DUAL ADAPTIVE CYCLES IN IMPLEMENTING INTEGRATED COASTAL MANAGEMENT

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ABSTRACT

Despite the place-based nature of integrated coastal management (ICM) implementation and the importance of considering country-specific knowledge, a number of uniformities in ICM implementation have been distinguished. In this paper, the theoretical validation of a place-based ICM implementation model developed for South Africa's sector-based governance system is undertaken using predefined theoretically-based evaluation criteria derived from such uniformities. Using an incremental, adaptive research process, the original place-based model is evaluated and then refined to enhance its theoretical validity. During the refinement of the implementation model, two interdependent yet distinctive cycles, the resource cycle and the actor cycle, emerged. The dual cycles in ICM implementation represent the process of inclusive ecosystem-based resource management (the resource cycle) capacitated by a supporting network of actors (the actor cycle). The new model incorporates insights from the recent literature on adaptive management in the fields of integrated water management and social-ecological systems into ICM theory and practice. Further, the learning-by-doing process that characterizes ICM implementation is expanded by connecting place-based design and theoretically-based learning.

Key words: Coastal governance, Adaptive management, ICM practice, Ecosystem-based management, Co-operative environmental governance

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1. Introduction

The place-based nature of integrated coastal management (ICM) implementation and the importance of considering country-specific knowledge are well documented in the literature. This is apparent from lessons learnt in ICM implementation, the topic of several review articles including those by Christie (2005), Christie et al. (2005), Cicin-Sain and Knecht (1998), Lowry et al. (1999); Olsen (1998); Olsen and Christie (2000), Shipman and Stojanovic (2007), Stojanovic et al. (2004), Sørensen (1993), Tobey and Vlok (2002) and Yao (2008). Frameworks and implementation models for ICM vary and include the cross sectoral integrated coastal area planning (CICAP) process (Pernetta and Elder, 1993), the model proposed by the Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection (GESAMP, 1996), the World Bank Guidelines (Post and Lundin, 1996), Olsen's ICM cycle (Olsen et al., 1997, 1999), the ICM guidelines of Cicin-Sain and Knecht (1998), the European Union Integrated Coastal Zone Management Recommendations (European Commission, 2002), the Canadian Integrated Management model (DFO, 2002), the Australian implementation model (NRMMC, 2006) and the flexible cyclical umbrella model proposed by the Global Programme of Action for the Protection of the Marine Environment from Land-based Activities (GPA) (UNEP/ GPA, 2006). A more detailed assessment and a comparison of these ICM models are provided in Taljaard et al. (2011), whereas the extension of the earlier, more result-based approaches (Binnendijk, 2000; Dearden and Kowalski, 2003) to ICM implementation is described in Taljaard et al. (2012). In the latter work, elements from the ecosystem-based management paradigm (Balchand et al., 2007; Moomaw, 1996; UNEP, 2006), the spatial planning paradigm (Agardy, 2010; Douvere, 2008; Ehler and Douvere, 2009; Halpern et al., 2008; Halpern et al. 2012; Jentoft and Chuenpagdee, 2009) and the cooperative environmental governance paradigm (Biermann and Pattberg, 2008; Cicin-Sain and Knecht, 1998; Hague and Harrop, 2007; Henocque, 2001; Paavola, 2006; Van Wyk, 2001) are introduced into ICM implementation and a prototype implementation model specifically adapted to sector based governance systems is developed (Taljaard et al. 2012). Aspects from these three paradigms were specifically identified in the literature as requiring serious consideration in the implementation of ICM (Crowder and Norse, 2008; Norse, 2008; Weinstein et al., 2007) and proved to be the critical means of achieving integrated implementation in the sector-based governance system of South Africa (Taljaard et al., 2012).

