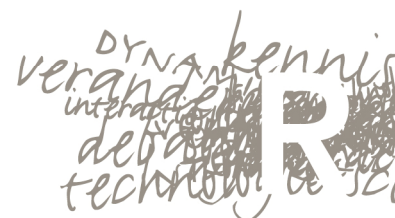


# Dutch Coastal Defense Research: Summary and Conclusion

The Socio-Cognitive Map  
of Dutch Coastal Defense Research: Report 6

Femke Merkx

Rathenau Instituut



# **Dutch Coastal Defense Research: Summary and Conclusion**

**The Socio-Cognitive Map  
of Dutch Coastal Defense Research: Report 6**

**Femke Merkx**

Rathenau Instituut - Department Science System Assessment

February 2007

## Table of contents

1	Introduction .....	5
1.1	Multidisciplinarity, Interdisciplinarity and Transdisciplinarity – Definitions .....	7
1.2	Multi-method Approach .....	8
2	Main Cross-disciplinary Research Challenges .....	10
2.1	Interdisciplinary Biogeomorphology Research for Dynamic Preservation Policy .....	11
2.2	Transdisciplinary Research for Integrated Coastal Zone Management .....	12
2.2.1	The transdisciplinary challenge of beta-gamma integration .....	15
2.2.2	The transdisciplinary challenge of eco-engineering .....	17
2.2.3	The transdisciplinary challenge of integration between formal scientific knowledge and the informal and tacit knowledge of practitioners .....	19
2.3	Social Sciences and Humanities Research .....	20
2.4	Interdisciplinary Climate Change Research .....	20
3	Barriers for Transdisciplinarity – Some Lessons for Policy Makers .....	22
4	Concluding Remarks .....	30
5	References .....	31
	Annex 1 .....	33
	Annex 2 .....	34

## 1 Introduction

In the Netherlands coastal defense is a national priority and coastal defense research is strongly developed. Large parts of the Netherlands lie below sea level. These areas can only be safely inhabited because man-made hydraulic engineering structures as well as natural coastal barriers such as dunes, protect the hinterland against flooding. Coastal erosion, sea level rise, extreme weather events and an increase of wave impact due to climate change endanger the future integrity of our coastal defense structures. A thorough understanding of the properties and dynamic behavior of both artificial and natural coastal defense structures is of national importance.

The social *importance* of coastal defense research is beyond question, but that does not imply that the social *relevance* of coastal defense research comes naturally. In this study we mapped the field of coastal defense research in the Netherlands. The overall objective of this study was to assess to what extent coastal defense research is well aligned with social and policy priorities. Responsiveness of the research system to the societal environment is one of the topics of the Science System Assessment research agenda at the Rathenau Instituut (Rathenau Instituut, 2006, table 14). There can be many reasons why scientific research does not fulfill its full potential for developing socially relevant knowledge. Interaction and communication between scientific researchers and the demand side of knowledge may be poorly developed,<sup>1</sup> or societal expectations on what scientific research can achieve may be unrealistic. Within this study we focused on one specific barrier for socially relevant research, namely the disciplinary organization of the science system.

While the last decades may have shown a gradual shift towards more multidisciplinary and strategic research (Nowotny, Scott, & Gibbons, 2003) the science system is still predominantly organized along disciplinary lines. This starts already with the educational system, where students are often educated in a specific academic discipline, rather than in a specific multi-, inter or transdisciplinary problem field. After graduation the disciplinary organization of the science system continues to structure academic careers, mainly because the academic reward system is organized along disciplinary lines. Funds for fundamental research are often organized along disciplinary lines, which can make it difficult to obtain research funds for interdisciplinary or multidisciplinary research. And academic credits are gained by publishing in high impact journals, which often have a strong

---

<sup>1</sup> On this issue, see (Mulder, 2003) and (Van Koningsveld, 2003), who developed the ‘frame of reference’ concept as a means to improve the productive relation between coastal policy/management and coastal research.

disciplinary orientation. As academic talent tends to follow disciplinary reputation structures rather than changing social or policy priorities, the internal disciplinary organization of the science system may impede a research orientation towards social relevancy.

It is widely recognized that the disciplinary organization of the science system can impede the development of socially and policy relevant research. Implicitly this recognition underpins the many calls for interdisciplinary research, which are found nowadays in research programmes which aim for social and policy relevancy. It should be noted however that there is not a one-to-one correlation between interdisciplinary research and social and policy relevant research. Rather, there is interdisciplinary research that is not immediately socially and policy relevant and the other way around, there is policy relevant research which is not interdisciplinary. Research programmes that aim for social relevant research by stimulating interdisciplinary research often fail. One of the reasons for this failure, is that concepts like interdisciplinary research and the relation between interdisciplinary research and social and policy relevancy are poorly defined and understood.

In this study we used the term cross-disciplinarity as a generic term for different types of research that combine, integrate or transgress knowledge, methods or concepts from different disciplinary origin. We made a distinction between three different types of cross-disciplinary research: multidisciplinary, interdisciplinary and transdisciplinary research. It depends on the type of societal or policy problem, which of these types of cross-disciplinary research is needed (RMNO, 2005). In this study we made an inventory of current coastal flooding policy objectives and translated these into different types of cross-disciplinary research challenges. Using both qualitative and quantitative methods we then mapped the Dutch research field of coastal defense research to assess whether these cross-disciplinary research challenges are taken up sufficiently.

Definitions of the different types of cross-disciplinarity are given in section 1.1. A brief discussion on the methodology that was used in this study is presented in section 1.2. In chapter 2 of this report we discuss the main cross-disciplinary research challenges that have been identified and we discuss whether these challenges are taken up and where the Dutch coastal defense research field is lagging behind. One of the important research challenges that were identified is 'transdisciplinary research for integrated coastal zone management'. In order to get a better understanding of the barriers that exist for developing transdisciplinary knowledge, we organized an expert meeting with a group of practitioners, administrators and researchers involved in integrated coastal zone management. The results of this expert meeting and some policy recommendations that followed

will be discussed in chapter 3 of this report. Chapter 4 gives some general concluding remarks.

### **1.1 Multidisciplinarity, Interdisciplinarity and Transdisciplinarity – Definitions**

In this section we will briefly discuss the different types of cross-disciplinary research that are distinguished in this study. For a more extensive discussion of the different types of cross-disciplinarity see the project outline of this study (Merkx, 2007c).

We speak of **multidisciplinary research** if respective disciplines contribute to a problem solution, while working alongside each other. Changing circumstances and changing policy priorities may call for a change in the multi-disciplinary mix that constitutes a field of research. Past changes in the multidisciplinary mix of coastal defense research include for example the entrance of climate research in response to the expected change in climate; and the growing importance of earth sciences, geomorphology and morphodynamics in response to the coastal policy of dynamic preservation.<sup>2</sup>

Within multidisciplinary research, synthesis of the different disciplinary contributions takes place post hoc, when the individual outcomes of disciplinary research are integrated within a problem solution. **Interdisciplinary research** on the other hand requires a more integrated approach throughout the research process: “Interdisciplinary research requires a joint research approach between researchers from different disciplinary backgrounds. Different disciplinary conceptual frameworks are used and problem definition, methodology and interpretation of results are dealt with in joint consultation” (RMNO, 2005, translation FM).

