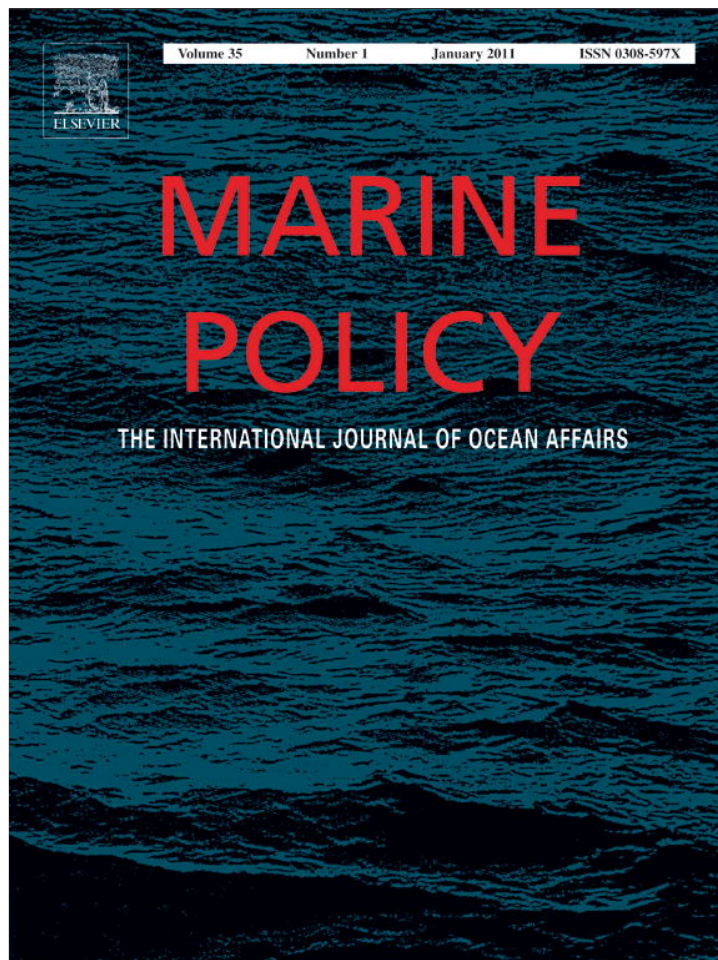




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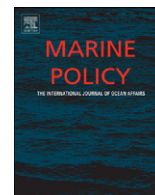
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Integrating the science education nexus into coastal governance: A Mediterranean and Black Sea case study

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ABSTRACT

Although continued knowledge acquisition is necessary, there is an increasing need for innovative manipulation. Consequently, the roles of sound science and considered educational practice need clarification within coastal policy. Research data, collected via semi-structured interviews with representatives of government and quasi government organisations encompassing various Mediterranean and Black Sea countries, was subsequently assessed alongside published work. Principal findings emphasised that policy makers need to engage more coherently with the existing science education nexus to facilitate, but not format research agendas. Although extensive information is readily available, there is need for further manipulation, translation, coordination, communication and adaptation between policy portfolios. Consequently, the science education nexus should be internalised into policy formulation, implementation and monitoring. Furthermore, to develop shared awareness, considered dissemination of knowledge and understanding requires both vertical and horizontal integration. Policy results should be clear and innovative knowledge transfer fora, using Technology Enhanced Dissemination (TED) within culturally sensitive contexts, must be developed. Science and education require legal incorporation from which professional norms and authority can evolve. Findings suggested that although the science is 'hard', incorporating it into policy decisions is 'harder' and hence, more effort is needed.

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1. Introduction

The relationship between Integrated Coastal Management (ICM) and the science education nexus is a story of unhappy bedfellows and yet the capabilities of these disciplines are the foundation of policy formulation and are assumed to improve the accuracy of policy solutions. Relentless pressures within coastal communities mean that the importance of clear and effective communication between policy, science and education is at the vanguard of ICM and yet this observation is often given scant regard. Science and education are entrusted with developing solutions to coastal problems, yet there are often knowledge gaps and governance incapacity to deal with issues. Furthermore it is fuelled by questions of legitimacy, credibility [1,2] and authority [3]. This research assessed tripartite relationships between ICM policy, science and education in the context of Mediterranean and Black Sea Basins. Interviews were undertaken with tripartite representatives with Medcoast proceedings subsequently used to establish relationship forms and rationales. Mechanisms were

then identified for improved integration of a science education nexus with policy.