Despite the strong place-based nature of ICM implementation, Stojanovic et al. (2004) observed a number of uniformities in their review of ICM successes worldwide. They determined nine factors important for successful ICM on the basis of a grounded theoretical assessment, yet did not connect the factors to easily recognizable elements of ICM practice. Taljaard et al. (2011) extend on the work of Stojanovic et al. (2004) to determine a set of fourteen theoretically based criteria against which the scientific credibility of contextual, place-based ICM implementation models may be validated. The evaluation criteria comprise a consolidation of ICM learning rooted in a deep and extensive scientific review.

As the usability of the prototype model in a sector-based governance system has been established empirically (Taljaard et al., 2012), the testing of the prototype model against the theoretically derived criteria forms a necessary next step in establishing the extent of its scientific credibility and wider applicability. Using the fourteen theoretical evaluation criteria, shortfalls are identified. Recent literature on adaptive management in the fields of Integrated Water Management (IWM) and Social-Ecological Systems (SES) is consulted and further insights regarding potential modifications to the ICM implementation model are derived. This represents a new iteration in the learning-by-doing approach that characterizes ICM practice by connecting place-based design and theoretically-based learning.

The literature on IWM reveals that the goals of IWM implementation strongly resemble the goals of ICM, including a) strong enabling environment, encompassing goal setting, legislation and financial allocation mechanisms, b) clear, robust and comprehensive institutional roles, including stakeholder participation, and c) effective use of management and technical instruments (Lenton and Muller, 2009, Butterworth et al., 2010). As with ICM, many implementation challenges have been encountered in attempting to implement IWM. New learning reveals that choosing smaller spatial management units (e.g. aquifers or wetlands) rather than the large spatial management units of a river basin or catchment allows for more effective implementation (e.g. Wester and Warner, 2002; Lankford and Hepworth, 2010). Scholars in IWM now argue for a much greater focus on locally rooted, pragmatic and adaptive approaches that encourage integration from within sectors and build upon existing institutions and participation mechanisms (Pahl-Wostl et al., 2007, Butterworth et al., 2010, Moriarty et al., 2010, Moss and Newig, 2010). The value of approaching integrated resource management in an incremental, adaptive manner, and the importance of appropriately engaging actors at all levels, emerged from practical experiences in both IWM and ICM. The EMPOWERS approach is representative of such a form of IWM implementation (Moriarty et al., 2010). Conceptually, the approach comprises two pillars, namely the stakeholder dialogue and concerted action (SDCA) and a framework. The SDCA engages actors at all levels in facilitated dialogue to take agreed action, while the framework or programme cycle guides and structures the actor dialogue process along a number of steps, including visioning, assessing, strategising, planning, implementing and reflecting. This glimpse into IWM implementation recalls the typology of ICM contexts of Cicin-Sain and Knecht (1998) where the framework or programme cycle can be thought of as their context of problems and opportunities present in the coastal area and the goals and objectives of ICM (‘the what and the why’), established by the socio-economic and physical variables within the coastal unit under consideration. The SDCA represents an expansion of their capacitating elements (‘the how and by whom’) beyond the realm of purely political variables.

The recognition that effective implementation of ICM and IWM requires continuous interconnection between people and the natural resource base is echoed in the social-ecological systems literature (Berkes et al., 2003, Turner et al., 2003, Steffen et al., 2004, Folke et al., 2005). This body of literature posits adaptive governance as the means of achieving sustainable and balanced resource management under varying environmental conditions (e.g. Anderies et al., 2004, Folke et al., 2005). Glavovic (2008) demonstrates the value of addressing social complexities in coastal governance, a concept from the social-ecological systems field, along the coast of New Zealand. Other examples include the inclusive, participatory, joint governance structures of the UK's coastal partnerships (Stojanovic and Barker, 2008) and the Saldanha Bay Water Quality Forum Trust in South Africa (Van Wyk, 2001, Taljaard et al., 2006).