“There are several definitions of **transdisciplinarity** but it is generally described as a specific form of interdisciplinarity in which boundaries between and beyond disciplines are transcended and knowledge and perspectives from different scientific disciplines as well as non-scientific sources are integrated (Flinterman, Tecler-Mesbah, Broerse, & Bunders, 2001; Thompson Klein et al., 2001)” (Pereira & Funtowicz, 2005, vertaling FM). Hoppe and Huijs argue that transdisciplinary research is needed to solve badly structured societal problems (Hoppe & Huijs, 2003). Problems are defined as badly structured if involved actors have very different problem perceptions, if relevant knowledge is controversial and

---

<sup>2</sup> In 1990 the national policy of ‘Dynamic preservation’ (Min V&W, 1990) was implemented to stop the structural recession of the Dutch Coast line. The policy objective is to preserve the so-called Basal Coast Line (BCL), the Dutch coast line at its 1990 position. ‘Dynamic preservation’ implies working with the natural processes of coast formation, with ‘soft’ interventions like sand nourishment as the principle method.

if uncertainties are big. Transdisciplinarity implies the need to accept local contexts and uncertainties and the need to be action oriented. There is a need to establish linkages between theoretical development and professional practice and the gap between scientific knowledge development and societal decision making processes needs to be bridged (Lawrence & Després, 2004, p.399) This means that other objectives apply then those that normally structure scientific research.

## **1.2 Multi-method Approach**

A combination of four different methodological approaches was used to obtain indicators for cross-disciplinary research challenges. First, coastal policy documents were analyzed to map the need for disciplinary, interdisciplinary and transdisciplinary research as implicated in current social and policy priorities (see (Merx, 2007b)). Second, annual reports, research assessments, institutional homepages and research databases were used to list the various research groups and institutes involved in coastal research and to map them in terms of main disciplinary orientation (see (Merx, 2007a)). Third, bibliometric methods were used to map the international development of the field, to map the position of Dutch research in relation to the international field, and to map national patterns of research collaboration (see (Van den Besselaar & Merx, 2007)). Finally, as a fourth methodological approach we organized an expert meeting with involved practitioners, researchers and intermediary actors to discuss drivers and barriers for what appeared to be one of the main cross-disciplinary research challenges, the challenge of transdisciplinary research for integrated coastal zone management (see (Wesselink & Merx, 2007)).

This study is relevant in two ways. First, the results of this study give insight in the cross-disciplinary challenges and constitution of the field. Researchers and policy makers in the field can use these results to improve the alignment between the research and policy agenda. Second, this study is relevant, because a new research methodology has been developed, that can be useful when investigating other fields of research. The method is more generally appropriate for mapping research fields whose main reason of existence derives from specific societal and policy priorities. At present social relevancy of scientific research is high on the Dutch science policy agenda (NWO, 2006). This emphasis on social relevancy constitutes a relative change compared to prior policy in which scientific quality per se was dominant. It requires new methods of assessment. Our method proved valuable to unravel the confusion between the challenges of multidisciplinary, interdisciplinary, transdisciplinary, socially relevant and policy relevant research, which is found in many (coastal) research policy documents (RMNO, 2005). By structuring our analysis of cross-disciplinary challenges explicitly along the distinctive lines of multi-, inter- and transdisciplinary research and by relating them to different problem types, we have contributed to improving this discussion.

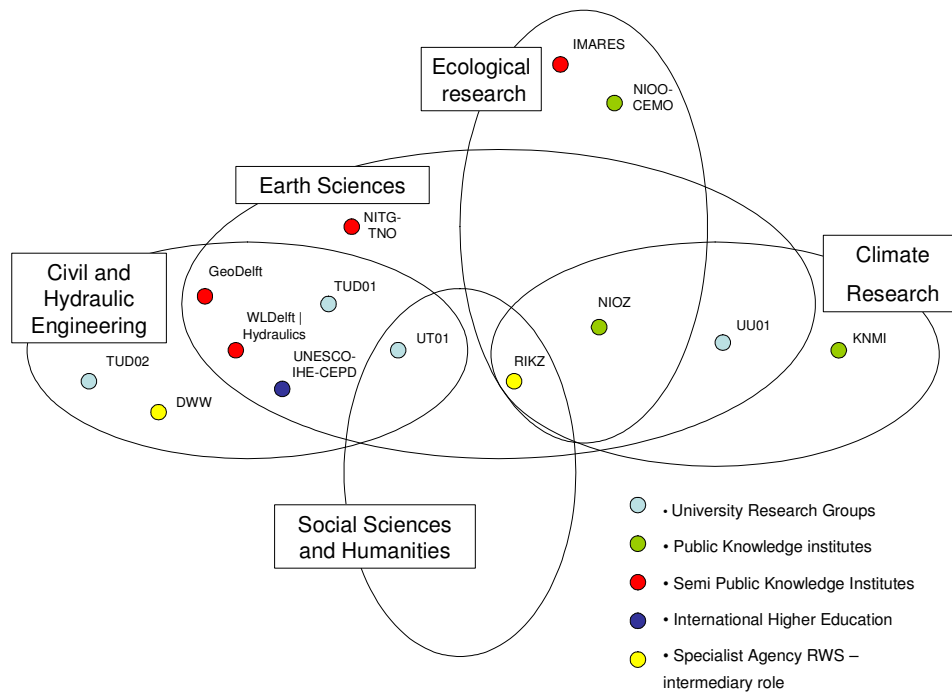
Improving the discussion is all the more important because stimulating multi-, inter- and transdisciplinary research requires different kinds of policy measures.

## 2 Main Cross-disciplinary Research Challenges

The analysis of coastal policy documents, research policy documents, advisory reports and academic studies shows that there is a variety of societal and policy priorities related to coastal defense research (Merkx, 2007b). From these priorities derives a variety of cross-disciplinary challenges. Summarizing, we distinguish four main cross-disciplinary research challenges:

1. Interdisciplinary biogeomorphology research for the dynamic preservation of the coast;
2. Transdisciplinary research for integrated coastal zone management, including eco-engineering;
3. Integrated coastal zone management and the paradigm shift from water defense to water accommodation both give cause for a change in multidisciplinary mix, namely a need for social sciences and humanities research;
4. Interdisciplinary climate change research.

The bird's eye view analysis (Merkx, 2007a) (see figure 1 for main results), the bibliometric analysis (Van den Besselaar & Merkx, 2007) and the expert meeting (Wesselink & Merkx, 2007) all provide indicators whether or not these cross-disciplinary research challenges are taken up sufficiently in the Dutch field of coastal defense research. Here, we will discuss the challenges one by one, integrating the results of the various methodological approaches.



**Figure 1** Bird's eye view of research clusters in coastal defense research and position of Dutch research groups and institutes <sup>3 4</sup>

## 2.1 *Interdisciplinary Biogeomorphology Research for Dynamic Preservation Policy*

The national policy of 'Dynamic preservation' (Min V&W, 1990) was implemented in 1990 to stop the structural recession of the Dutch Coast line. The policy objective is to preserve the so-called Basal Coast Line (BCL), the Dutch coast line at its 1990 position. 'Dynamic preservation' implies working with the natural processes of coast formation, with 'soft' interventions like sand nourishment as the principle method. In the context of soft coastal engineering and the policy priority of dynamic preservation interdisciplinary biogeomorphology research is an important research challenge. Biogeomorphology is the study of the interaction between geomorphological features and organisms. This interdisciplinary

<sup>3</sup> A list of the abbreviations used in this figure can be found in Annex 1.

<sup>4</sup> The bird's eye view presents different types of research units: university research groups with an average size of 45 people, next to large knowledge institutes like WLDelft with a size of 350 people. Obviously, the chance to find more than one discipline within the larger institutes is bigger than it is in the smaller institutes. We took these scale differences into account when positioning the various research units within the various subfields. That is to say that we judged the cross-disciplinary orientation of a research group or institute in relation to its size.

combines expertise from ecology and geomorphology. The bird's eye view of coastal defense research indicates that on the level of research groups marine and estuarine ecological research and morphodynamic and geophysical coastal research are hardly integrated (see fig.1). We think however that this need not form a barrier for developing interdisciplinary biogeomorphology research, because the lack of organizational integration is compensated by an emerging bottom-up national network of research collaboration, the bio-geomorphology platform. Furthermore, geomorphological researchers and estuarine and marine ecological researchers both participate in the Netherlands Centre for Coastal Research (NCK). Also biogeomorphology is an important research theme on the agenda of research groups in marine and estuarine ecology as well as of research groups in coastal geomorphology.

