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Opening up the coast

Alexander G. Rumson*, Stephen H. Hallett

School of Water, Energy and Environment, Cranfield University, Bedford, UK

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ABSTRACT

Coastal zones attract human settlement, business and industry, and are instrumental to the functioning of societies both in coastal states and the wider global community. However, the oceans and coasts are under growing pressure as human practices change, populations rise and climate change impacts increase. In managing coastal regions, high quality data forms the basis of rational decision-making. Large volumes of 'triple bottom line' data exists representing a wide variety of environmental, social, and economic themes in coastal regions. Such data is especially crucial to development of environmental risk evaluations for the coast. The momentum driving the Open Source data movement across the world is accelerating and consequently, huge quantities of data are becoming freely available to the public. This presents a valuable opportunity for coastal managers, policy makers and land planners, who need to evaluate the full implications of their choices. Decision-makers frequently need to draw on many disparate datasets. However, this can be complicated by many factors, including a lack of awareness of the full range of datasets available. This paper seeks to explore this area, taking the UK as an example, to reveal how currently available open data sources relate to coastal management decision-making. Environmental risk management is a cross-cutting theme, relevant to all areas of coastal management. As such, this topic is discussed and addressed within a case study focusing on the vulnerable coastal region of East Anglia. In collation and analysis of coastal data Geographical Information Systems (GIS) can play an important role, in line with this GIS approaches were utilised within the case study. The case study led to development of a conceptual framework which can be applied to future coastal risk assessments, using Open Source data. The UK is currently at the forefront of the Open Source data movement and as such it is used as an example within this paper, however the issues addressed have international relevance, and the UK perspective is used to illustrate wider opportunities, resulting from freely available data sources, extending to management of coastal regions globally.

1. Introduction

Coastal regions are home to the majority of the Earth's population and therefore 'much of the world's economy, is at least partly dependent upon the health and integrity of coastal resources' (Misdorp, 2011, p.9). Coastal zones provide jobs, ports, recreation areas, energy generation and ecosystem services, and have been ranked 'among the top places in the world in terms of population and value accumulation' (Kron, 2013). In recent times coastal regions have experienced 'amenity driven growth' (Roberts, 2012). Yet examples from across the world (such as highlighted by Cooper and Mckenna (2009)) indicate how economic growth has also produced negative impacts for sustainability in coastal zones, as settlements have formed in high risk areas (Cooper and McKenna, 2009). Such risk can be seen as the product of a high probability of a hazard event and the severe consequences which result (Kron, 2013; Nicholls et al., 2015; Filatova and Veen, 2006; Filatova et al., 2011; Dávila et al., 2014; Defra, 2009; Dodds, 2009; Defra, 2005; Goverment Office for Science and Foresight Future Flooding, 2004; Viavattene et al., 2015). Consequences are generally calculated in relation to potential impacts (monetary damage and human casualties) (Filatova et al., 2011). The highest risk levels are generally experienced in locations having the highest concentration of people and value, and where there is a likelihood that a threatening natural event (for example a storm surge) may occur (Kron, 2013). Coastal hazards are normally associated with 'weather hazards', the most common being the storm surge, which can inundate low-lands (Deeming, 2008). Pollution represents another significant consequence of increased human usage of the marine environment. Rodwell et al. (2014) draw attention to prominent public concern over land-based industries polluting the marine environment. Threats presented by high levels of pollution and seawater inundation are both exacerbated by catalyst factors such as climate change, increasing coastal population densities, and resource

* Corresponding author. School of Water, Energy and Environment, Building 53, Cranfield University, Bedford, MK43 0AL, UK.
E-mail address: al.rumson@cranfield.ac.uk (A.G. Rumson).

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depletion. These factors can result in the impacts to humans and the environment being both more severe and extensive.

The process of managing coastal resources is fraught with challenges, due in part to the coast being an interconnected domain where stakeholders and users have competing interests which, invariably, do not align with optimal, sustainable solutions for regions. The role of data, information and knowledge within the process of coastal management is paramount. In line with the increased availability of datasets relating to the coast, 'data' has thus become a prominent theme of discussion within academe and the coastal management community. This has influenced approaches taken by governments in managing risk on the coast. In the 2000s coastal governance arrangements were often in flux (Fataleeva, 2011 in Nicholls et al. (2015). In many countries, changes occurred mirroring those in England, where the dominant approach of installation of hard adaptation measures (Mokrech et al., 2011) and maintenance of the current extent of sea defences, was recognised as unsustainable (Cooper and McKenna, 2009). Publications such as *The Foresight Future Flooding report* (Evans et al., 2004), exemplified a shift to a holistic, whole-shoreline approach to understanding and addressing coastal risk (Environment Agency, 2010). Yet it is argued that a disconnect still exists between scientific evidence and decision-making at a supranational level, such as within the European Union (Dodds, 2009). Nevertheless Open Source data initiatives are now seen to be 'transforming the availability and ease of access to high quality public sector data' (Smith, 2016), acting as a driver for increased utilisation of such data by coastal decision-makers. This is aided by the ability to collate and manage these diverse datasets using tools such as Geographic Information Systems (GIS). Access to many datasets, relevant to coastal management, is provided online in the form of web-services, which can be accessed in real time, reducing requirements to download and store data locally. This paper further seeks to raise awareness of the range of Open Source datasets available related to the themes of coastal management (taking the UK as an example), revealing how these datasets can be drawn on in applications evaluating coastal risk.