In this paper, we take a further step in an incremental and adaptive research process (Newman et al., 2002), by evaluating the scientific credibility of the prototype implementation model specifically adapted for sector based governance systems (Taljaard et al., 2012). Using the fourteen theoretical evaluation criteria distilled by Taljaard et al. (2011), shortfalls are identified. On the basis of this evaluation, and drawing on recent IWM and SES literature, a refined implementation model is developed. In the refined model, the ICM implementation process emerges as two interlocked adaptive cycles – a novel understanding. Finally, we offer this iterative learning process as a means of bridging the divide between practice and theory in designing and refining ICM implementation models.

2. Approach and Method

Following a design science approach (Bots, 2007), we undertake the next stage in our adaptive, step-by-step research process (Newman et al., 2002) to refine a prototype ICM implementation model (Taljaard et al., 2012), embarking on its theoretical validation (Figure 1). In the first stage of the design science approach, the prototype model was developed by drawing on the strong issue-based approaches applied in traditional ICM implementation models (e.g. Pernetta and Elder, 1993, GESAMP, 1996, Post and Lundin, 1996, Olsen et al., 1999, UNEP/GPA, 2006), which are grounded in the result-based management paradigm. Specifically, aspects of ecosystem-based management and spatial planning as well as elements of cooperative environmental governance (i.e. institutional structures and arrangements, capacity building, and public education and awareness) are included in the prototype model. The ICM implementation model is represented as a cyclical process. The cyclical process emphasises the importance of continuous adaptation based on new learning, thus allowing for a systematic refinement of the overall implementation process, and reflects the adaptive policy cycle of Plan-Do-Check-Act (UNEP/GPA, 2006). While the importance of identifying specific tasks in the management cycle and articulating their logical sequencing is commonly understood as necessary, here it is the informed and well established three support elements that are viewed as the crucial drivers in the successful and sustainable implementation of ICM. A key distinguishing characteristic of the prototype model is that it accommodates sector-based management programme silos, by anchoring these in the overarching Resource: Vision, objectives and zoning; and the Monitoring and evaluation components of the management cycle (Figure 2). This implies that management programmes, even though sector- or issue-based, remain nested in an ecosystem-based approach subservient to the agreed requirements and needs of the coastal ecosystem.

The second stage in the design science approach involved an empirical validation to assess the usability of the prototype and its compatibility with a sector-based governance system using empirical information derived from a South African case study (Taljaard et al, 2012). Results indicated compatibility and alignment with coastal management practices in South Africa, with shortcomings ascribed to the lack of, or inefficiencies in, operationalizing existing legislation, rather than any inherent conflict between the prototype model and the existing sector-based statutory framework. This indicates the potential suitability of the model for countries with similar coastal management milieus. The next stage of the incremental, adaptive process is the theoretical validation followed by the refinement of the prototype implementation model (Figure 1).

The theoretical validation step is undertaken in this paper using the evaluation criteria developed by Taljaard et al. (2011) for evaluating the scientific credibility of ICM implementation models. Adopting a stance of critical realism (Sayer 2000), Taljaard et al (2011) used paradigms (cf. Frantzeskaki et al. 2010) to frame uniformities (cf. Stojanovic et al. 2004) in ICM implementation. The paradigms in integrated environmental management (IEM) implementation, the broader domain within which ICM practice is nested, were characterized in terms of their key concepts. The key concepts of the paradigms were then used to distil uniformities in ICM practice as described in ICM review articles over the previous two decades (e.g. Sørensen, 1993, Cicin-Sain and Knecht, 1998, Olsen et al., 1997, Olsen 1998; Olsen et al. 1999, Olsen and Christie, 2000, Lowry et al., 1999, Tobey and Vlok, 2002, Stojanovic et al., 2004, Christie, 2005, Christie et al., 2005, Yao, 2008). This resulted in a set of fourteen building blocks, identified as forming the evaluation criteria. As such the evaluation criteria comprise a consolidation of ICM learning rooted in a deep and extensive scientific review. This accords with the Newman et al. (2001) approach which emphasises the importance of placing research in an appropriate theoretical framework, and in the context of previous work conducted in a specific field. During the theoretical validation, insights regarding the scientific credibility of the prototype implementation model emerged, leading to the identification of shortfalls and the further refinement of the model – the 'artefact' arising from this stage in the design science approach of Bots (2007).