At the international level of formal scientific communication, the interdiscipline of biogeomorphology is not yet visible in the set of journals we analyzed. The journal-journal citation analysis of the Journal of Coastal Research shows marine ecology and geomorphology as two distinctive factors of this multidisciplinary journal (Van den Besselaar & Merkx, 2007, table 1). And as is shown in the 'meta journal' citation analysis (Van den Besselaar & Merkx, 2007) the information flow between these two factors is very low.

In a first check on title key words we did not find any words that signify the subject of biogeomorphology. We did find key words though that relate to issues of soft coastal engineering and it was found that the Dutch share of articles using such title words was well above international average. From this we conclude that – although biogeomorphology research is not yet visible - the policy priority of dynamic preservation is well-reflected in the Dutch research agenda: soft coastal engineering forms one of the core themes in Dutch coastal defense research. As the interdiscipline of biogeomorphology is not yet visible at the international level of formal scientific communication, we conclude that the Dutch researchers in this field are internationally at the forefront of this development.

## ***2.2 Transdisciplinary Research for Integrated Coastal Zone Management***

Integrated Coastal Zone Management (ICZM) is high on both societal and policy agendas and will probably continue to be in the future. ICZM entails an administrative approach in which all parties and stakeholders are involved to find integrated problem solutions and in which the many problems of the coastal region are dealt with in a coherent way. Examples of such integrated solutions are for example: multifunctional spatial planning, combining different spatial functions

like coastal defense and nature development or accommodation of economic activities to changing natural conditions, such as developing salty agriculture.

In integrated coastal zone management problem definitions are not clear, different values are at stake and models used to define solutions have considerable uncertainties. A variety of solutions may exist and the choice of optimal solutions results not only from a creative search but also from a political negotiation process. This kind of problems is called 'badly structured'. Dealing with badly structured problems requires transdisciplinary research (Hoppe & Huijs, 2003) (Regeer & Bunders, 2007).<sup>5</sup> Transdisciplinary knowledge is developed through the interaction of research, policy making and project implementation aimed at solving a particular problem. In transdisciplinary research "boundaries between and beyond disciplines are transcended and knowledge and perspectives from different scientific disciplines as well as non-scientific sources are integrated" (Pereira & Funtowicz, 2005).

The question whether or not the Dutch coastal defense research field is well-directed towards the development of transdisciplinary knowledge has been addressed at different levels. In chapter 3 of this report we will report on the outcome of an expert meeting in which drivers and barriers for transdisciplinary knowledge development were discussed. In this section we will assess whether transdisciplinary research is visible on the level of actual research practice. That involves two questions: 1) whether there is collaboration and integration across different disciplines and 2) whether there is collaboration and integration across research practices on the one hand and practices of design, decision making and implementation on the other hand.

To address the first question we need to be more specific. Because, as one of the experts in the expert meeting noticed, transdisciplinarity in the context of integrated coastal zone management does not by definition mean that everything – all disciplines – need to be involved. We have focused our analysis on two specific kinds of transdisciplinary research, which are relevant in the context of Integrated Coastal Zone Management: 1) the integration of social sciences and humanities research with engineering and natural sciences, and 2) the integration of hydraulic and coastal engineering expertise with ecological expertise in order to address issues of eco-engineering. We will start with discussing the first transdisciplinary challenge, which is often referred to in Dutch as beta-gamma integration.

---

<sup>5</sup> In the context of integrated water management and integrated North Sea management a number of authors similarly argue for transdisciplinarity (NRLO/AWT/RMNO, 2000; RMNO, 2004; Stel & Luiten, 2004). One of the recommendations of the agenda for sea research reads that: "Much sea research should preferably be transdisciplinary. That implies integration between different disciplines, as well as integration between different types of knowledge (basic knowledge, applied knowledge, practical/local knowledge). In that way societal knowledge is taken into account. This form of research averts unproductive sectoring and parcellation." (RMNO, 2004)



### 2.2.1 The transdisciplinary challenge of beta-gamma integration

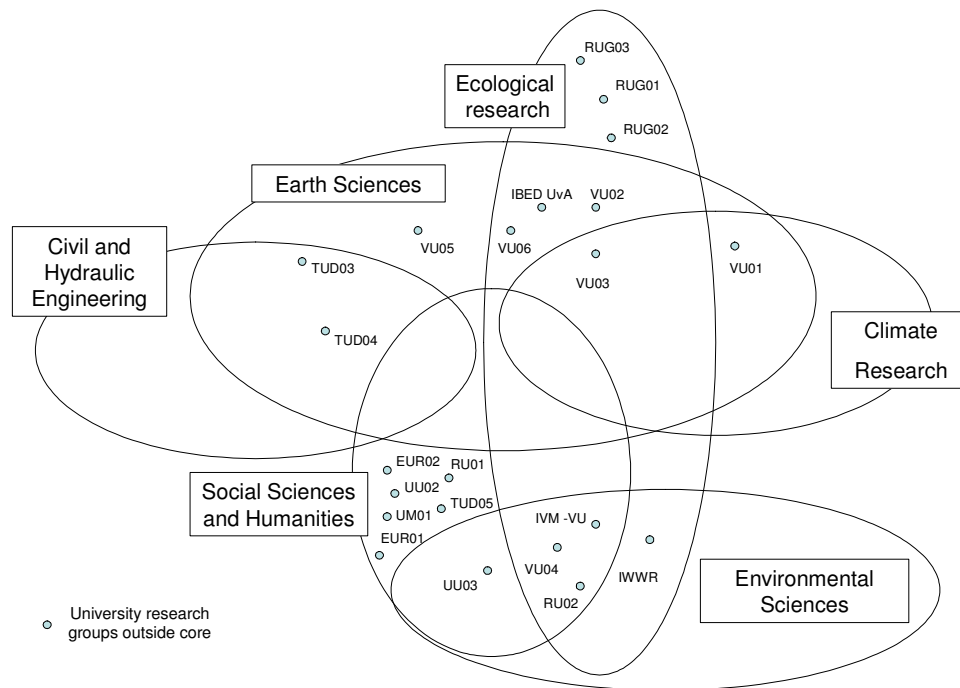
Since the publication of the ‘Over stromen’ advisory report in 2000 (NRLO/AWT/RMNO, 2000), the idea that social sciences expertise is needed in order to face the future challenges of integrated water management is generally accepted and over the last years initiatives have been taken to stimulate the development and application of social science expertise for integrated water management. That includes for example the BSIK programme ‘Leven met Water’, which aims in general at stimulating social sciences research to contribute to the knowledge needs of integrated water management and the paradigm of water accommodation and which aims in particular at the integration of natural sciences and social sciences expertise in the context of practical projects. Despite the presence of some funding opportunities the share of transdisciplinary beta-gamma research in coastal defense research is still low.

The bird’s eye view analysis of coastal defense research, which pictures the disciplinary orientation of the main research groups and institutes involved with coastal defense issues and Integrated Coastal Zone Management (ICZM), shows that gamma research is underrepresented in this field of research and that the organizational integration of social sciences and humanities research with engineering and physical science oriented research is low. Except for one cross-disciplinary research group and one cross-disciplinary governmental institute this type of integration is lacking (see figure 1). Among the university research groups and institutes that have a marginal involvement with issues of coastal defense and integrated coastal zone management, beta-gamma integration is somewhat stronger developed (see figure 2). That regards in particular integration of social sciences with environmental studies and ecology.<sup>6</sup> These existing forms of beta-gamma integration might form a fruitful basis for strengthening transdisciplinary integration between social sciences, civil and hydraulic engineering and physical coastal research.

