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Viewpoint

Environmental perverse incentives in coastal monitoring

Mark T. Gibbs *

University of Queensland, School of Mathematics and Physics, St. Lucia, Queensland, Australia

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ABSTRACT

It can be argued that the intensity of monitoring of coastal marine environments lags behind the equivalent terrestrial environments. This results in a paucity of long-term time series of key environmental parameters such as turbidity. This lack of management information of the sources and sinks, and causes and impacts of stressors to the coastal marine environment, along with a lack of co-ordination of information collection is compromising the ability of environmental impact assessments of major coastal developments to discriminate between local and remote anthropogenic impacts, and natural or background processes. In particular, the quasi outsourcing of the collection of coastal information can lead to a perverse incentive whereby in many cases nobody is actively or consistently monitoring the coastal marine environment effectively. This is particularly the case with regards to the collection of long-term and whole-of-system scale data. This lack of effective monitoring can act to incentivise poor environmental performance.

1. Introduction

Private ownership, management and exploitation rights to the coastal marine zones around the world have largely not been allocated and hence these environments mostly remain as common pool resources. This also means that Government, who manage common pool resources of behalf of the citizens of nations also retain the obligation to effectively manage these resources and environments. The majority of management efforts in these coastal marine zones often focus on the management of living marine resources, in particular commercial and increasingly recreational fishery resources. By contrast sessile benthic habitats and pelagic habitats in general are mostly unmanaged with the exception of habitats enclosed within some form of marine protected area.

Management of any system requires time series information of key management performance indicators. By contrast to the terrestrial environment, the acquisition of relevant and timely management information in the marine environment is costly and logistically difficult (Gibbs, 2012a). For example whilst data returned from airborne or satellite sensors has high utility in the marine environment, this utility focuses on the sea surface and is poor by comparison of the utility of the same data streams for terrestrial environments. Similarly, remotely sensed data is often less accurate in the coastal zone by comparison to oceanic waters (Mao et al., 2013). In addition, the physical size of many EEZ's (Exclusive Economic Zones) by comparison to the population and tax base can be substantial for many nations, limiting the pool of funds for marine monitoring and management. This means that for the marine environment, wherever possible environmental management information must be used to the fullest potential and any opportunities to subsidize information collection must be investigated.

A number of government agencies have taken up this latter challenge by seeking ways of using the private sector to collect relevant environmental information that can be used to underpin generic management of the coastal marine zone. The most obvious example is piggybacking off environmental impact assessment legislation where it exists. For example, owners and operators of large coastal infrastructure must comply with environmental management legislation and this commonly involves the assessment of impacts of specific operations, in addition to often sporadic background coastal monitoring. Given these requirements it is therefore not surprising that a number of government agencies have sought to use data acquired from privately funded environmental impact assessments (EIAs) or associated background monitoring implicitly or explicitly undertaken to partly or completely fulfil coastal management information requirements.

For example, in New Zealand statutory regional authorities in the form of Regional Councils undertake some State of the Environment reporting that includes sampling water quality, although these efforts tend to focus on operational considerations in terms of monitoring swimming water quality rather than monitoring and analysis programs that aim to identify the impacts of catchment point and non-point sources over time. Major marine monitoring programs are undertaken by large coastal facilities such as the Manapouri power station that discharges into the coastal zone (Gibbs et al., 2000) although this program covers a small spatial area by comparison to the size of the marine environment that is

* Tel.: +61 7 35534156.
E-mail address: Mark.Gibbs@aecom.com

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managed. Similarly, the 2007 Western Australian State of the Environment assessment (WA Govt., 2007) highlights that "Monitoring of the condition of Western Australia's marine environment is extremely limited". In Western Australia, the substantial offshore oil and gas industry lies within Commonwealth Government managed waters yet the same situation applies in that the majority of marine environmental data acquired is privately collected by this industry. This is common across both industrialised and developing nations, and seems to be an increasing trend as many governments seek to outsource operations, and in some cases obligations.

However, as argued here, this practice can embed perverse incentives which act to undermine the sound management of coastal marine ecosystems and environments. The objective of the work presented here is therefore to demonstrate the existence of perverse incentives by considering the case of turbidity or suspended sediment in the coastal zone.

The scientific literature contains a large number of studies that have investigated the behaviour and dynamics of turbidity in coastal zones around the world. It is clear that turbidity levels in coastal zones vary according to short term events such as rainfall events, and seasonal and inter-annual timescales that correlate with changes to local land use policies and larger-scale processes such as El Nino/La Nina oscillations (Aalto et al., 2003). Our understanding of especially the spatial variability of suspended sediments has also increased over recent decades as a result of remote sensing platforms and sensors such as MODIS (Saldías et al., 2012).