3. Evaluating the Scientific Credibility

The theoretical soundness of the prototype implementation model (developed by Taljaard et al., 2012) is established by assessing its compliance to the fourteen evaluation criteria derived in Taljaard et al. (2011). This assessment reflects the extent to which scientific learning on the uniformities in ICM practice is incorporated in the prototype. The outcome of the evaluation is presented below by dealing with each criterion in turn.

Criterion 1: *Model acknowledges participatory, actor involvement.*

Compliant. The prototype model acknowledges participatory, actor involvement. The concept of support elements (i.e. institutional structures and arrangement, capacity building, public participation and awareness) in the prototype design was incorporated to explicitly acknowledge important avenues through which participatory, actor involvement can be achieved, primarily by addressing the organisation of and cooperation between different actor groups which is crucially important in integrated management initiatives such as ICM.

Criterion 2: *Model acknowledges valid and relevant scientific information and knowledge (scientific support) as an integral element.*

Non-compliant. The prototype model does not explicitly acknowledge valid and relevant scientific information and knowledge (scientific support) as an integral element in ICM implementation. The accessibility and use of valid scientific information, knowledge and decision support was implicitly assumed in the prototype model. As such, policy-related science and technology was not explicitly incorporated as an essential support element for environmental decision making and problem solving in ICM.

Criterion 3: *Model requires clear process management to be adhered to so as to achieve a desired outcome.*

Compliant. The prototype model requires clear process management to be adhered to to achieve a desired outcome. The prototype design is presented as a cyclic framework that is transparent regarding the different components in the ICM implementation process. Also, in the management programmes component the prototype model proposes the identification of specific sectors (or activities) for which generic management objectives must be achieved to facilitate a focussed approach to the development and implementation of action plans within the different sectors.

Criterion 4: *Model requires cooperative institutional structures – across tiers of government and sectors and with clearly defined roles and responsibilities, embedded in a sound legal framework.*

Compliant. The prototype model requires cooperative institutional structures across tiers of government and sectors having clearly defined roles and responsibilities embedded in a sound legal framework as critical elements for effective implementation of ICM. The prototype design explicitly incorporates the establishment of appropriate cooperative institutional structures as a key support element (i.e. institutional structures and arrangements). These structures may include specific sector-based institutions (e.g. residing in a single sector), multi-level institutions (e.g. facilitating communication of strategies and actions between different tiers of governance in a top-down but also a bottom-up approach) and cross-sectoral institutions (e.g. facilitating collaboration and partnerships between the different sectors in government, business, civil society and the scientific and professional communities).

Criterion 5: *Model requires the establishment of overarching (common) objectives, and associated indicators and targets related to the (central) coastal system against which to measure compliance (i.e., providing the environmental limits or thresholds of potential concern to* *be adhered to by activities potentially affecting the coastal system), as well as to assess results-based outcomes (i.e., extent to which ICM initiatives were able to achieve such overarching objectives for a coastal system).*

Compliant. The prototype model requires the establishment of overarching (common) objectives, and associated indicators and targets related to the (central) coastal system against which to measure compliance, as well as to assess results-based outcomes. The prototype design is explicit about the establishment of objectives and associated indicators and targets. It distinguishes between two types of objectives, namely resource objectives (addressed in the resource vision, objectives and zoning component) and management objectives (addressed in the management programmes component). Resource objectives refer to those objectives specifically related to the resource (i.e. the coastal system) and its uses. For example, what is required from the coastal marine environment and what are the indicators and measurable targets that will indicate the successful outcomes for such objectives? Management objectives refer to objectives and associated indicators and targets set for specific sectors (or activities) in order to ensure compliance with the resource objectives. For example, what are the requirements for wastewater disposal to the marine environment and what are the effluent standards to be enforced so as to meet the target values associated with the overarching resource objectives?