The under representation of social scientists is also visible at the level of networks of research collaboration. The Netherlands Centre for Coastal Research is a network that focuses on research collaboration between the natural sciences and engineering subfields of coastal defense research. The social sciences are not represented in this network. The same holds for the Delft Cluster consortium. Although this consortium is dedicated to strengthening the linkages between science, market and society, it is strongly dominated by the subfields of civil and hydraulic engineering, physical coastal research and earth sciences.

---

<sup>6</sup> This kind of beta-gamma integration can be found for example in the Institute of Environmental Studies (IVM) at the Vrije Universiteit Amsterdam, in the department of Innovation and Environmental Sciences at the University of Utrecht, in the department of Environmental Science at the Radboud University and the department of Spatial Economics at the Vrije Universiteit Amsterdam.



**Figure 2** Bird's eye view of university related research groups and institutes that have a marginal involvement with issues of coastal defense research<sup>7</sup>

The under representation of social sciences research is also visible at the level of funding programmes that are dedicated to this type of research. The NWO-MaG Social science research for Environment and Nature programme (GaMON, Gamma-onderzoek Milieu, Omgeving, Natuur) funds social and behavioral science research for sustainable development. The programme originates from a number of advisory reports by the sector council for Environmental and Nature Research (RMNO). Integrated Water Management forms one of the five policy themes within the programme. In the first round however no projects have been funded that have a strong focus on this theme and the Ministry of Transport, Water Management and Public Works did not contribute to the programme. It is still uncertain whether budget will be available for a second round ([www.nwo.nl](http://www.nwo.nl)). In the BSIK programme 'Leven met Water' projects in the regional domain of coast and sea are underrepresented, compared to the other regional domains in the programme.<sup>8</sup>

The bibliometric analysis, in particular the journal-journal citation analysis shows that the integration of social sciences with the other subfields that constitute the

<sup>7</sup> A list of the abbreviations used in this figure can be found in Annex 2.

<sup>8</sup> The other regional domains of the 'Leven met Water' programme are river area, low-lying Netherlands, high-lying Netherlands and urban region.

coastal defense research field is not only weak at the national level, but also internationally. At the level of formal international communication, coastal defense research is a *multidisciplinary* field, which is best covered by the *Journal of Coastal Research*. Factor analysis of this journal has shown that coastal management is one of the subfields of coastal defense research. Analysis of the citation relations between the different factors shows that the number of citations to and from the coastal management factor is very low, indicating that the integration of this subfield with the other subfields of coastal defense research is very low.

Coastal engineering is one of the subfields that is covered by the *Journal of Coastal Research*. Because coastal engineering is directed at the design of coastal structures it is the most obvious candidate field to have a transdisciplinary dimension. We therefore expected that the subfield of coastal engineering would also be the most obvious candidate field to develop transdisciplinary integration with the social sciences and humanities. But this appeared not to be the case. The factor analysis of *Coastal Engineering* shows that coastal management or social sciences research does not form a part of the citation environment of *Coastal Engineering* (Van den Besselaar & Merkx, 2007, table 14).

It is interesting to note that, whereas the social sciences are hardly visible in the citation environment of the main journals of the coastal defense research field, the title keyword analysis shows a frequent use of contextual terms that relate to societal and managerial aspects of coastal defense. This suggests that broader societal, managerial and policy aspects are being addressed, but that this does not involve a cognitive contribution from the social sciences.<sup>9</sup>

### 2.2.2 The transdisciplinary challenge of eco-engineering

Eco-engineering forms another transdisciplinary challenge for the field of coastal defense research. In 2001 Water-Front<sup>10</sup> put eco-engineering on the agenda as an important future challenge. Eco-engineering refers to the integration of civil engineering expertise with ecological expertise. It is a type of engineering in which both technological and ecological boundary conditions form the basis for the

---

<sup>9</sup> This lack of involvement of social scientists is also found in the process of setting the research agenda. De Wit and Van Mansfeld (2004) commented on this practice claiming that “There is a tendency amongst well-disposed beta scientists to formulate the research agenda for ‘the others’” (De Wit & Van Mansfeld, 2004, p.21,22, my translation) The authors stress the importance of involving non-beta researchers in setting the research agenda.

<sup>10</sup> Water-Front is an independent advisory council for knowledge development and application in the hydraulic engineering and spatial planning sector. Water-Front has a hybrid composition, representing a large number of different parties: the hydraulic engineering private sector (VBKO en ONRI), (Delft based) knowledge institutes, Alterra, Natuurmonumenten, WWF and Public Works and Water Management (RWS). (source: [www.water-front.nl](http://www.water-front.nl))

design. Within the final design the technically feasible and the ecologically desirable are optimized. The Water-front task group on eco-engineering concludes that an integrated approach forms the main requisite for successful eco-engineering, which implies that both disciplines are willing to collaborate and to put themselves in the position of the other discipline (Source: [www.water-front.nl](http://www.water-front.nl)). Recently the need for this type of research has been emphasized again by the dredging industry who submitted a Smartmix proposal on this issue.<sup>11</sup>

Eco-engineering requires collaboration between the engineering disciplines and ecological disciplines. From the bird's eye view analysis we conclude that at the level of research organizations eco-engineering is not yet visible: there are no multi- or interdisciplinary research groups and institutes that cover both the field of engineering and the field of ecological research (see figure 1). At the level of formal research collaboration there is some interaction between the two fields as groups from both sub fields participate in the Netherlands Centre for Coastal Research (NCK). But taken from the main themes of research, it seems that eco-engineering is not a subject of research collaboration in the NCK. The Delft cluster 2 consortium is also lacking partner institutions that have a strong orientation in ecological research. The inter-institutional co-authorship analysis of Dutch publications confirms the impression that research collaboration in this field is marginal or absent. Research institutes in marine biology and marine ecology have no co-authorship relations with the hydraulic and coastal engineering groups and institutes.

Also at the international level eco-engineering seems at best a marginal field of research. The journal-journal citation analysis shows no indication that a strong form of coastal eco-engineering is well-established internationally. A strong form of coastal eco-engineering would entail a substantial share of ecological literature in the citation environment of *Coastal Engineering* and that has not been found. The other way around, a quick analysis of some journals in aquatic and applied ecology showed that engineering literature is also not part of the citation environment of ecological journals. Only one journal was found that seemed to address the subject of eco-engineering: *Ecological Engineering*. Estuarine, coastal and shelf science forms a substantial part of the citation environment of this journal, which indicates that a fair amount of the research in this journal focuses on the coastal zone. Coastal engineering literature is however not part of the citation environment of this journal. Therefore we presume that the journal *Ecological Engineering* mainly addresses issues of ecosystem restoration and that a truly integrated approach between engineering and ecology is not a strong subject of this journal.

To conclude, it seems that the transdisciplinary research challenge of eco-engineering is at best only marginally developed both nationally and

---

<sup>11</sup> The proposal was not granted.

internationally. To answer the repeated calls to develop this field of research, substantial efforts and investments are therefore required.

### **2.2.3 The transdisciplinary challenge of integration between formal scientific knowledge and the informal and tacit knowledge of practitioners**

Transdisciplinarity entails the integration of different forms of formal scientific knowledge with the informal and tacit knowledge of practitioners, administrators and policymakers. The formation of knowledge networks that bring these two worlds together is a way to achieve and improve transdisciplinary integration. The existence of such transdisciplinary networks forms an indicator that the challenge of transdisciplinary research is seriously addressed. In the field of coastal defense research and integrated coastal zone management there are indeed two promising network activities that do so.