Within the domain of coastal management and maritime spatial planning, the requirement to embrace a process of evidence-based decision-making has been recognised (European Union, 2014), as opposed to prioritisation of the interests of those actors and organisations within society who wield power and influence. Access to information enables governments to make informed choices, and to explore alternatives. The requirement for information includes ecological, scientific, social and economic data (Kullenberg, 2010). This is recognised within a dominant coastal management process, being applied across the world, termed Integrated Coastal Zone Management, ICZM. ICZM encompasses a broad range of themes, and of these the threats posed by erosion and flooding represent a dominant focus of many coastal organisations, especially those within the case study site of this paper (East Anglia, UK). Yet coastal management covers a far broader remit than these issues alone. The broader themes outlined by England's Local Government Association Special Interest Group on Coastal Issues (The LGA Coastal SIG), (Table 1), provide a sound thematic basis to guide an understanding of these issues. This clearly illustrates the broad range of areas which coastal managers must contend with, and necessitates their drawing upon a wide-ranging variety of data sources, to generate an expansive knowledgebase. This paper expands upon these themes; Fig. 1 relates these themes to Open Source coastal datasets, further illustrating how adoption of a thematic approach can enable freely available information relating to these topics to be easily located. Although the main examples drawn on in this paper relate to the UK, similar data sources exist within other countries, therefore the examples given are used to illustrate wider opportunities that extend to managing coastal regions globally.

Table 1
Themes covered by the LGA Coastal SIG position statements.

Coastal Management Areas
1. Integrated Coastal Zone Management
2. Energy
3. Managing Fisheries
4. Minerals and Dredging
5. Ports and Harbours
6. Marine Planning
7. Waste Management
8. Beach Management and Inshore Bylaws
9. Coastal Access
10. Marine Protected Areas
11. Marine Pollution
12. Coastal Regeneration and Economic Prosperity
13. Coastal Adaptation

2. Data use within coastal risk analysis

Coastal datasets originate from a vast array of sources, the majority (90%) of reported data collection for the coast of the UK being from publicly-funded sources (Dyer and Millard, 2002). This is data collected by the national government, environmental bodies, national mapping and charting agencies and government (sponsored) data collectors (such as universities, private companies, local authorities and non-governmental organisations). However, not all data collection relates to public projects. On the coast of East Anglia, for example, private data gathering is also frequently undertaken. One example of this is a bathymetric survey that Bourne Leisure group commissioned of the inshore area fronting a stretch of coast owned by the company in Suffolk. This formed part of their investment in private coastal defences (The Lowestoft Journal, MPC Marine Planning Consultants). Also, many high-quality datasets are retained by energy companies, who have conducted independent surveys of inshore areas. The Crown Estate partially addresses this issue through a mandatory requirement for data and reports generated from renewable energy projects in UK waters, to be made available to the public after a specified period. The Crown Estate makes this information available to the public via its web portal, the 'Marine Data Exchange' (The Crown Estate). Beyond the UK there are many organisations who collect data and make this available at a regional and international level. NOAA (the National Oceanographic and Atmospheric Administration) (NOAAa) in the USA, is one such example; others from Europe being EMODnet (EMODnet), HELCOM (Helcom) and OSPAR (OSPAR) (more details are provided of these organisations in the supplementary material, available online). In addition to this, global coastal datasets collected using Earth Observation (EO) satellites, are available for free, from sources such as Copernicus (Copernicus), who host a Marine environment monitoring service.

Evaluation of risk in coastal regions, is a process reliant on the availability of accurate information sources. Coastal datasets generally represent raw facts and figures, whereas processing of this data generates information outputs, usable in decision-making. This information can be further transformed to encapsulate understanding, which in turn can form the basis of knowledge (Anderson, 1991). Coastal risk calculations involve recognition of specific hazards present on the coast, broader coastal vulnerability, the potential impacts of these to society and the environment, and the role offered by adaptation measures. Given this, information needs to be acquired detailing past and existing occurrences of coastal hazards, as well as estimations of their future probability. Data relating to human activity and use of coastal regions is also essential, as this helps determine how vulnerable an area is (in anthropocentric terms) and the consequences which can result from the occurrence of hazard events. Table 2 identifies potential types of data and information that could be included in a risk evaluation relating to a given stretch of inhabited coastline. These data types are split between the data themes typified within the 'Triple bottom line approach'