By contrast, it is becoming increasingly apparent that turbidity levels in many iconic coastal regions increased dramatically sometimes over 100 years ago in response to large scale land clearance and the introduction of industrial fishing activities (i.e. Houziaux et al., 2011). Such changes are mostly not recorded in instrument records since recording turbidity instruments are only a relatively recent innovation, and still today the majority of instrument records of coastal turbidly extend back only short periods in time. Therefore in effect, the context and path dependency underpinning the state and trends in coastal turbidity levels remains unclear in many, if not in most coastal regions around the globe despite recent advances in remote sensing technology. This lack of path understanding and context pre-conditions the development of perverse incentives when we consider the interaction and cross-dependency of privately and publicly funded environmental monitoring data, as discussed below.

2. Perverse incentives

The logic of the coastal monitoring perverse incentive is demonstrated through a thought experiment. Following this approach, consider a large port operation located in the mouth of an estuary.

Many, if not most large ports have environmental monitoring programs in place. However these assessment and monitoring programmes are generally in response, as prescribed in environmental management legislation, to the perceived greatest threat of environmental damage associated with port operations. In terms of the marine environment, this is often associated with dredging operations for maintenance or port expansion developments. In such cases it is becoming increasingly common to establish intensive environmental monitoring during dredging operations, and these are commonly configured as BACI (Before–After-Control–Impact) frameworks (i.e. Guerra et al., 2009). This invariably involves establishing monitoring sites at least a number of weeks before the operations, and at control or reference sites during operations.

However, despite sometimes comprehensive monitoring programs, the assessment of realised or potential impacts of dredging operations often distil down to an argument that compares the intensity and extent of measured dredge plumes to 'natural' variability in turbidity as observed during or immediately prior to the operations (see for example Orpin et al., 2004 for in-depth discussion). One of the reasons for this is because it can be challenging to develop defensible cause-effect relationships relating the marginal increase in suspended sediment loads to impacts to benthic communities. However, when the argument does reduce to a comparison to background levels, as it is argued is commonly the case, then the context of the background levels of clarity, turbidity and suspended sediment becomes critical.

In BACI studies this is largely aimed to be addressed through the comparison to data from control sites. However this also implicitly assumes some sort of stationarity in the control time series or assumption that the control, and before impact time series adequately capture the key trends and dynamics of the system (Veríssimo et al., 2013). In the case of turbidity, this can sometimes only be captured with extensive data sets that go back many decades in time and these often do not exist. The reason for this is that present day turbidity levels are the integrative result of both past bottom dredging activities and multiple but independent and un-co-ordinated land clearing activities in catchments. All that is measured in impact assessments is a snapshot of the present levels, without the context of previous sources and vectors.

The operational management and environmental impacts within the jurisdiction of port companies generally does not include having to encompass or manage other sources of land-derived sediments such as distributed point and non-point catchment sources. Hence from the perspective of the port company, and impacts studies therein, the background conditions are often decreed to be external to the studies. To this end, there is an implicit expectation that these other sources of sediments are being actively managed. However, as highlighted above over recent decades many governments have also pro-actively sought opportunities to divest the monitoring of coastal systems to the private sector where possible, and obvious candidates have been port companies. Hence it can be argued that many governments have claimed to be fulfilling coastal monitoring obligations at least partially through imposing environmental management standards on large coastal operators like port companies. By contrast, when implemented this often takes the form of monitoring programs that focus on when port companies may be undergoing significant dredging operations, and hence not focused on understanding or managing the other sources of sediment loads and trends in background conditions.

So why is this potentially a problem? From the perspective of the port company, having a high background turbidity implicitly incentivises dredging operations to produce dredge plumes that push up to the envelope of natural variability. This can lead to the phenomena often labelled as shifting baselines, development creep or in the case of fisheries, Pauly's ratchet (Pauly, 1995). Furthermore, given that often the only background monitoring data available comes from these monitoring programs, there is no mechanism to understand the causes or context of the background levels. Development proponents are then incentivised to argue that the high background levels are not associated with port operations, but rather are the result of mismanagement of land-derived sediment loads or are somehow naturally occurring. However given that the only data comes from port monitoring, these data are rarely suited to seeking cause-effect relationships linking other sources of sediments to turbidity levels, or for ascertaining if they are in fact entirely natural. For example, it may be the case that long term fishing activities using benthic trawls has led to loss of filter feeders that previously acted to maintain high water clarity (Gilkinson et al., 2003). Similarly, changes in land use may have drastically increased sediment loads into the coastal zone. All of these may have contributed to an elevated background turbidity. However environmental monitoring associated with port operations will often not be able to discriminate these influences as it