2. Case study policy context

Coastal zone policy in the Mediterranean and Black Sea basins is founded on the interplay between political structures, natural processes and social actions [4]. The two basins are semi-enclosed ecosystems with comparable coastal and marine physical features and processes. Furthermore, both basins have dynamic demographics associated with an increasing urban and seasonal population and their irregular distribution due to topography and proximity to the sea [5,6]. This evolving demography makes policy [7], science and education research crucial, as it impacts on water and energy consumption, waste production, coastal infrastructure provision [8] and sea level rise, sea stratification, historical and ecological inheritance [9]. Although there are similarities in terms of physical and human processes, there are also significant differences between and within the basins.

2.1. Black Sea basin

Perestroika and Glasnost initiated a political, economic, social and environmental transformation of the Black Sea Basin. The

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legacy of Soviet dominance became apparent and political form became more differentiated. However, Bulgaria, Georgia, Romania, Russian Federation, Turkey and Ukraine were signatories to the Bucharest Convention (1992) and Odessa Declaration (1993) which acknowledged significance of Integrated Coastal Zone Management (ICZM) in the goals of sustainable development. The resultant Commission on the Protection of the Black Sea Against Pollution and associated Black Sea Strategic Action Plan (updated 2009) have had an active programme of events and projects [10]. Nonetheless, coordination difficulties continue and Black Sea coastal management has often been nationally orientated and locally applied. For example, the Marine Doctrine of the Russian Federation to 2020, is a package of internal policies [11] with no apparent collaborative orientation. A review of the Medcoast (Sochi, Russia, 2009) conference and its proceedings highlights the national/local orientation of Black Sea scientific papers whereas many of the Mediterranean papers were contextualised for the whole basin. Furthermore, the Medcoast conference demonstrated the political delicacy when the Commission on Protection of Black Sea Against Pollution relocated its advisory group meeting to Istanbul due to some delegates not gaining access to Russia. Nonetheless the scientific legacy is still evident with high quality institutions that have longevity of baseline data used to inform policy, but there has been continuing differentiation. For example, within the Russian Black Sea zone there are now more than 100 organisations (many commercial) engaged in coastal research and its application [12]. Hence Black Sea coastal policy, with its need for coordinated and holistic strategies, seems marginalised due to geopolitical forces.

The Black Sea States have continued a period of reform with deregulation and demanding investment activities putting pressure on the coastal environment. The associated social change has been dominated by a demographic process that has attracted people to coastal resorts, where intensive development is in need of further impact research [12]. For example, the Sochi region hosting the 2014 Winter Olympics, has enviable tourist features, with winter sports and summer coastal activities. In 2008 16 million tourists visited the area and income is increasing by 15–18% per annum [13] and there are significant economic development pressures along the coastal strip. Although the Sochi case is acute, Black Sea basin climatic and economic attractions are reminiscent of parts of Mediterranean basin and this is reflected in terms of benefits, problems and policy portfolios.

2.2. Mediterranean basin

International and national efforts in recent decades have failed to produce a sustainable solution to Mediterranean coastal management [14]. Up to 80% of Mediterranean country's people live in coastal regions [8] and this is fuelled by urbanisation/littoralisation, particularly in the south and east [9]. There has been a doubling of coastal cities since 1950 [8] and 137 million more tourists are predicted by 2025 [15]. Demographic and other processes have led to a need for the development of international coastal management strategies because of the mutuality of the coastal and marine environment. The Mediterranean basin has embarked on coordinated scientific and educational programmes principally via the 7 Protocols of the Barcelona Convention. The ICZM Protocol for the Mediterranean signed on 21st January 2008 in Madrid completed the international legal protection of the regions coastal and marine environment [16]. It was originally signed by 14 Mediterranean states for them to ratify, with some notable exceptions. It has recently been ratified by a sixth state (Syrian Arab Republic, September 2010) and hence the Protocol can now 'enter-into-force'. The resultant legal instrument is unique in management of coastal regions and hence is of

Table 1

Science education nexus from the Protocol in ICZM in the Mediterranean.

