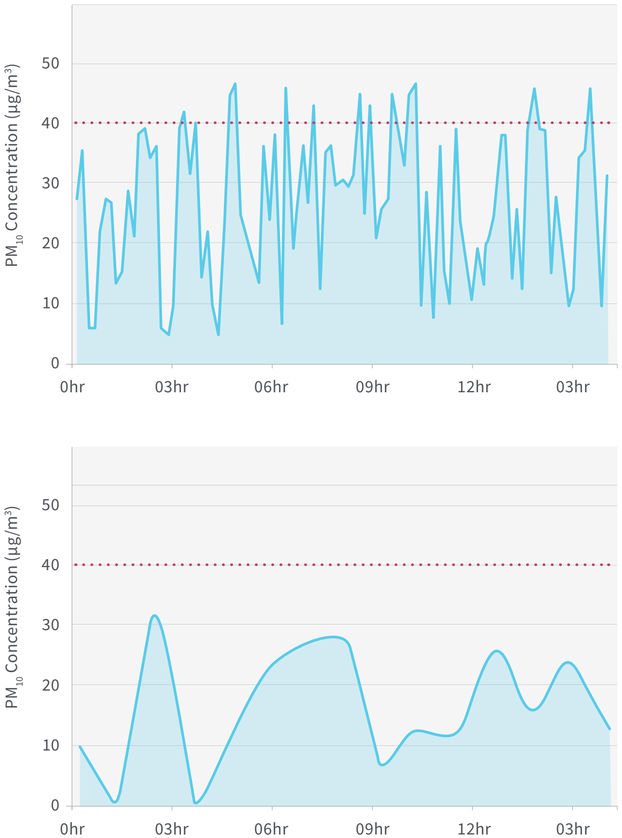
Fixed averages will smooth out short-term peaks but slow down response times. A longer-term average will reduce the number of false alarms linked to monitoring and can often be transferred directly to meet internal and external reporting obligations.

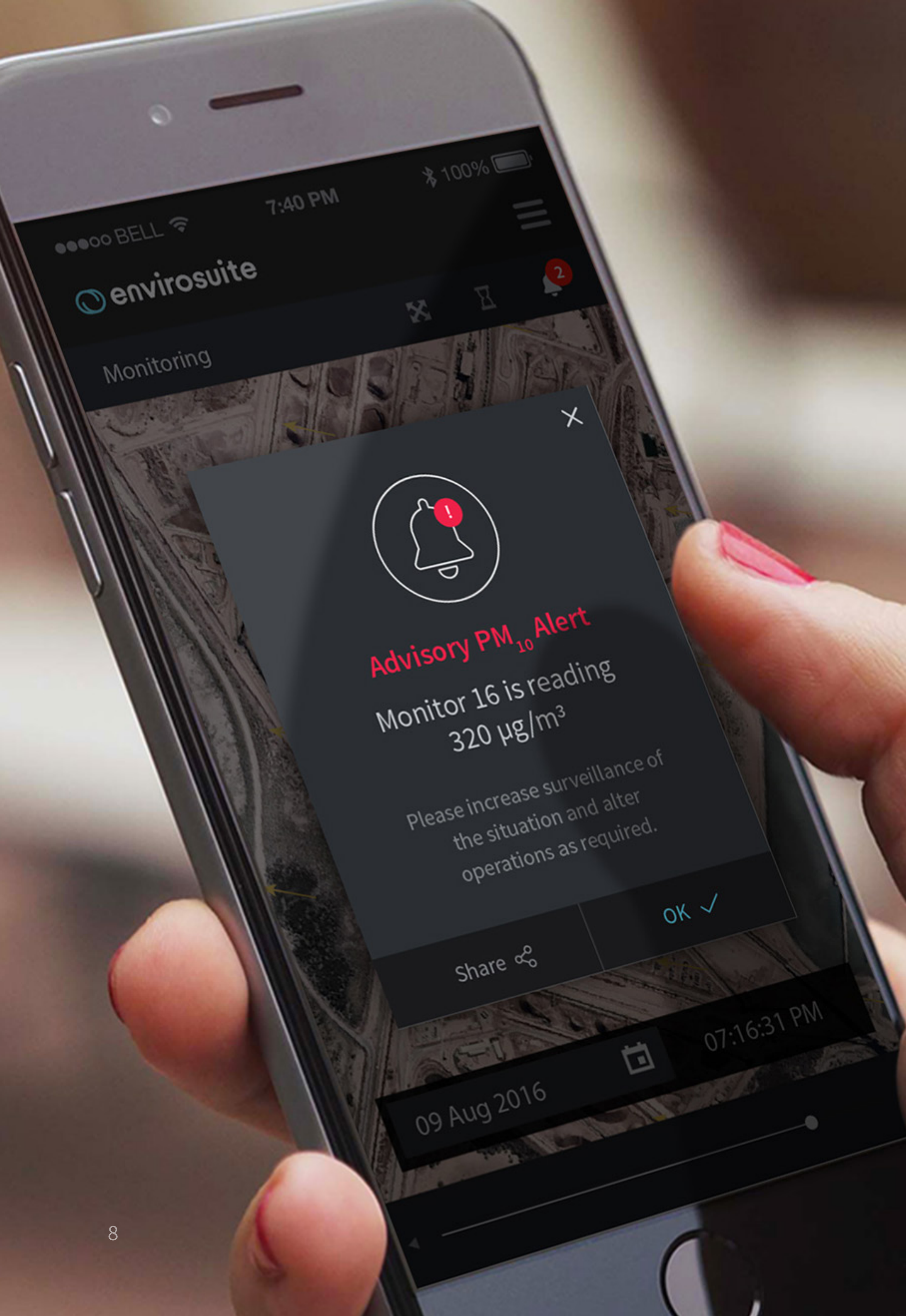
In a similar category, moving or rolling averages give an indication of sustained trends. Because moving averages are based on the latest available information, they can facilitate a quicker response to emerging issues if very large jumps to monitored values occur. Moving averages provide a balance between rapid response and smoothing out short-term peaks.

