Adaptation to Sea-level Rise in the People's Republic of China

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Assessing the Institutional Dimension of Alternative Organisational Frameworks

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Working Paper FNU-94

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Abstract

Global sea-levels are rising due to global warming. Major impacts on the world's coasts are sand beach erosion, salination of ground water, and inundation. Adaptation is the only option to address these future threats as the mitigation of CO_2 emissions is not capable of preventing sea-level rise. There are several organisational frameworks existing that can incorporate adaptation measures. Integrated Coastal Zone Management is proposed most often. Alternative frameworks are disaster management and sectoral frameworks involved in prevention activities, such as the water management that often holds responsibility for dike building. However, the integration of adaptation into an organisation framework is further dependent on institutional capacity within a political system. In order to illustrate what approach is feasible for a hierarchical political system the People's Republic of China is taken as an example. An analysis of various frameworks and institutional responsibilities shows that the institutional dimension of organisation is decisive when seeking for an adequate framework to include adaptation to sea-level rise in. This paper is based on empirical results from a series of interviews and the analysis of official publications on frameworks and institutional responsibilities. It concludes with a recommendation on a climate change based framework.

Keywords: adaptation, sea-level rise, climate change, institutions, frameworks

1. Introduction

Latest estimates of sea-level change predict a rise of up to 88 cm (IPCC, 2001a) within the next hundred years. Related are physical changes of the coastal regions of the world. These range from accelerated storm frequency and intensity, erosion of sand beaches and loss of wetlands to salination of ground water and threat of coastal flooding and inundation. Due to a time lag of reaction, i.e. the ocean temperatures are very slowly raised by atmospheric warming but also store this temperature change longer, the effect of sea-levels rising due to global warming are not to be avoided even by global mitigation efforts of CO_2 emission reduction (Walsh et al., 2004). One remaining question is how much exactly the sea-level will rise – globally and locally in certain parts of the coast, that are of interest to a nation or economic region. Any detailed prediction of global change effects is subject to a high degree of uncertainty.

The results of natural scientific research have been the basis for an extended academic discussion ongoing since the 1990s on adaptation options as well as management and conceptual frameworks. During this time many different aspects have been covered. The technical perspective on adaptation options has been discussed and contributions from a diverse group of sciences, e.g. economics and social sciences, have enriched the debate. By doing so they shed light on important factors like the time frame of implementation, the costs of adaptation or the relation of adaptive capacity to globalization and equity issues. Nonetheless one perspective has not been sufficiently covered yet: the political science approach of institutional impacts on adaptation. So far most views have been limited to acknowledging non-climatic factors, but have not directly related them to constraints caused by political systems, economic conditions or cultural preferences. Although some attempts exist to include, for example, poverty as a defining aspect for vulnerability and adaptive capacity in developing countries, institutional factors have been widely neglected.

This paper aims at filling this gap with a case study on the adaptation to sea-level rise in the People's Republic of China (PRC, China hereafter). The PRC has a mainland coastline of 18 000 km and is prone to experience impacts by sea-level rise. Additionally, rapid economic development is ongoing in the coastal provinces. A very large part of the population either lives there or is directly dependent on the well-being of the coastal economic areas. Despite significant economic and some administrative reforms during the past 25 years the PRC is still a centralized socialist country in which institutional and organizational constraints are persisting. This paper maps decision-making processes and discusses institutional and policy-related constraints by using, firstly, empirical evidence derived from a series of interviews and, secondly, analyses of accessible governmental policies, programs of coastal related ministries and bodies as well as the Chinese contribution to climate change research. As this paper is based on many Chinese language sources, it presents an original overview of adaptation in China. Since there are a range of organisational frameworks that may include adaptation, such as coastal zone management and disaster management, this paper furthermore attempts to find a suitable institutional framework for adaptation to sea-level rise in the PRC.

The first section of this paper consists of a selected literature review on adaptation. Then an overview of the methodology that has been used is given. The second section defines the framework of the institutional analysis as organisational and delimits it to other frameworks and concepts of assessment. It takes a more detailed look at the general adaptation discussion including adaptation options. One focus is on institutional

change. The exposure of China to climate change impacts is discussed with the emphasis on sea-level rise. Adaptation in China and the public perception of sea-level rise are further issues. In section three an analysis of institutions that are related to activities in the coastal zone is undertaken. The selected activities are land reclamation, dike building and coastal construction. On this basis the organisational frameworks that could include the planning and implementation of adaptation in China are introduced. Integrated coastal zone management (ICZM), disaster management, water management and river basin management are discussed. Finally section four concludes with the proposal of a framework of climate change management.

1.1 Literature review

The literature on climate change can be distinguished into several categories of interest for this paper's analysis. One group is the adaptation literature, another is covered by conceptual works on coastal zone management and disaster mitigation, yet another group is literature on sea-level rise in general. For this paper the Chinese literature and the official Chinese opinion on the mentioned issues is of great importance.