Article	Quotes and themes
7	Coordination
14	Participation
15	Awareness raising, training, education and research
16	Specialized research centres
	Monitoring and observation mechanisms and networks
	National inventories ... resources and activities, legislation
	Exchange of science in a Mediterranean network
	Public access to information
25	International training and research
26	Scientific and technical assistance
27	Exchange of information and activities of common interest
35	Relations with third parties

considerable interest to other international marine environments [14]. Table 1 shows extracts from the Protocol that emphasise the science education nexus and in particular Article 25 which clearly stipulates the importance of training and research.

There are inherent difficulties for the Protocol, many being spatially and temporally diverse [8] and include economic, cultural, political, physical and historical differences, which all make implementation of a coherent policy difficult [4]. For example, cultural differences between non EU and EU states is a challenge [8] which [17] highlights in his suggestion that although Mediterranean Islamic countries could be considered the cradle of scientific enquiry some of them are now wary of science and its association with policy. Hence this needs to be considered and understood in the development of any Mediterranean policies involving the science education nexus. Further considerations are evident in the 'Arab Spring' which will undoubtedly influence future coastal strategies and needs.

3. Knowledge transfer

Coastal needs means problem resolution is under a constant spatial and temporal siege. Some of these problems have been caused by previously discredited policy decisions [18], while inter-organisational implementation is often problematic [19]. It is important that knowledge transfer is achieved and the gap between science/education and policy-making is narrowed. Knowledge transfer can be accomplished through an ongoing dialogue and one such method is negotiated knowledge [20]. Furthermore, ICM requires a paradigm shift to create effective knowledge transfer processes between research institutions and government authorities [21]. However, behaviour and attitude differences between scientists and government can contribute to difficulties transmitting and translating scientific information into policy [22].

Scientists need to communicate scientific information, as well as convey scientific knowledge uncertainties and limits [23]. This is especially important in a period where public participation is central to ICM and the public's perception of science is becoming more engaging [24]. Therefore, it is essential that the scientific community: produces information in a readily accessible format; effectively communicates all information regarding issues; and only give absolutes where they can be proven. Calado et al. [25] found conceptual ambiguities were barriers to conflict resolution and policy-makers and non-scientists wanted certainties. It is also important that authorities and scientists can communicate what information they need and their relative responsibilities. Watson and Hewitt [26] argued this can be facilitated through knowledge transfer which would save resources. In some respects this is already happening within regional organisations and collaborations

such as: Pegaso, IFREMER, Ourcoast, Coastal Action Management Programme (CAMP), Eurosion, Beachmed-e, SPICOSI, Conscience, Mediterranean Coastal Foundation, the Commission on the Protection of Black Sea Against Pollution, Environmental Collaboration for the Black Sea (ECBS), Environment Partnership Environmental Collaboration for the Black Sea, information updates from DG Environment news alert service (Coastal Management Special Issue, February 2010) and in 2011 the European Commission (Jointly DG Environment and DG MARE) initiated an impact assessment of maritime and spatial planning. However, it is important to coordinate existing research on the two basins in the form of a knowledge repository. For the benefits of such a repository to accrue, there must be something of value to reuse and people must utilise this knowledge in developing solutions and policies [26].