The European coordination action ENCORA aims to improve and stimulate the interaction and sharing of knowledge between coastal science, policy and practice. The initiative is of recent date and therefore it is too early to judge whether it is effective. Because the EncoraNL network co-exists next to the well-established cross-disciplinary science-oriented Netherlands Centre for Coastal Research (NCK), there is a risk that EncoraNL will fail to attract and actively involve coastal scientists. Therefore it is recommended to monitor the development of EncoraNL and to consider merging with NCK if the former fails to be effective. A second promising transdisciplinary network is the biogeomorphology platform, which brings together experts from science with end users.

As another type of indicator for the integration of formal scientific knowledge with the knowledge of practitioners we have looked at the kind of organizations that publish in the ISI journals which constitute the field of coastal defense research. If we distinguish between types of organizations, we get the following picture: University based institutes in science and technology: 41%; University based institutes in social sciences: 7%; (Semi)Public research institutes (with partly an application and policy task): 19%; (Engineering and consulting) companies: 26%; (N)GO's: 7%. This broad variety suggests that the coastal defense research field has a transdisciplinary dimension, in which knowledge is developed within the context of application.

When looking at the relative share of publications that are authored by non-research organizations, such as consultancy and engineering firms, NGOs, companies and governmental organizations we find that universities and (semi) public research organizations are the big publishers, together responsible for more than 90% of all publications. Still, almost 10 % of all publications is authored by a company, a governmental organization or an NGO (Van den Besselaar & Merckx,

2007, table 19). This is a pretty high number, given that we have only analyzed the research literature which is processed in the ISI database. Furthermore if we look at the collaborations between categories of organizations, we find that there is quite a large amount of co-authored publications - about 11% - that include authors from both groups – research organizations and non-research organizations (Van den Besselaar & Merckx, 2007, table 21). This indicates that the field of coastal research has indeed to some extent a *transdisciplinary* orientation.

### **2.3 Social Sciences and Humanities Research**

Integrated coastal zone management and the paradigm shift from water defense to water accommodation both give cause for a change in multidisciplinary mix, namely a need for social sciences and humanities research. As was discussed above in section 2.2 social sciences and humanities research is only weakly represented in the field of Dutch coastal defense research. The bibliometric analysis shows that this weak representation is not to an equal extent an attribute of the international field of coastal defense research. Rather the share of Dutch publications in journals of coastal engineering is relatively high whereas it is relatively low in journals of social, managerial and policy research. This relative weakness of social sciences research is confirmed by the title key word analysis. Dutch researchers publish below international average on issues that relate to integrated coastal zone management and to issues that relate to socio-economic, policy and managerial aspects.

It seems that this relative weakness of the involvement of Dutch social scientists with issues of coastal safety and integrated coastal zone management can be easily raised. Because, whereas social science research is weakly represented in the core of Dutch coastal research groups and institutes, there is a fair amount of social sciences research groups that have a modest involvement with issues of coastal defense, integrated coastal zone management or integrated water management (see figure 2). Thus there seems to be enough research potential available to strengthen this weakness in the multidisciplinary mix.

### **2.4 Interdisciplinary Climate Change Research**

Interdisciplinary climate change research is one of the cross-disciplinary challenges that were identified in relation to the social and policy priorities of coastal defense. It was however outside the scope of this study to map the field of climate change research in detail. Therefore we cannot answer the question whether interdisciplinary climate change research is taken up sufficiently. However, the

large amount of university wide, and interinstitutional climate change research centers (VU, WUR, IMAU, CKO) suggests that the challenge of interdisciplinary climate change research is seriously taken up in the Netherlands. But to provide a more decisive answer further research would be needed.

The bibliometric analysis showed that climate change research is an important subfield of coastal research. Since 1996 climate change research belongs to a factor/journal cluster that dominates the citation environment of the *Journal of Coastal Research*. And the analysis of citation relations between the journal clusters shows that the citation relations between the climate change cluster and the marine geology cluster to which belongs the *Journal of Coastal Research* are quite strong. So whereas we cannot conclude on the field of climate change research as such, we can conclude that it is visible as a subfield of the multidisciplinary field of coastal research.

### **3 Barriers for Transdisciplinarity – Some Lessons for Policy Makers**

The expert meeting on transdisciplinarity for integrated coastal zone management confirmed and strengthened our finding that transdisciplinarity for integrated coastal zone management poses a major research challenge. Following from the expert meeting we have identified four main barriers to the development of transdisciplinary knowledge. These barriers are located both within and outside the science system. They relate to communication skills and reflexive capacity of individual researchers; the scientific reputation system; societal steering of the research agenda; and political and administrative inertia. The promotion of transdisciplinary knowledge development requires changes on all these levels and should therefore be taken up as a collective endeavor of many people both within and outside the scientific research system. While our study is specifically concerned with transdisciplinarity for integrated coastal zone management, it was stated during the expert meeting that many of the barriers that were identified also apply to the challenge of transdisciplinarity more generally. We will discuss the main barriers that were identified and – when appropriate – we will relate this discussion to some current research policy developments and discussions.

#### **Transdisciplinarity, whose responsibility?**

Transdisciplinarity refers to a kind of research that is formulated with relevant, societal problems as a starting point, and with continuous interaction with the context where the question arose (= a part of society) as a working method. Situating the development of transdisciplinary knowledge within the context of planning, implementation and decision making processes, raises the question whether there is a role for academic researchers or if rather transdisciplinarity is the prime responsibility of the professionals working in the local context. From the discussions during the expert meeting we conclude that transdisciplinarity is not the sole responsibility of practitioners and professionals and that there is indeed a role for academic research. There are 3 main reasons why the academic research world needs to be involved with transdisciplinarity:

- 1) to realize the claim that academic research addresses social problems
- 2) to provide quality assurance of transdisciplinary research
- 3) to build up transdisciplinary human capital

### **First Barrier: Communication Skills, Respect and Reflexivity**

Transdisciplinary working is difficult. On the level of individual researchers it requires a strong disciplinary background in combination with the ability to communicate and collaborate with researchers who have a different disciplinary background, who talk a different language, who use different concepts and methods, and who are educated in different paradigms on how to do research. Many scientists lack the communication skills, reflexivity and mutual respect to engage effectively in transdisciplinary research collaboration. Communication skills, respect and reflexivity concerning the strengths and weaknesses of one's own discipline therefore need to be taught in the education system.

### **Second Barrier: The Scientific Reputation System**

The scientific reputation system was identified as another important barrier for scientists to participate in transdisciplinary research as it is difficult to establish a career on transdisciplinary research. Scientific excellence and output in disciplinary oriented journals form the dominant evaluation criteria of scientific research. That is even the case for funding programmes that are directed at socially relevant research and which aim to contribute to the resolution of important societal problems.<sup>12</sup>

The assessment of transdisciplinary research asks for new type of quality standards and evaluation criteria. Transdisciplinary work is always tied to a specific local context; there is a need to accept uncertainties and transdisciplinary research takes place within a concrete design and decision making process. That means that other objectives prevail than those that normally structure scientific research. Transdisciplinarity requires the skill to integrate one's own expertise and knowledge with those of others. Likely, such skills translate more easily in a good reputation within the local context of problem solution than that they translate into a good reputation within the own discipline.