High-resolution, site-specific forecasts of meteorology may also be used in preference to real-time monitoring data as a better basis for decision making. For example, stockpiles of dusty material may require several hours, or more than a day, to absorb effective levels of moisture or dust suppressant. An SMS or email alert from a boundary monitor in this case will be too late. The most effective way to avoid incidents will be to act in advance of the event, based on a forecast for the area.

Note also that accuracy may not be as important a consideration for operational purposes as for regulatory purposes; a response (such as applying higher levels of control) can often be based on a simpler trigger, such as whether a significant increase in impact has occurred. Provided the general magnitude of the impact is correct, the monitoring device itself does not necessarily need to be as accurate as a compliance instrument. This allows for significant improvement in monitoring coverage of a site, as many more devices can be deployed for the same budget.

Figure 3: PM_{10} 10 min average (above) vs PM_{10} 1 hour average (below) highlighting the number of times trigger values are reached using the different methods.





Form of communication

Form also refers to how information is to be distributed and consumed. Management in real-time implies that important information is communicated as it happens to the relevant person. That may be via a PC monitor or a TV, but it may be sufficient to supply summaries of information as emails or SMS to ensure that the right people see the right information at the right time.

Setting the trigger form and level of the trigger will always depend on the specific objectives of each business, and flexibility is important. The objective is to achieve a balance between too many alerts (leading to annoyance) and too few alerts, where important events are missed.

Some examples of techniques that can be used to optimise alerts are:

- Alerts are turned off during certain wind directions, or when it is raining, or during the night.
- Alerts are based on the difference (or some other relationship) between two or more monitors.
- Alerts occur when something is forecast to happen, as well as when it happens.
- There are different levels of alert (e.g. red, orange, green) linked to different responses.

Design

Design in this context relates to how information is presented. The key requirements for managing environmental issues in real-time are:

- Understanding whether a problem is occurring right now or about to occur.
- Understanding the source of the problem.

Any environmental issue contains a level of complexity, as the issue itself often requires subject matter expertise (internal or external) to understand, while the decisions related to how the process operates (or how environmental issues are controlled in real-time) are made by others in the business.

To operate effectively, any form of information should quickly help the decision maker in a business understand a) whether there is a problem and b) the likely source of that issue. These two pieces of information can then facilitate a targeted and effective response to the issue. That response can be manual (e.g. an investigation by on-site personnel) or automated (e.g. switching on control systems linked directly to input data).

Examples of poor design (Figure 4) and good design (Figure 5 and Figure 6 are shown below and opposite.

Figure 4: Information not designed for operational management – requires subject matter to understand, source of issues difficult to identify