4. Methodology

Ninety three semi-structured and informal interviews were undertaken with officials from 57 administrations and institutions, to assess the science education nexus in Mediterranean and Black Sea ICM implementation. These included: the European Commission, PAP/RAC, Ifremer Mediterranean Centre, Shirov Institute of Oceanology and ICZM Georgia. Interview data was supplemented by informal participant observation and a proceedings review of international conferences organised by the Mediterranean Coastal Foundation. These included: The State of the art ICM in the Mediterranean and Black Sea: Immediate needs for research, education/training and implementation 14th–18th October 2008 (Akyaka, Turkey) and The Ninth International Conference on the Mediterranean Coastal Environment 10th–14th November 2009 (Sochi, Russia). Delegate expertise was wide ranging and presentations at these conferences were on both the Mediterranean and Black Sea Basins. Therefore, they represented a unique opportunity to elicit knowledge from various perspectives and experiences. The principal aim of the methodology was to obtain specific organisational representative opinion, to enable clear understanding of thought and policy processes. The qualitative methodology adopted was varied and comprehensive to clarify subject complexity. Although qualitative interviews are criticised as “methodologically promiscuous” and participant observation is “biographically shaped” they are appropriate for initial assessment [27]. This is because interviews allow research to be free from analytical jargon and enable narrative development to engage theoretical material. Interviews were undertaken using a stratified sampling strategy based on interviewee organisation. These included organisations from EU member states, non EU states (although these included candidate states), Black Sea Basin states and expert commentators from organisations outside the study areas (Table 2). Sampling was also stratified into a matrix based on level of government involvement, spatial jurisdiction and research focused institutions. Furthermore, numbers interviewed were provisionally based on countries coastal length and population.

Table 2
Interview matrix.

Spatial jurisdiction	Numbers interviewed	Percentage
EU members	30	32.26
Med. non EU/candidate	32	34.41
Black Sea	17	18.28
Other expert commentators	14	15.05
Total	93	100

5. Results and discussion

Principal research results are presented in Table 3 and have been categorised into issues, science and education. Respondent percentages who commented on particular issues are also included and ranked in the science column. This categorisation is not designed to be definitive but representative of respondent's views on the role of science and education within their particular jurisdiction.

Results showed that 82.8% of comments focused on the importance of legislative support for science projects and to a lesser extent, for education (25.8%). Science both informs and then justifies interpretation of legislation and this seems to be of primary scientific importance within the basins. For research to be fully effective, it needs to be applied through legal channels to help embed it into the policy process and this supported the findings of [14,28,29]. For example, O'Connor et al.'s [30] findings in Ireland showed that EU water quality legislation is well perceived due to legislative support. However there are often conceptual and data uncertainties that can limit coastal policy effectiveness beyond legislative jurisdiction. A number of respondents referred to professional norms and administrative inertia that develops when education and science are formally encased in ICM policy. The Mediterranean Protocol was regularly referred to and although some of the comments highlighted a cosmetic engagement with science and education, many others highlighted that it was an improvement on previous mechanisms due to its regulation. Research elsewhere has shown that although close cooperation with scientists can help management, only a formal regulatory instrument can deliver sustainable shoreline management [31]. In addition, there was considerable comment on the relationship between policy formulation, science and education with the need to clearly define and set research questions, as well as propose innovative, technology enhanced result dissemination. This concurs with findings in north-western Europe [21,32]. Furthermore, response analysis suggested that methods and research structures should be set by experts organising the project, and this could only be effectively completed if carefully coordinated by organisations such as PAP/RAC. Hence there is a need to internalise the science (55.9%) education nexus (54.8%) into policy to stimulate negotiated knowledge [20] and sustainability science [21] which in turn will facilitate nexus engagement. Developing authority and its often misplaced linear relationship between the nexus and policy [3], is an important component of this research. There is a need for clear accountability which needs to be defined at the ICM initiation so that legitimacy, credibility and accountability are understood by all stakeholders.

Interestingly research showed that coordination should be horizontal between local projects and vertical between administrative levels within science (29%) and education (34.4%). Comments referred to some improvement in this respect with PAGASO and Medcoast demonstrating good practice. However, a minority of respondents did mention that there were too many organisations with relatively short timeframes (18.3%), which ultimately lead to confusion and limited dissemination. It was suggested that PEGASO or equivalent, should be expanded both temporally and legally to establish a permanent, clearly identifiable and responsible organisation for the coordination of science and education within each basin (75.2%, 83.9%). Certainly research in north-western Europe revealed mixed adherence to coastal management principles at national, regional and local levels. However, there were some promising results regarding local specificity and stakeholder engagement [33]. Additionally, the importance of university research and pedagogical centres with a focus beyond national boundaries, both in terms of remit and personnel was highlighted and supports the concepts of knowledge exchange and transfer systems [26].

Table 3
Summary of interview results.