To conclude, new type of evaluation mechanisms and quality standards need to be developed to assess transdisciplinary research. Such evaluation mechanisms and quality standards would serve two goals. First, it would provide recognition of specific transdisciplinary skills, improving the attractiveness of transdisciplinary research as an alternative career path for scientific researchers. Second, evaluation

---

<sup>12</sup> Bill Kamphuis observes that scientific evaluation criteria and mechanisms promote analytical research at the cost of coastal engineers' orientation towards improving the design of coastal engineering structures and measures (synthesis). "The question that is not asked is: What do these "improvements", which are essentially study results (analysis), do for the design (synthesis)? We need to be clear as engineers that the ultimate goal of our research is improved design (synthesis). If it is not, we have become scientists (analysts). (Kamphuis, 2005, p. 12)"

mechanisms and quality standards are important if transdisciplinary researchers want to keep their independence, while working on societal issues and problems in which there are interests at stake. As Scholz et al. put it: “One critical issue is that the sciences keep their independence and develop appropriate strategies and standards for transdisciplinarity which extend and complement the traditional criteria.” (Scholz, Mieg, & Oswald, 2000, p.486). The development of transdisciplinary quality criteria and evaluation mechanisms is slowly beginning to be taken up. See for example (Bergmann et al., 2005; Pereira & Funtowicz, 2005). This development indicates that changes in the scientific reputation system are beginning to emerge from within the science system.

Changing the scientific reputation system and overcoming barriers against transdisciplinarity is not solely an internal scientific matter. Research policy makers also play a role in consolidating and changing the scientific reputation system, as they determine the rules for research funding schemes. At the moment research funding in the Netherlands is characterized by a diversity of research funding schemes and research funding objectives, ranging from open programmes for curiosity-driven research to narrowly defined programmes for socially relevant or innovation oriented research, and managed through different organizational arrangements (NWO, STW, BSIK, smart mix etc.) (Versleijen A. (ed.) et al., 2007). As opposed to this heterogeneity of different research funding arrangements, there is a remarkable homogeneity in the ex ante and ex post evaluation mechanisms that are used to allocate funding. Traditional academic peer review and the use of disciplinary quality and academic output criteria, remain dominant for ex ante and ex post research evaluation. In the BSIK programme ‘Leven met Water’ for example, which is directed at beta-gamma transdisciplinary integration, the outcome of a research project is evaluated in terms of the number of PhD theses and academic publications, output criteria that do not tell much about the amount of transdisciplinary integration that is reached. Criteria on social and economic relevance are only used in addition to these traditional criteria. Thus, multiple evaluation criteria are used on top of each other. This can be seen as an attempt to have best of both worlds: both academic excellence and social relevance. Using multiple evaluation criteria might be a fruitful approach for some types of socially relevant research, but in the case of transdisciplinary research we think it is an unproductive approach.<sup>13</sup> As was argued above, disciplinary evaluation criteria are not useful when evaluating transdisciplinary research. Transdisciplinary research needs other type of evaluation criteria.

As a general lesson for science policy makers, we conclude that different kinds of research policy objectives asks for a diverse set of evaluation criteria and that the use of multiple evaluation criteria is not always appropriate.

---

<sup>13</sup> Similarly, the use of multiple evaluation criteria on top of each other may also be unproductive when stimulating basic scientific research.

### Third Barrier: Societal Steering of the Research Agenda

A third barrier for transdisciplinary research is formed by the dominant model for science-society interactions and the way in which societal steering of research is organized. In the dominant model science and society are two more or less distinct worlds and the model for science-society interaction is one of demand & supply, where science produces knowledge and this is applied to societal problems (see figure 3). In this model societal steering of research is organized by means of agenda setting. Societal stakeholders, such as representatives from industry and policy are involved in setting the research agenda. This will only work when there are clear problem definitions on the part of society, which remain stable over the period of a research programme.

In integrated coastal zone management however the problem definitions are not clear, rather problems are ‘badly structured’ and require transdisciplinary research. Transdisciplinary knowledge is developed through the interaction of research, policy making and project implementation aimed at solving a particular problem (See figure 4). Accordingly, all parties involved contribute to the development of transdisciplinary knowledge: not only scientists but also policymakers, consultants, stakeholders, etc.

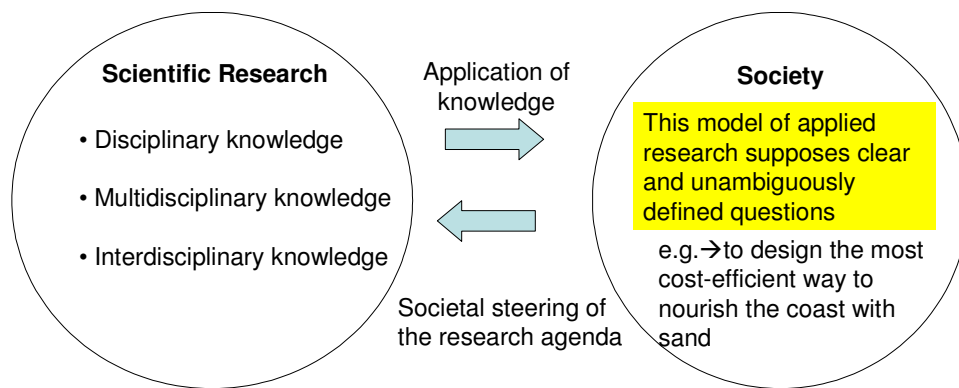
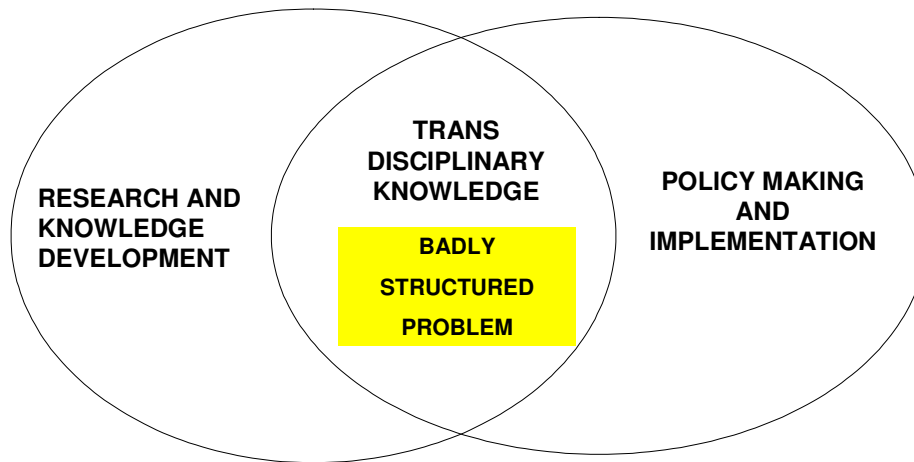


Figure 3 Traditional model of science-society interaction



**Figure 4** Locating transdisciplinary knowledge development

When problems are badly structured the usual models of societal agenda setting will fall short as a means for societal steering of research. Many participants of the expert meeting stressed that the development of transdisciplinary knowledge for badly structured problems requires an ongoing and intensive interaction between researchers on the one hand and administrators and policy makers on the other hand. The role of administrators and policy makers in this process should not be underestimated. Like transdisciplinary researchers they need the capacity to communicate with people with different disciplinary backgrounds and they need enough background knowledge to direct these researchers towards joint problem solution. In order for government and public administration to be successful in the role of principal in transdisciplinary research projects government needs to employ people with relevant research competence and expert knowledge. In that respect, it can be questioned whether it has been a good decision to split up the specialist services of the Directorate General of Public Works and Water Management into, on the one hand, a knowledge and research section to be accommodated by the Delta Institute and, on the other hand, a policy section to form a new water agency.

