Introduction

The definition of coastal zones, regions or areas is variable; entrenched in laws for the purpose of regulation or by the scientific community in relation to research and classification. In considering the definition (Box 1) we can start to consider why these areas are important; these areas provide essential ecological services for fisheries production, nutrient cycling, coastal defence, as well as services for humans, such as residential living, recreation, commercial, navigation, wastewater disposal and tourism activities (after Daforn et al, 2016).

A schematic of coastal ecosystem services is provided in Figure 1. Ecosystem services are “contributions given by the environment that support, sustain and enrich human life” (Yoskowitz et al, 2010). Few studies have established ecosystem value in monetary terms for the ecosystem components specific to the Arabian Gulf (the ‘Gulf’), however one recent region specific study estimates that the “present value of the regional economic loss of not protecting wetlands by 2050 is between US dollar 2.3 billion and US dollar 7.2 billion (expressed in 2007 US dollars) (Eppink et al 2014)”. Intrinsic worth is harder to value but it is clear that throughout the world coastal environments and the natural contained within have long since been desirable locations to live and work.

Coastal development requires the modification of natural systems and can range in scale, intensity and permanence; physical alteration and the destruction of habitats are regarded as one of the most significant threats to coastal areas (UNEP, 2008).

The physical changes required to enable development typically involve the creation of permanent modifications to coastal features which often involve the construction of hard engineered structures and removal of coastal habitats.
Regional context

Historical development of communities within the Gulf is inherently linked to the coast; the area provided a major food source and revenue from fishing, income from pearl mining and access to trading areas from overseas trade routes to the sub-continent. In more recent times the coastal areas in the region have seen massive unprecedented changes (Burt, J (2014), Van Lavieren et al 2011). Discoveries of hydrocarbons and subsequent exploitation and associate revenues have seen a concomitant increase in coastal development. The southern Gulf is now home to numerous ports, major cities, offshore and nearshore oil and gas facilities, as well as industrial developments (no fewer than 199 desalination are reported plants lie within the GCC area together with associated intakes and outlets (Dawoud & Mulla, 2012).
Coastal development in the region cannot be discussed without noting the ambitious and complex dredging and reclamation activities; Dubai is famous for its Palm Jumeirah, Palm Jebal Ali and ‘World’ developments, however dredging and reclamation schemes are present throughout the region.\(^6\)

**Sustainable development challenges**

**BOX 2 - Sustainable Development:**
“development which meets the needs of the present without compromising the ability of future generations to meet their own needs.”

*Brundtland report, Our Common Future, 1987.*

Box 2 sets out the familiar definition of sustainable development, but what does this mean in the context of coastal systems? Meeting the demands of current generations but not at the detriment of future generations means maintaining functionality of ecosystems. Fundamentally this involves maintaining and enhancing natural systems for use by future generations. Accounting for climate change, the pressures on the marine systems with the Gulf have perhaps never been greater.

The Gulf is a shallow sea, and due to its geographical location and morphology it experiences great extremes of temperature and salinity. Notwithstanding the harsh conditions the coastal habitats are varied and include saltmarshes and sabkhas, algal mats, rocky shores, beaches and mangroves together with macroalgal beds, seagrass meadows and reef communities. Development and its associated changes to natural systems push environmental limits further resulting in environmental degradation and habitat losses.

Considering urban development against the backdrop of the unique and harsh coastal environment of the Gulf, how can development and economic aspirations continue whilst reversing the trend in coastal damage?

**Meeting the challenge**

Internationally a wealth of information exists documenting the approaches to more effective coastal management; from the evolution of Integrated Coastal Zone Management (ICZM)\(^8\) and Ecosystem Based Management to activity specific guides, the subject continues to evolve specifically with increased global consensus on adapting to the effects of climate change.

Table 1 proposes just some of the considerations that could be incorporated within formal plans and strategies aimed at improved approaches to coastal development with associated benefits.
**Table 1: Considerations for improved coastal management**

|-------------------------------------------------------------------------------|----------------------------------------------------------------------|----------------------------------------------------------------------|----------------------------------------------------------------------------------|
| **Restore and maintain ecosystem functionality**                              | To preserve and enhance the services (and therefore economic benefits from natural systems). | • Decreasing the ecological footprint of coastal and marine infrastructures  
  • Inclusion of ecological enhancement* and soft engineering techniques – knowledge transfer from proven case studies.  
  • Increase engineering 'buy in' – pilot studies that harness urban marine structures for biological and ecological purposes without compromising function.  
  • Further designate protected areas/ controlled use zones. | • Safeguard, improve and enhance natural systems and associated valued services.  
  • Reduce need for hard engineered and costly coastal protection measures.  
  • Reduced capital costs through innovative cheaper 'soft' engineered solutions.  
  • Create more visually appealing coastlines. |
| **Improved regulation of industrial and commercial users / Strengthened institutional frameworks** | Avoid, eliminate and reduce inputs to coastal systems to improve water quality and avoid secondary impacts.  
To provide clear unambiguous requirements for future development.  
Reduce fishing pressure to allow fish stock recovery. | • Work with users for operational improvements.  
• Increase awareness of developers, operators and regulators  
• Empowered regulators  
• Training for alternatives to fishing.  
• Integrated schemes to enhance fishing grounds and nursery areas. | • Incentivize operational improvement which may have longer term benefits to operators (reduce economic losses from fines and inefficient operations)  
• More diversification of occupations.  
• Long term safeguard of fisheries resource. |
Abu Dhabi’s draft Plan Maritime 2030 marks a clear acknowledgement of the benefits of more organized planned approach to coastal development. Elsewhere in the region governments are placing more thought on the way coasts are used; an ICZM committee exists within Qatar with new policies anticipated in the near future, and in Dubai the regulator has published a technical manual on guidelines to be followed in infrastructure development. On a project basis a collaborative effort between scientists, marine engineers, landscape architects and policy makers is needed from scheme conception to construction and monitoring. Whilst not always easy to do it can be done - for the sake of marine ecosystems of the Gulf let us hope it catches on.

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<td>Improve environmental research and monitoring</td>
<td>How can we know what is and isn’t working if we don’t monitor?</td>
<td>• To effectively manage new and existing marine artificial structures research is required to understand ecological principles within the engineering designs of marine structures. • Collaboration between private entities, regulators and research bodies.</td>
<td>• Development of datasets with commercial value to third party developers. • Increase revenues from fines of noncompliance. • Development of local capacity by involving local researchers.</td>
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<td>Regional cooperation and data sharing</td>
<td>To make use of scientific data to underpin decisions and help drive the development of better and more innovative approaches to development.</td>
<td>• Make use of intergovernmental bodies (i.e. ROPME) • Improve collaboration through regional research institutions • Develop in country data portals at ministries and environmental regulators.</td>
<td>• Reduce duplication of effort in acquiring data (and associated costs). • Increase understanding of issues amongst senior leaders.</td>
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* Using nature to improve the sustainability, resilience and multifunctionality of hard urban infrastructure*"after Naylor et al. 2011"
Further reading:

http://unesdoc.unesco.org/images/0018/001865/186559e.pdf
http://www.unep.org/ecosystemmanagement/

References