Issue	Science (% of 93 respondents)	Education (% of 93 respondents)
Legislation	Legally supported research for administrative inertia 82.8	Education driven by legislation and professional norms 25.8
Policy formulators	Help set research questions but not methodology 77.4	Define dissemination procedures 17.2
Projects	Coordination, amalgamation and dissemination of science 75.2	Conscience, Pegaso, Ourcoast, Medcoast, IFREMER, Spicosa 83.9
Human resources in CZ	Research equipment and personnel. Respond to needs of managers and public 72.0	Commitment to education and ICM resources. Respond to needs of managers and public 61.3
Lack of coordination between results and policy development	Scientific non-symbolic engagement in policy process 72.0	Educational non-symbolic engagement in policy process 49.5
Committee structure and membership	Research bureaucracy needs streamlining. Capacity building 67.7	Education bureaucracy needs streamlining. Capacity building 72.0
Physical processes	Engagement with existing coastal geomorphology research. Expert non-symbolic scientific engagement in policy process 66.6	Inclusion of University research centres 61.2
Heritage	Classification and prioritisation 62.3	Public and political awareness 44.1
Scientific disengagement	Internalise science into policy 55.9	Internalise science into education 54.8
Visibility, awareness and transparency	Innovative and accessible dissemination of research findings 54.8	Innovative and accessible forums of knowledge transfer. Improved traditional dissemination 61.3
Limited number of 'personalities' great influence	Clearly communicated roles 53.7	Selection and regional ICM champions/educators 62.4
Classification	International research forums. Classification of coastal vulnerability: geomorphologically, economically and historically 50.5	Dissemination of classification to policy makers and public 20.4
Clearly defined, understood and achievable objectives	Applied research focused on the issues 49.5	Case specific education based on need 9.7
Technology and science	Use of remote sensing /GIS 40.9	Application of RS and GIS in ICM 16.1
Public participation	Identifying research agendas 39.8	Composing education programmes 19.4
Compare share integrate	International research centres 38.7	International education programmes 33.3
Awareness	Need for horizontal and vertical coordination of research 29.0	Need for horizontal and vertical coordination of education 34.4
Administrative and management capacity building	Increased and coordinated research capacity 29.0	Increasing local independence and <i>learned implementation</i> 8.6
ICM language and procedures	Definitional research 24.7	Clear translations and personal correspondence. Agreed culturally specific glossaries 32.3
Measurement of aim and outcome	ICM needs to clearly state measurement and success criteria. Ex-ante Report 21.5	Understanding of results 19.4
Europeification	International networking especially with the non EU states 20.4	International ICM courses (Medcoast) 64.5
Clearly defined guidelines and terminology	International research forums 19.4	Agreed culturally specific glossaries 23.7
Measurement and variable complexity	Research into effective assessment methodologies 19.4	Public awareness of results 67.7
Timeframes	Realistic 18.3	Short and long term embedded education 20.4
Interim reporting	Include science 12.9	Dissemination 4.3
ICM objectives evolve during the process Can equal conflict	Flexibility with transparency in research 9.6	Rapid publication, dissemination and discussion of research findings 34.4
Consider unforeseen implications of policy	Scenario research 8.6	Adaptable education programmes 3.2
Independent assessment	Independent assessors of research 5.4	Independent assessors of education 6.5

In addition, respondents noted that the supply and form of human ICM resources was a concern, with the need to match them with objectives, opinions and public concerns (72%, 61.3%). However, this is an ideal which is unlikely to be fully realised until accounting and delegation mechanisms are fundamentally restructured. Research results were supported by examples of regional ICM that had grand policy objectives but cosmetic resource allocations, a situation which is common elsewhere [28]. This creates symbolic scientific and educational attainment, further encouraged by disengagement of good science/education with the policy process (72%, 49.5%). Comments suggested this was fuelled by slow and cumbersome research and education capacity which was particularly pronounced when funding was allocated by supranational organisations (67.7%, 72%).

A particularly interesting and resource efficient result was the need to coordinate and disseminate existing research findings in the two basins (66.6%, 61.2%). There was a realisation that considerable knowledge and good practice already exists and yet *the wheel is being reinvented* on a regular basis. This seemed particularly true of coastal geomorphological research which, it was argued, needs additional engagement between research centres and ICM managers. It is evident that physical process understanding is more advanced than the political, cultural and economic understanding in both the Mediterranean and Black Sea Basins suggesting people are more difficult to manage/predict. If the regions are able to agree on physical processes, then management of the physical coastline can be accommodated and human and ecological population management can be more

effectively identified. Hence, it is proposed that every effort should be focused on understanding, cross-referencing and disseminating the findings of physical process research.