To conclude, in many current approaches towards societal steering of research, top down agenda setting dominates. Whereas such an approach may *shorten* the linkages between scientific research and society, it does not strengthen the *local* linkages between research and practice. Something which is much needed in

transdisciplinary research. Indeed, more than that, top down societal steering of research may impede productive local interactions and bottom up societal steering of research.<sup>14</sup>

#### **Fourth Barrier: Political and Administrative Inertia**

The fourth and last main barrier for transdisciplinary knowledge development is located at the political and administrative level. As transdisciplinary knowledge development evolves when addressing concrete societal problems and when designing and realizing concrete solutions, transdisciplinary knowledge cannot develop as long as decisions to start concrete projects are postponed. There is a need for experimentation and learning by doing. Or, as was said during the expert meeting, we should not debate too much how to do transdisciplinary research, but start doing it. A missing sense of urgency of the problems to be solved is one of the reasons that transdisciplinary research and projects are not started. The missing sense of urgency may be related to uncertainties about both time and spatial scale for ‘typical’ transdisciplinary problems, with climate change and its consequences as a good example. It is not clear whether these problems should be solved now or can wait, and it is not clear at which scale they are best investigated and solved. This uncertainty results in procrastination. Furthermore, political and administrative inertia is related to the distributedness of the problem and the many administrative levels that are involved and co-responsible for decision making (NRLO/AWT/RMNO, 2000).

---

<sup>14</sup> Similar side effects have been reported in relation to the Technological Top Institutes.

**Lessons for current research policy discussions:****The establishment of large inter- and multidisciplinary research organizations**

The discussion above on barriers for transdisciplinary knowledge development is highly relevant in the context of the current reorganizations within the public knowledge infrastructure for delta, coastal and sea research. In particular this concerns the reorganization of public and semi public research institutes to form the Delta Institute and to form Imares.<sup>15</sup> Both these reorganizations can be regarded as an improvement compared to the earlier situation in which there were many research institutes with partly overlapping research agenda's ('versnippering'). But the reorganization still follows disciplinary boundaries. At the moment there is a discussion whether or not we need even bigger organizational structures, with a broader cross-disciplinary constitution. Hessel Speelman in his report on 'Renewal of the Dutch public knowledge infrastructure' suggests that all non-university knowledge institutes should be brought together in 6 umbrella organizations. Improving synergy between these knowledge institutes forms one of his arguments: "Complex questions of companies, societal organizations and governments can better be answered when combining the knowledge of several knowledge institutes." It is also expected that on the larger scale of umbrella organizations beta-gamma integration can be better realized, than on the level of separate knowledge institutes (Speelman, 2006, p.83,84).

From our analysis on the main barriers for transdisciplinary knowledge development it follows however that the establishment of large cross-disciplinary research organizations is not a panacea for overcoming barriers towards the development of transdisciplinary knowledge. In the expert meeting that we organized institutional disciplinary segregation was not regarded as an important barrier towards the development of transdisciplinary knowledge. The four barriers that were discussed above were considered more important. Therefore we expect that on itself institutional integration will not help much for stimulating transdisciplinary knowledge development.

It was even brought up by one of the participants of the expert meeting that cross-disciplinary institutional integration might impede transdisciplinary knowledge

---

<sup>15</sup> Institute for Marine Resources & Ecosystem Studies, a merger of the Netherlands Institute for Fishery Research (RIVO, 120 people), the research group Ford and Sea ('Wad en Zee') from Alterra Texel (20 people) and the department Ecological Risks from TNO Build Environment and Geosciences in Den Helder (20 people).

Research in the Delta Institute will address the many knowledge questions that relate to living, building and working in a Delta region. Within the Delta Institute the two Grand Technological Institutes (GTIs), WLIDelft Hydraulics and GeoDelft will merge with some parts of TNO-NITG, and with the knowledge sections of the Specialist Services of the Directorate General of Public Works and Water Management. That includes parts of the National Institute for Coastal and Marine Management (RIKZ) and the Road and Hydraulic Engineering Institute (DWW)

development. The homogenizing processes that we expect to take place in large cross-disciplinary organizations may lead to an overall decline in the variety and heterogeneity of available theoretical, conceptual and methodological approaches. Especially when it comes to transdisciplinary knowledge development for badly structured problems such as integrated coastal zone management, the loss of variety in research approaches and expertise forms a problem. Because when problems are badly structured it is hard to tell beforehand what knowledge or which approach will prove useful for solving the problem. Under such circumstances it is wise to have a research policy strategy that cherishes variety and heterogeneity in the research portfolio. We recommend research policy makers to take this into account when determining and implementing research policy strategies. In particular, we think they need to reflect on the dominant research policy of creating focus and mass in the research portfolio. Although there are certainly good arguments to support this policy, this policy also seems to diminish variety and heterogeneity. Research policy makers need to take this side effect into account, in particular when it comes to research fields in which transdisciplinary problem solving is important.

## 4 Concluding Remarks

In this study we have mapped the field of coastal defense research. The overall objective of the study was to gain knowledge which could be useful for improving the alignment between the research agenda on the one hand and the questions posed by society and policy on the other hand. We focused in particular on the various cross-disciplinary challenges in the coastal defense research field that follow from social and policy priorities. We asked whether these cross-disciplinary challenges are taken up sufficiently and what are the main barriers for the various cross-disciplinary challenges.

The results of this study are relevant in two ways. First of all, our study gives an overview of the Dutch coastal defense research field and it gives insight in its relative strengths and weaknesses and how these relate to social and policy priorities. This information can be used by the different actors involved in this field of research to inform and improve the choice of research directions and strategies. That concerns scientific researchers as well as science policy makers.

On a more general level, the study of the coastal defense research field has resulted in insights on the interaction between on the one hand the specific characteristics and dynamics of a certain research and problem field and on the other hand the research policy instruments that are used to manage such a field. We found that generic science policy instruments are not always well-adjusted to the specific characteristics and needs of the coastal defense research field. That concerns in particular the barriers that generic research policy instruments put up against transdisciplinary knowledge development. These results are relevant because they inform science policy makers on how to better adjust their science policy instruments to a specific field of research. In the future, we plan to do similar kinds of studies for other research fields. In that way the science system assessment department of the Rathenau Instituut can gradually build a knowledge base for field specific research policy.

## 5 References

- Bergmann, M., Brohmann, B., Hoffmann, E., Loibl, C., Rehaag, R., Schramm, E., et al. (2005). *Quality Criteria of Transdisciplinary Research. A Guide for the Formative Evaluation of Research Projects*. Frankfurt am Main: Institut für sozial-ökologische Forschung (ISOE)
- De Wit, H., & Van Mansfeld, M. (2004). *Identificatie van kennisvragen NBW bij waterschappen. Zoektocht naar de kennisbehoefte bij de implementatie van het Nationaal bestuursakkoord Water en de startovereenkomst waterbeleid 21e eeuw*. Utrecht: STOWA
- Flinterman, J. F., Teclerariam-Mesbah, R., Broerse, J. E. W., & Bunders, J. F. G. (2001). Transdisciplinarity: The New Challenge for Biomedical Research. *Bulletin of Science, Technology & Society*, 21(4), 253-266.
- Hoppe, R., & Huijs, S. (2003). *Werk op de grens tussen wetenschap en beleid : paradoxen en dilemma's*. Den Haag: RMNO
- Kamphuis, J. W. (2005). Coastal Engineering - Quo Vadis? *Coastal Engineering Journal*, 53(2), 133-140.
- Lawrence, R. J., & Després, C. (2004). Introduction. Futures of Transdisciplinarity. *Futures*, 36, 397-405.
- Merkx, F. (2007a). *A Bird's Eye View of Coastal Defense Research in the Netherlands*. The Hague: Rathenau Instituut - Department Science System Assessment
- Merkx, F. (2007b). *Cross-Disciplinary Challenges in Coastal Defense Research*. The Hague: Rathenau Instituut - Department Science System Assessment
- Merkx, F. (2007c). *The Socio-Cognitive Map of Coastal Defense Research - Project Outline*. The Hague: Rathenau Instituut - Department Science System Assessment
- Min V&W. (1990). *Coastal defence after 1990, a policy choice for coastal protection. 1st Coastal Policy Document*.
- Mulder, J. P. M. (2003). *A review of coastal policy development revealing a systematic approach to science- management interaction, in: Delft Cluster – Coasts: Final Report: WL | Delft Hydraulics*
- Nowotny, H., Scott, P., & Gibbons, M. (2003). Mode 2 Revisited: The New Production of Knowledge. *Minerva*, 41, 179-194.
- NRLO/AWT/RMNO. (2000). *Over stromen. Kennis- en innovatieopgaven voor een waterrijk Nederland: NRLO/AWT/RMNO*
- NWO. (2006). *Wetenschap gewaardeerd! NWO-strategie 2007-2010*. The Hague: NWO
- Pereira, A. G., & Funtowicz, S. (2005). Quality Assurance by Extended Peer Review: tools to Inform Debates, Dialogues & Deliberations. *Technikfolgenabschätzung Theorie und Praxis*, 14(2), 74-79.

