How System Dynamics Modelling Can Support MSP In The WIO Region

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Background
Increasing demands on ocean space and resources are resulting in a decline in ocean health with direct and indirect knock-on effects on human uses. There is therefore a growing need to adopt integrated ocean governance approaches, which has led to widespread adoption of the marine spatial planning process. Marine spatial planning entails managing the spatial and temporal complexity of marine uses in order to achieve desirable social-ecological outcomes. It has been adopted globally to facilitate a transition to a sustainable oceans economy, including in the Western Indian Ocean region. In support of the MSP process, this study proposes the application of a systems analysis approach, and exclusively system dynamics modelling, to explore the temporal change in marine uses and associated user conflicts under alternative growth scenarios.

Method
We developed the Algoa Marine Systems Analysis Tool (AlgoaMSAT), an exploratory system dynamics model that provides a platform for scenario and trade-off analyses. Algoa Bay, South Africa, was chosen as an appropriate study area because it is experiencing a rapid expansion of marine activities, coupled with a growing uncertainty regarding marine sustainability outcomes. AlgoaMSAT consists of seven sub-models, five of which represent selected marine uses in Algoa Bay, and the sixth and seventh which integrate the outputs from each marine use in terms of sustainable management indicators (marine health, marine wealth and marine labour). Model development, an iterative process, was supported through a collaborative modelling process, which entailed engaging with multiple stakeholders to integrate the knowledge on different marine sectors’ activities, impacts and planning visions into the model framework.

Results
Model results were generated under various scenarios to investigate changes in the growth of marine activities and marine sustainability indicators under different levels of ocean governance. Model results showed that current ocean governance practices are ineffective in sustaining the projected growth of the marine uses, particularly for uses that are vulnerable to negative feedback effects from changes in marine health. To alter these growth trajectories will require multiple, cross-sectoral management interventions that are directed towards the ‘deeper leverage points’ that are able to maintain the
growth of marine activities within appropriate management limits defined by both infrastructure capacity and marine health thresholds.

**Conclusion**
Using the model interface, decision-makers and stakeholders can further use the model to explore the temporal change in marine activities under alternative policy interventions or global change scenarios. Such analytical assessments and tools are critical to progress the ecosystem-based management approach to MSP, as is required to achieve global sustainable development goals. Follow up research will aim to explore methods to soft couple the model results with spatially explicit software (e.g. Marxan) to inform spatial-temporal scenarios. The researchers further aspire to apply and adapt the model to similar transdisciplinary marine planning areas in the WIO region.