However, scientific study to resolve natural environment problems takes years to complete, while policy-makers want immediate solutions [34]. A number of respondents did support the view that the coastal populous rarely understands the scientific review process and this queries the role of public participation in scientific policy application [35]. Furthermore, the problems associated with achieving academic consensus amongst the scientific fraternity and the validity of the review process means results can be questioned by policy commentators. This scepticism needs to be addressed via better communication and appreciation of the policy process. Investigations have shown how coordinated research between science and management can have advantages, if considered within the founding principles of ICM policy [21].

Analysis also highlighted the importance of heritage within the basins and in particular the Mediterranean. It was argued that regional heritage, both qualitatively and quantitatively, led to an ignorance of its global and even local significance. Commentators highlighted the need to initiate a comprehensive and coordinated assessment of coastal heritage with a clear classification, risk assessment and prioritisation of identified sites (62.3%, 44.1%). Subsequently, ICM can develop conservation programmes, supported by political and public awareness, with clearly identifiable rating systems which need to contextualise site significance and stop extemporaneous destruction. However, the classification question leads to methods of quantifying coastal features. Work is being done valuing coastal and marine areas, especially within an economic context, and [36] highlighted the need for clear valuation methodologies.

A result of particular educational importance was the development of innovative and accessible forums of knowledge transfer, agreeing with Wibeck's [23] idea that scientists and managers should carefully consider how and what knowledge is communicated. Furthermore, innovation is central to ICM and requires capacity building to address sector complexities [21]. There was general agreement that progress in communication technology had not been fully embraced within the basins ICM however it was clearly on the agenda for further consideration and case study application. Its importance has been applied in other coastal communities, for example, in the Azores island communities are linked via websites for stakeholder engagement and information dissemination [25] and Stojanovic et al. [32] presented the case for an holistic approach to technology application in ICM. Respondents representing the Black Sea were especially committed to the role of 'new communication' forums for dissemination of research and practice to ICM professionals and the coastal user. The use of remote sensing, GIS, video conferences, iPods, iPhones, wikis, blogs, bar code readers, lotteries, were all mentioned and others including, augmented and virtual reality, smart phone apps, data surface visualisation, microblog, data mashups and 3D visualisations, are all technologies being considered in the coastal zone. These have cheap, widespread, innovative knowledge transfer mechanisms that are going to become increasingly accessible because they are forms of 'mobile information' [32]. Additionally there was a view that the regions ICM needs to embrace and consider the implications and opportunities of new technologies (40.9%, 16.1%). For example, the extent of language and cultural diversity is a problem for ICM across the basins and yet technology can potentially deal with many inherent difficulties. Some suggestions included: bar codes on beaches for information that can be quickly scanned and in a preferred language, text translators for research findings and downloadable podcasts from local coastal zone managers.

However, this research also indicated that there was a need to consider traditional knowledge transfer tools more effectively, especially the use of internationally understandable signage that use a combination of words and symbols for awareness raising [37]. This is particularly important in the region due to the international visitor context and the transient nature of their local engagement. Many Mediterranean and Black Sea visitors return annually but do not always visit the same locality or country. Therefore, initial knowledge acquisition is crucial to the quality of their vacation. To achieve this, there is a need to consider education of coastal managers in an international context which was highlighted by Cicin-Sain et al. [38] and specifically for the Mediterranean by Ozhan [39] and Trumbic [40]. However, literature indicates that it is only applied in isolated examples of regional or local excellence.