Criterion 6: *Model requires monitoring and evaluation programs to be established.*

Compliant. The prototype model requires monitoring and evaluation programmes to be established. The model views monitoring and evaluation as a distinct component in the implementation process, where the selection of appropriate indicators and measureable targets is considered essential to providing quantitative measures to evaluate progress in the operationalisation of ICM. Such indicators can be adopted from those predetermined for the resource and management objectives but can also include process indicators that provide quantitative measures to evaluate progress in, for example, the development and efficiency of institutional structures, capacity building and public education and awareness initiatives.

Criterion 7: *Model considers the coastal ecosystem in its entirety (i.e., as a social-ecological system) with the coastal system as the central focus (rather than specific issues, problems or sectors) through which cooperative governance occurs between different sectors – the essence of the ecosystem-based approach.*

Compliant. The prototype model considers the coastal ecosystem in its entirety with the coastal system as the central focus through which cooperative governance occurs between different sectors. The reason for introducing the resource vision, objectives and zoning component was to explicitly introduce the ecosystem-based approach into an implementation model. The establishment of an overarching vision and resource objectives for the coastal ecosystem in its entirety (i.e. considering ecological, social and economic aspects) provides a means of centralising the requirements of the ecosystem and its goods and services as a common benchmark for different (often sector-based) management programmes of activities in and around the ecosystem.

Criterion 8: *Model requires the delineation of coastal management units and the geographical demarcation as well as geographical zoning of different uses or use areas within management units.*

Compliant. The prototype model requires the delineation of coastal management units and the geographical demarcation, as well as geographical zoning of different uses or use areas within management units. In the model resource vision, objectives and zoning component, the geographical demarcation of the boundaries of coastal management units, as well as the geographical demarcation or zoning of uses or use areas within the management unit are addressed. However, explicit recognition of this component could enhance implementation success (cf. Wester & Warner 2002; Lankford & Hepworth 2010).

Criterion 9: *Model presents ICM as an iterative, adaptive process.*

Compliant. The prototype model presents ICM as an iterative, adaptive process. The prototype design is presented as a cyclical process to emphasise the importance of continuous adaptation based on new learning, thus allowing for a systematic refinement of the overall implementation process.

Criterion 10: *Model acknowledges the concept of ecosystem limitation.*

Compliant. The prototype model acknowledges the concept of ecosystem limitation. Although the design is not explicit in this acknowledgement, it is inferred in the resource vision, objectives and zoning component where stakeholder agreement on uses or use areas within a coastal management unit is required and, importantly, that such uses or use areas are geographically demarcated or zoned. A prime reason for including this aspect in the prototype design is the experience of the primary author in marine water quality management where the explicit mapping of uses proved to be the most suitable approach to acknowledge and address potential cumulative or synergistic effects of numerous activities occurring in a single coastal system. This gives credence to the limits of the ecosystem.

Criterion 11: *Model requires an enabling legal framework.*

Compliant. The prototype model requires an enabling legal framework. In the management programmes component the prototype model explicitly acknowledges the importance of an enabling legal framework in different sectors to facilitate effective management and control of the activities within a specific sector (i.e. as one of its management objectives).

Criterion 12: *Model acknowledges continuous development of education and awareness as an integral element.*

Compliant. The prototype model acknowledges continuous development of awareness as an integral element in ICM implementation. The prototype design explicitly incorporates public awareness programmes as a key support element (i.e. public participation and awareness) which is considered as one of the important avenues to facilitate participatory, actor involvement in the implementation of ICM.

Criterion 13: *Model acknowledges continuous capacity-building programs as an integral element.*

Compliant. The prototype model acknowledges continuous capacity-building programmes as an integral element in ICM implementation. The prototype design explicitly recognises the decisive role of appropriate capacity-building programmes in sustaining effective implementation of ICM, as reflected in the capacity building support element.