- Rathenau Instituut. (2006). *Research program Science System Assessment*. The Hague: Rathenau Institute
- Regeer, B. J., & Bunders, J. F. G. (2007). *Kenniscocreatie: samenspel tussen wetenschap & praktijk*. Den Haag: RMNO.
- RMNO. (2004). *De zee kent geen grenzen. Een kennisagenda die ons leert de golven van de Noordzee op hun waarde te schatten*: RMNO
- RMNO. (2005). *Interdisciplinariteit en Beleidsrelevantie in Onderzoeksprogramma's. Een stellingname*. The Hague: RMNO
- Scholz, R. W., Mieg, H. A., & Oswald, J. E. (2000). Transdisciplinarity in Groundwater Management &mdash;Towards Mutual Learning of Science and Society. *Water, Air and Soil Pollution*, 123(1/4), 477-487.
- Speelman, H. (2006). *Vernieuwing van de publieke kennisinfrastructuur van Nederland*: TNO
- Stel, J. H., & Luiten, E. E. M. (2004). *Sea Ahoy! Sustainable use of marine resources*: Netherlands Study Centre for technology Trends (STT) - Innovation Network Rural Areas and Agricultural Systems
- Thompson Klein, J., Grossenbacher-Mansuy, W., Häberli, R., Bill, A., Scholz, R. W., & Welti, M. (Eds.). (2001). *Transdisciplinarity: Joint problem-Solving among science, technology and society. An effective way of managing complexity*. Basel: Birkhauser Verlag.
- Van den Besselaar, P., & Merkx, F. (2007). *Coastal Defense Research - A Bibliometric Map*. The Hague: Rathenau Instituut - Department Science System Assessment
- Van Koningsveld, M. (2003). *Matching Specialist Knowledge with End User Needs*. Veenendaal: Universal Press.
- Versleijen A. (ed.), Van der Meulen, B., Van Steen, J., Boneschansker-Kloprogge, P., Braam, R., Mampuys, R., et al. (2007). *Dertig jaar publieke onderzoeksfinanciering in Nederland 1975-2005. Historische trends, actuele discussies*. The Hague: Rathenau Instituut
- Wesselink, A., & Merkx, F. (2007). *Transdisciplinarity for Integrated Coastal Zone Management. Report on an Expert Meeting* The Hague: Rathenau Instituut - Department Science System Assessment

## **Annex 1**

### **List of abbreviations of core research groups and institutes in the field of coastal defense research**

DWW	Road and Hydraulic Engineering Institute
Geodelft	National Institute for Geo-engineering
IMARES	Institute for Marine Resources & Ecosystem Studies
KNMI	The Royal Netherlands Meteorological Institute
NIOO-CEME	The Netherlands Institute of Ecology, Centre for Estuarine and Marine Ecology
NIOZ	The Royal Netherlands Institute for Sea Research
NITG-TNO	Netherlands Institute of Applied Geoscience TNO, a division of TNO Built, Environment and Geosciences – also known as Geological Survey of the Netherlands
RIKZ	National Institute for Coastal and Marine Management
TUD01	Hydraulic Engineering Section, Department of Hydraulic Engineering, Faculty of Civil Engineering and Geosciences, Technical University of Delft
TUD02	Environmental Fluid Dynamics Section, Department of Hydraulic Engineering, Faculty of Civil Engineering and Geosciences, Technical University of Delft
UNESCO-IHE-CEPD	UNESCO Institute for Higher Water Education Coastal, department of Hydraulic Engineering, Coastal Engineering and Port Development Core
UT01	Water Engineering and Management at the University of Twente
UU01	Coastal Research at the University of Utrecht is accommodated by different partly overlapping organizational structures: 1) the coastal group within the Research Group Coastal and River Systems, within the Institute of Physical Geography, Faculty of Geosciences; 2) Theme Coastal systems and lowland river systems, Utrecht Centre of Geosciences; 3) Theme Physical geography and oceanography of the coastal zone, Institute for Marine and Atmospheric Research.

## **Annex 2**

### **List of abbreviations of university research groups and institutes outside the core of coastal defense research**

EUR01	Integrated Water Management and Interactive Management of Water Systems forms, Erasmus Centre for Sustainable Development & Management, Faculty of Social Sciences, Erasmus University Rotterdam.
EUR02	Dutch Research Institute for Transitions (DRIFT), Faculty of Social Sciences, Erasmus University Rotterdam
IBED-UvA	Institute for Biodiversity and Ecosystems Dynamics, Faculty of Science, University of Amsterdam
IVM-VU	The Institute for Environmental Studies, Faculty of Earth and Life Sciences, VU University Amsterdam.
IWWR	Institute for Wetland and Water Research, Radboud University Nijmegen
RU01	Research theme water management, research programme governance and places (GaP), Institute for Management Research, Radboud University Nijmegen
RU02	The Department of Environmental Science, Radboud University Nijmegen
RUG01	Community & Conservation Ecology research group (COCON), Centre for Ecological and Evolutionary Studies (CEES), Faculty of Mathematics and Natural Sciences, University of Groningen
RUG02	Department of Marine Benthic Ecology and Evolution (MarBEE), Centre for Ecological and Evolutionary Studies (CEES), Faculty of Mathematics and Natural Sciences, University of Groningen
RUG03	Department of Ocean Ecosystems (OE), Centre for Ecological and Evolutionary Studies (CEES), Faculty of Mathematics and Natural Sciences, University of Groningen
TUD03	Applied Geology Section, department of geotechnology, Faculty of Civil Engineering and Geoscience at the Technical University of Delft

TUD04	Chair of Hydrology, Section of the Water Resources, Department of Water Management, Faculty of Civil Engineering and Geoscience, Technical University of Delft
TUD05	Section Policy Analysis, department Multi Actor Systems, Faculty of Technology, Policy and Management, Technical University of Delft
UM01	The international Centre for Integrated assessment & Sustainable development (ICIS), Maastricht University
UU02	The Centre for Environmental Law and Policy (CELP)/NILOS, Utrecht University
UU03	The department of Innovation and Environmental Sciences, Faculty of Geosciences, University of Utrecht
VU01	Department of Paleoclimatology & Geomorphology, Institute of Earth Sciences, Faculty of Earth and Life Sciences, VU University Amsterdam
VU02	Department of Geo-environmental Science and Hydrology, Institute of Earth Sciences, Faculty of Earth and Life Sciences, VU University Amsterdam
VU03	Department Systems Ecology, Institute of Ecological Science, Faculty of Earth and Life Sciences, VU University Amsterdam
VU04	Department of Spatial Economics, Faculty of Economics and Business Administration, VU University Amsterdam
VU05	Acacia Institute, Solutions in groundwater, Faculty of Earth and Life Sciences, VU University Amsterdam.
VU06	Biosaline Innovation Centre (BaSIC), Faculty of Earth and Life Sciences of the VU University Amsterdam.