Additional findings demonstrated the need for international research and education fora which initiate programmes to develop coordinated knowledge repositories and dissemination mechanisms (38.7%, 33.3%). For example, the organisation of international ICM courses (64.5%) such as events organised by the Mediterranean Coastal Foundation which diffuse good practice and knowledge between science, policy and states. Furthermore, findings highlighted the importance of classifying the two basins coastlines with an identifiable and comparable quantifiable index (50.5%) which is understood and applied by policy makers to create, implement and monitor coastal policies at various spatial scales (20.4%). Within this context the importance of clearly understood and defined terms was seen as crucial to the basins coastal policy portfolio (24.7%, 32.3%). Evaluations emphasised the significance of research into developing an internationally agreed glossary of terms and practices which are central to the success of any internationally orientated policy objectives (19.4%, 23.7%). The multiplicity of language, cultures, religions and legal systems means this is a difficult and yet a crucial issue to be addressed and the widespread use of numerical communication should be the basis of definitional debates.

While the foregoing were principal findings, a number of other issues were identified. Firstly, the comparative low importance of public participation in relation to its significance for the science education nexus (39.8%, 19.4%), indicates that the difficulties outlined by McKenna and Cooper [28], are being experienced within the basins, and particularly the Mediterranean. Furthermore questions of legitimacy within public participation cannot be solved entirely via legislation [41]. Secondly, the importance of individual 'personalities' in ICM needs further consideration (53.7%, 62.4%) suggesting there should be a formal group of coastal regional ambassadors who coordinate vertical and horizontal governance. Certainly the basins could develop profiles of ideal managers within a professional and local context which would facilitate individual impact [9]. However, Burningham et al. [42] highlighted problems when a personality became associated with an ICM project and subsequently leaves, resulting in the project being less effective. Thirdly, the role and form of ICM assessment monitoring was highlighted as a concern. Some argued that considerable resources had been allocated to ICM policy formulation, such as the Protocol, but mechanisms and methodologies for results assessment had not been fully realised and should be incorporated in ex-ante reports (21.5%, 19.4%). Moreover, mechanisms for raising public awareness of findings need to be carefully developed (19.4%, 67.7%). While these need to be developed by research establishments they must be transferable and understandable throughout the basins. Finally, some respondents mentioned the need for longer embedded ICM research and education timeframes. Other research such as Pickaver et al. [43] suggested 8 and 15 years for assessment, while Sabatier [44] identified the need for politically unfashionable long term research projects with

appropriate time horizons. This research considers cascading to be most appropriate when projects are regularly internally, but more infrequently externally, assessed (5.4%, 6.5%). Therefore, linkages between assessment and practice needs to be strong and embedded in the system breaking the traditional linear relationship between the nexus and policy [2].

Table 3 identifies a number of other points and it is clear that there is a general feeling of disengagement between the nexus and policy process. Fig. 1 represents this perception and highlights the need to engage with all parts of ICM. It seems that the principal finding of a need for legislative structures to be internalised between the policy process and the scientific educational nexus environments responds to perceived disengagement. Disengagement findings are further supported from perspectives of professional norms and administrative inertia that perpetuate the nexus policy divide. This is demonstrated by resource allocation from the policy domain to the nexus being slow, quantitatively deficient and temporally unrealistic. Therefore power is in the policy initiators domain and as they are often the implementers, engagement with the science educational nexus is often symbolic in form and nature. Fig. 1 reflects this by showing two separate domains that need connecting for ICM to become more effective. The science educational nexus has an obligation to inform policy formulation as emphasised by President Obama, who suggested the policy community should apply good science and dissemination 'even when it is inconvenient to do so ... indeed especially when it is inconvenient' [45]. Therefore the science education nexus needs to engage, respond and adapt to policy needs even when it is inconvenient to do so. Although Fig. 1 is produced from research findings, its principal message is conceptual and hence applicable to the wider policy, science education nexus.

Research also suggests there is a need for clearly identified and supported knowledge transfer mechanisms which culminate in quantitative and semi-qualitative assessment of effectiveness, based on frequent internal and infrequent external assessment (Fig. 2). Horizontal and vertical coordination seems a crucial corollary to ICM because it would support clear knowledge transfer channels with agreed terminology. Results indicated the potential role of innovative forums of knowledge transfer in facilitating this goal due to increasingly 'mobile information'. Fig. 2 proposes a model of Technology Enhanced Dissemination (TED) which is designed to complement other research findings and bridge the disengagement gap identified in Fig. 1. There is a clear need to triangulate policy and the science education nexus at various levels of administration so that knowledge and understanding become coherent across the basins. For example, findings