Criterion 14: *Model acknowledges sound funding structures (financial support) as an integral element.*

Non-compliant. The prototype model does not acknowledge sound funding structures (sustainable financial support) as a key support element for the implementation of ICM.

The prototype is found to comply with twelve of the fourteen evaluation criteria. The two criteria to which it does not comply are Criterion 2 (*Model acknowledges valid and relevant scientific information and knowledge (scientific support) as an integral element)* and Criterion 14 (*Model acknowledges sound funding structures (financial support) as an integral element.* The omission of these elements as vital support elements to an ICM implementation process is viewed as a shortfall in the prototype implementation model. Additionally, while compliant with Criteria 8 (*Model requires the delineation of coastal management units and the geographical demarcation as well as geographical zoning of different uses or use areas within management units)*, more explicit recognition of this element is considered a potential improvement to the implementation model. The explicit recognition and inclusion of these elements, therefore, is explored in a refinement of the implementation model.

4. Refining the model – Dual Adaptive Cycles

Although the prototype model reflects the majority of the uniformities identified internationally as central to ICM implementation, its theoretical validity can be enhanced by the inclusion of the two missing support elements, namely scientific support and financial support. During the process of including and refining, the two elements were added to the three existing support elements depicted in the prototype. Subsequently the realisation dawned that these five elements together form a supporting network of actors. Further, such a network of actors is not conceived as a grouping of static support entities as depicted in the earlier representation of the prototype implementation model (Figure 1, Taljaard et al., 2012). Instead the actor network is viewed as a dynamic interaction between supporting elements acting to capacitate ICM implementation. Accordingly, two interdependent yet distinctive cycles emerge as prospective refinements to the implementation model. These two cycles represent the process of inclusive ecosystem-based resource management capacitated by the supporting network of actors. The refined model therefore incorporates these dual, adaptive cycles, coined the resource and actor cycles (Figure 2).

The resource cycle can be thought of as the context of problems and opportunities present in the coastal area and the goals and objectives of ICM ('the what and the why'), established by the socio-economic and physical variables within the coastal unit under consideration, distinguished in Cicin-Sain and Knecht's (1998) typology of ICM contexts. The actor cycle can be thought of as an expansion of their capacitating elements (i.e. 'the how and by whom'). For instance, experiences in marine water quality management in southern Africa revealed that socio-economic variables also play an essential role in 'the how and by whom'. For example, a nation's level of literacy influences the nature of public education and awareness programmes and the design of capacity building programmes. Further, the degree and speed of social change in South Africa since 1994 has highlighted the institutional dynamism that any implementation model needs to be able to accommodate. This aspect is less apparent within the stable institutional environment characteristic of many other countries e.g. north-west Europe, but is distinguished as an essential element in adaptiveness within the social-ecological field (Anderies et al., 2004; Folke et al., 2005). In this literature, the ecological system is viewed as intricately linked with and affected by the social system. In summary, the non-static nature of influencing variables within the resource and actor components supports the conceptualisation of both the resource and actor cycles as adaptive cycles.

The two cycles also closely resemble the two conceptual pillars of the Integrated Water Resource Management-based EMPOWERS approach (Moriarty et al., 2010); namely, a framework or programme component and a stakeholder dialogue and concerted action (SDCA) component that engages actors at all levels in facilitated dialogue aimed at taking agreed action. Interestingly, in this approach the framework or programme component is viewed as a means of *guiding and structuring* the actor dialogue process (SDCA) along a number of steps; that is, the framework serves the engagement process. This contrasts with our view of a process of inclusive ecosystem-based resource management *served* by a capacitating and supportive network of actors. The rationale for distinguishing the various components of the resource cycle and the different elements of the actor cycle are explained in the following sub-sections.