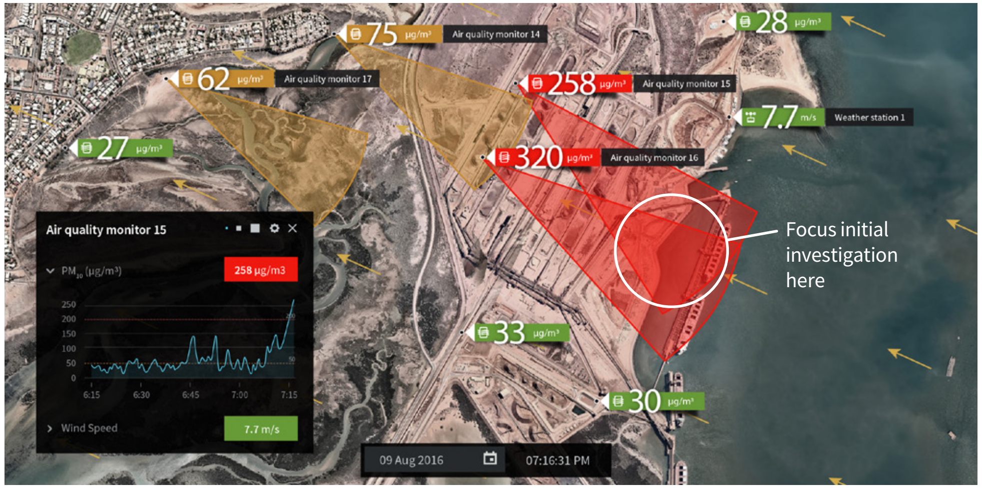


Figure 5: Monitoring information designed to quickly identify whether there is a problem and source of the issue – integrated air quality and meteorological monitoring

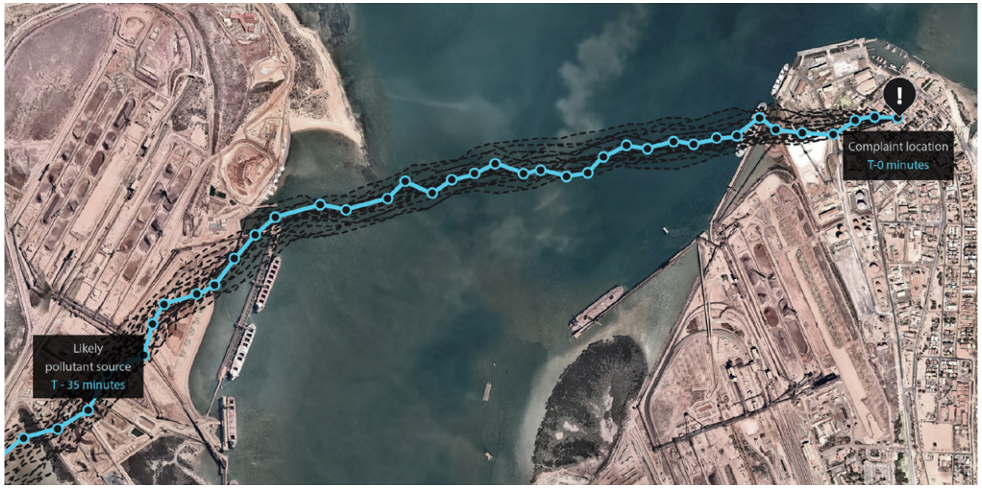


Figure 6: Use of three dimensional, non-steady state meteorological modelling to quickly identify the likely source of a peak event or complaint

Accessibility

Accessibility refers to how people access information and whether it is matched well to objectives of the system. Accessibility needs to be considered in the following ways:

- What is the typical schedule of the people that need access to the information? Will they be in front of a screen, in a control room or at a desk, or will they be on the plant or remote from the plant? This defines whether information is presented as dashboards, automated reports, support tickets or emails/SMS alerts.
- How much context is needed? For example, is it sufficient to alert an operator that a specific action is needed with a red, amber, green alert, or is further context required (e.g. why is that action required)? Can the response be entirely automated by sending signals back to devices?

Figure 7 opposite shows a complex meteorological forecast that has been translated into a simple measure of risk for operational personnel. Although the forecast is sophisticated, the operator of control systems is only interested whether a response is needed. For example, when forecast meteorology is unfavourable, control systems are activated for that period only. Traditionally, action was based on a forecast for the entire day. This fine scale of time allows for control only to be applied when needed and in advance of issues occurring.

Figure 7: A complex meteorological forecast presented in a simple format for decision making. A fine-scale of time (hourly) and translated into levels of risk (red amber green) based on known triggers in the area.

5. CONCLUSIONS

The key variables that influence whether data can deliver improved environmental performance are the form of data used, the form of communication, design and accessibility.

With increased environmental regulation come vast amounts of environmental data collected for compliance purposes. There is a general assumption that connecting devices to the internet will deliver value to ports wishing to managing environmental issues. The transfer of value from the connection of devices is, however, not a natural progression.

Only with careful consideration of these issues will ports deliver both operational and environmental improvement from real-time and predictive systems.

6. REFERENCES

Gartner (2017) Gartner Says 8.4 Billion Connected “Things” Will Be in Use in 2017, Up 31 Percent From 2016, Gartner, Egham, U.K., February 7, 2017, Accessed 27/08/2011: http://www.gartner.com/newsroom/id/3598917

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