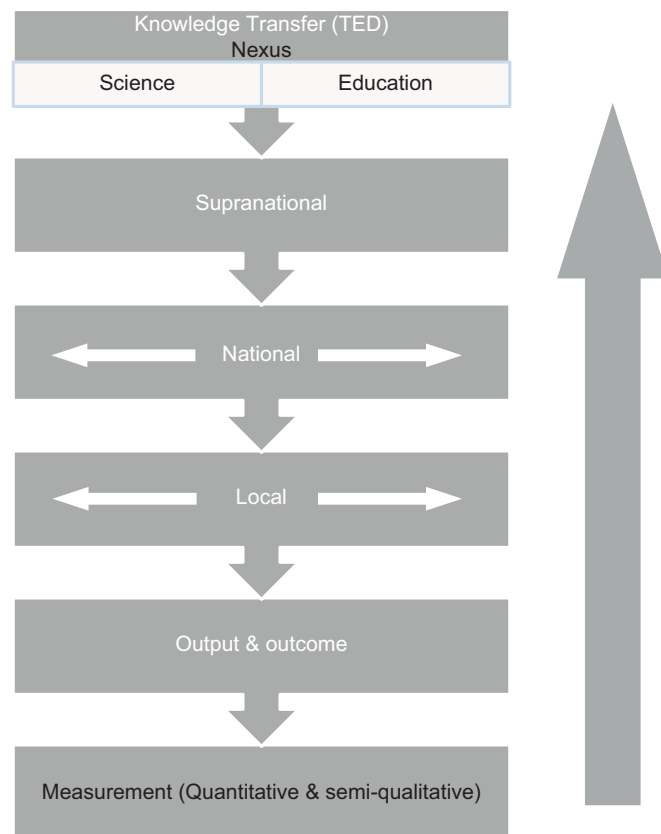


Fig. 2. Proposed framework for Technology Enhanced Dissemination (TED).

show a need for easily accessible knowledge repositories and TED is the most efficient and effective medium to perform this role. Furthermore, the need for coordinated classification of various aspects of the basins coast lends itself to TED orientated systems. Cultural diversity means a flexible, resource efficient set of tools need to be shared so that disengagement becomes marginalised and learning from each other becomes endemic. The need for such a system is already recognised with the excellent work being done by organisations such as Ourcoast, but these should be coordinated fully with full recognition of TED's potential.

6. Conclusion

This work identified the disengaged but improving relationships between ICM and the science education nexus in Mediterranean and Black Sea basins. Principal findings emphasised the importance of more effective policy engagement with existing and future research agendas. ICM implementation is founded on science and education being internalised into the policy process by creating legally binding relationships from which professional norms can evolve. Although extensive knowledge is already available, there is a need for further manipulation, translation, coordination, communication and adaptation between ICM policy portfolios. The policy process needs to be transparent and use innovative Technology Enhanced Dissemination (TED) systems to transfer knowledge within a culturally sensitive context. Finally, there is a need to coordinate Mediterranean and Black Sea research and knowledge within an identifiable governance structure, of which the Bucharest Convention and the Mediterranean Protocol in particular, are a step in the right direction.

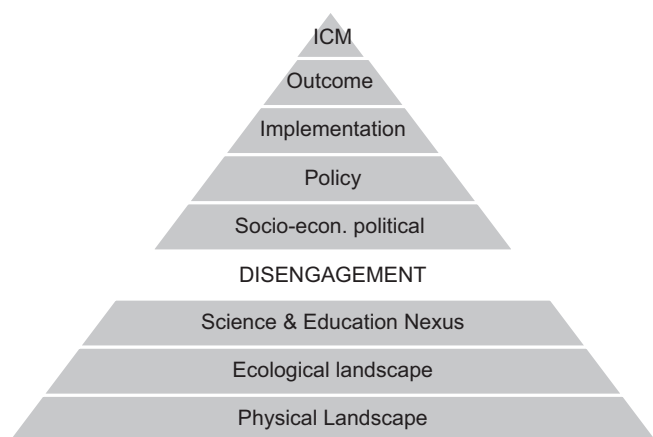


Fig. 1. Disengagement of science/education nexus from policy process.

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