4.1. Resource cycle

The resource cycle primarily identifies distinct actions that are relevant to the management of the resource (i.e. the coastal marine environment) and the activities in and around that resource. Four of the five action components are the original components of the prototype implementation model (Figure 2, *Prototype model*). The inclusion in the refined design of the 'management unit demarcation' as a separate fifth component represents a distinct modification from the prototype implementation model. The geographical demarcation of coastal management units is so fundamental to ICM implementation that it warrants the addition of an explicit component in the resource cycle, rather than being hidden in the resource: vision, objectives and zoning component, as was the case in the prototype implementation model. Indeed, the importance of demarcating appropriate spatial management units formed a key learning point in the field of IWM in recent years (Wester and Warner, 2002; Lankford and Hepworth, 2010). The priority tasks for ICM implementation associated with each of the components of the resource cycle are summarised in Table 1.

Table 1. Summary of priority tasks associated with each of the action components in the resource cycle of the refined model

COMPONENT	PRIORITY TASK
Situation assessment	• Consolidate information on the coastal marine environment relevant to its management, including: - Status and importance of the coastal marine environment; - Key sectors (and associated activities) contributing to problems or posing threats to this environment; - Existing statutory and governing structures; and - Opportunities and constraints.
Management unit demarcation	• Delineate geographical boundaries of coastal management units, including large marine management units (typically covering extensive areas and subdividing a country's waters from a demarcated boundary inshore out to the seaward limit of the EEZ) to the smaller, local coastal management units (nested within larger management units).
Resource: Vision, objectives and zoning	• For a coastal management unit, agree on a common vision and shared resource objectives (including ecological, social and economic aspects). • Translate resource objectives into measurable targets using appropriate indicators within the coastal system or resource. • Map (or zone) agreed uses or use areas for zoned activities within the management unit (e.g. conservation areas, tourism and recreation, fishing zones, mariculture, port and harbour and navigation routes), as well as the location of activities posing potential threats within the management unit (e.g. exploration platforms, wastewater discharge sites, dumping areas).
Management programmes	• Identify sectors/activities for inclusion in management programmes. • Assess the following for each of the selected sectors/activities and identify shortcomings (future actions): - Management and control are adequately addressed in legislation (acts); - Regulations and/or best practices are available to guide effective implementation of the legislation, including best available technologies, specification of critical limits (e.g. effluent emission targets), minimum (compliance) monitoring requirements, and efficient penalty and/or incentive systems; - Effective implementation is achieved by executing and enforcing legislation, regulations and best practice using sufficiently skilled and motivated personnel, equipped with the appropriate material and financial resources throughout the planning and design, construction, operational and decommissioning phases of an activity; and - Compliance monitoring programmes are designed and implemented to measure the effectiveness of the management programme specifically related to the sector/activity. • Prioritise for operationalisation.
Monitoring and evaluation	• Develop and implement monitoring programmes on: - Achievement of actions and outputs (implementation monitoring); and - Achievements of outcomes and goals (results monitoring).

4.2. *Actor cycle*

ICM implementation is driven by people (actors) organised in collaborative institutional structures or networks that include partnerships within and between government, business, civil society, and the scientific and professional communities. These partnerships may evolve, changing over time as they are influenced by political and socio-economic variables. In essence, the actor cycle identifies the basic elements capacitating such actor involvement. Three of the elements in the actor cycle are original elements of the prototype implementation model (Figure 2, *prototype model*). The two missing elements identified during the evaluation of the scientific credibility of the prototype, namely scientific support and financial support, are included in the refined model (Figure 2, *refined model*). Of the five elements, the institutional structures (comprising cross-sectoral, multilevel institutional networks including all relevant actors) form the anchoring element in the actor cycle. The rationale for this lies in the nature of institutions as the accepted societal structures through which human interaction with and use of the environment is moderated (Crawford and Ostrom, 1995). The other elements in the actor cycle are the true supporting elements, contributing to the long-term success and efficiency of ICM implementation. The different elements comprising the dynamic, adaptive actor cycle are described briefly in Table 2.

Table 2. Elements in the actor cycle of the refined implementation model

ELEMENT	DESCRIPTION
Institutional structures	Appropriate, multi-actor institutional structures are the critical routes through which to achieve cooperative management of complex management processes such as ICM. These institutional networks need to include all actors relevant to specific issues and need to facilitate partnerships and collaboration between different sectors in government, business, civil society, and the scientific and professional communities, i.e. structures that will support effective cooperative environmental governance. The design of the institutional networks needs to consider existing statutory and institutional structures and accommodate the political and socio-economic milieus of a country.
Financial support	A key support element for sustainable ICM is sound financial support for effective implementation in the long term, from national to local level. While the initial funding for ICM implementation often occurs on a project-by-project level, it needs to evolve into a well-designed financial model that will be sustainable in the long term. Such models can take on different shapes to fit specific socio-economic and political environments, ranging from government-funded to privately- (e.g. NGOs) funded to public-private partnerships.
Scientific support	There is increasing recognition that sustainable decision making needs to be based upon sound scientific evidence that is certified against standards judged acceptable by the scientific community and insulated from the interference of politics. The term “co-production” of science and policy supports this notion that policy-related science is an essential component of (environmental) decision making and environmental problem solving. However, despite these two activities being interlinked and strongly influencing one another, science is a distinctly different activity from policy, following its own principles.
Capacity building	Effective capacity building mechanisms are a critical support element in the long-term sustainability of an implementation process and should not be dealt with in an *ad hoc* manner. Capacity building requires a long-term strategy including the establishment of partnerships between responsible authorities and training institutions (e.g. universities) aimed at providing a workforce with qualified personnel who are properly trained through dedicated environmental management training programmes. Within governing institutions strategies for skills retention and the deployment of effective mentorship programmes for new recruits are essential.
Public education and awareness	Public education and awareness is a very distinct support element in a people-centred approach to environmental management. This requires the establishment of initiatives to

ELEMENT	DESCRIPTION
	facilitate the active involvement of civil society and create awareness of, and a sense of responsibility for, environmental issues among ordinary people. These may include initiatives that physically involve civil society, using environmental issues to promote social equity for economically marginalised people through job creation and training opportunities and public education (often undervalued in its ability to support environmental issues).

5. Conclusions

In this study the scientific credibility of a prototype design for ICM implementation was assessed against predefined theoretically-based evaluation criteria. The prototype was found to comply with twelve of the fourteen evaluation criteria. The two criteria that were not addressed - relating to the scientific support and financial support - were viewed as shortfalls in the prototype implementation model. In accordance with the incremental and adaptive research process adopted in this paper, modifications to the prototype model were made to enhance its theoretical validity. During the refinement of the implementation model, two interdependent yet distinctive cycles that represent the process of inclusive ecosystem-based resource management (the resource cycle) capacitated by a supporting network of actors (the actor cycle) were identified. The new model incorporates insights from the recent literature on adaptive management in the fields of Integrated Water Management and Social-Ecological Systems into Integrated Coastal Management theory and practice.

The learning-by-doing design approach with its iterative empirical and theoretical validation is proffered as a general process for the design and refinement of ICM implementation models for wider international application. This represents another contribution to ICM practice by demonstrating a means of connecting place-based design and theory-based learning.

Finally, the paper contributes to a practical management perspective on ICM implementation. However, there are manifold perspectives from which to approach effective and sustainable ICM. ICM implementation can also be viewed from a purely economic perspective (e.g. incentive or financial support models); a public administration perspective (e.g. exploring the interface and dynamics between the actor cycle and the resource cycle in coastal management); a participative perspective (e.g. exploring public consultation and awareness approaches); or an educational perspective (e.g. investigating mechanisms to link training and education institutions with sector-based institutions). Opportunities exist for scholars in such fields to extend the learning on ICM implementation through their lenses and in so doing continuously improve its operationalisation.

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