The literature on adaptation is permanently advancing; see Olmos (2001) for an extensive overview. Essentially the literature distinguishes between mitigation and adaptation, in which the former is usually used for CO_2 emission abatement (Smit et al., 1999) following the International Panel on Climate Change (IPCC, 2001c). The term further appears in disaster issues (Klein and MacIver, 1999; Bruce, 1999). For this reason this paper prefers the term disaster management to disaster loss mitigation, as adaptation may be a part of this management structure and mitigation and adaptation are usually understood as exclusive terms (Tol, 2003).

Most studies are based on assessment frameworks and they sometimes include discussions on implementation aspects such as time frames or costs of adaptation. Nicholls (2003) provides a meaningful conglomeration. Only few of the assessment framework studies on adaptation explicitly mention the importance of non-climatic conditions for the success of adaptation. Apart from studies on social vulnerability (Adger, 1999; Adger and Kelly, 1999; Handmer et al., 1999) these are Smit et al. (1999), Wheaton and MacIver (1999), United Nations Framework Convention on Climate Change (UNFCCC, 1999), Tol et al. (forthcoming), and Olsen (2003).

Organisational aspects of conceptual framework approaches are only sparsely included in the current literature. The conceptual frameworks based upon most often are coastal zone management (Olsen, 2003; Tol et al., forthcoming; Carey and Mieremet, 1992; Pernetta and Elder, 1992; De Groot and Orford, 2000; Nicholls and Leatherman, 1995a; French, 2002) and disaster management (as emergency management (Handmer et al., 1999) or hazards (Klein et al., 2003; Arthurton, 1998) or disaster loss mitigation (Bruce, 1999)).

The Chinese literature on climate change and sea-level rise is mainly rooted in natural science. Cui and Zorita (1997) study the impacts of atmospheric changes to sea-level rise. Han et al. (1995) estimate the impacts of sea-level change on the national as well as the local level, in the main three river deltas. Wang et al. (1993) investigates the trends of sea-level rise along China's coast. Zhang (1997) provides a forecasting model for sea-level rise in China. Information on zones vulnerable to sea-level rise can also be taken from Du (1993), and Yang (1996). Li et al. (2000) are further addressing

problems with vulnerability assessment in China's coastal zone. These assessments are based upon literature, that is to a large extent not accessible or part of governmental studies not published.

Authors addressing the issue of sea-level rise and adaptation are Du and Zhang (2000), Du (1997), and Du et al. (1997b, 1997c). All take economic aspects into account as they assess the vulnerability of the Chinese coast. A geomorphologic view of sea-level change can be taken by studying the works by Zhao Xitao (1984, 1993, 1994). Further reading into the context of climate change and sea-level rise is possible at the website of the China Ocean Information Network, including articles by Du et al. (1997b), Zhang (1997), and Tian and Ma (1997). Some more articles have also been published in Du et al. (1997a). A regional study on sea-level rise impacts is by Wang et al. (1995) for the Shanghai area. The Zhujiang Delta Area and especially population at risk is issue of a study by the Lü et al. (1997), whereas the China Ocean Information Network (COIN, b + c) focuses on the vulnerability of offshore islands and estimated costs through loss. Further regional studies can be found in Du et al. (1997a).

Information on disaster management in China is based on Ye (2001), Zhu (2000), State Oceanic Administration (SOA, 1996), JICA (2002), and ADRC (2005). Additional information on climate change perception and partly on adaptation measures can be drawn from the official statements by China's National Coordination Committee on Climate Change and newspaper publications. All information on specific policies and institutional structures has been taken from official publications of the various agencies involved in coastal zone management and disaster management (for CZM refer to Lau, 2005). A comprehensive list of the agencies' websites can be found in Appendix 1.

1.2 Methodology

This paper applies a political science perspective on adaptation to sea-level rise. Hence its analytical methods have its roots in the social and political sciences. The paper aims at mapping the institutional dimension within organisational frameworks of adaptation and is therefore also based on information about institutions participating in coastal activities. A range of publications on coastal zone management and disaster management give an insight to the organisational framework approach. Most information on such organisational structures in China was gained by looking at the institutions' internet appearances and analysis of their programs. Information on China's climate change policy was gained by some related websites and other official publications by the government. A major part of information from websites and publications used are in Chinese language.

However, the most important source for verifying information and deepening insight into institutional structures and objectives was produced through a series of open interviews. A structured (standard) interview or even the distribution of a questionnaire was considered not to be sensible for a couple of reasons. Generally the response rate of written material is low and may be even lower in Asian countries, where personal contact is decisive. On the other hand the interviews were planned to be expert interviews on specific issues that need to leave opportunity for an open structure.

In China usually all contacts to the (national) ministerial level have to be pre-arranged and supported by a bi-lateral project type. This study is part of the EU-project DINAS-

COAST[1], which was not laid out to provide these official connections. Therefore, research on the national level was mainly restricted to contacts to scientists. On the local level, in contrast, it is much easier to gain access to administrative units and interviews mostly took place without official appointments. Another reason for choosing this way for allocating interview partners can be found, firstly, in official bureaucratic constraints, i.e. being forced to take the way via the foreign affairs department of an administrative unit and risking to talk to non-experts on the field. Secondly, in China making contact is a matter of *guanxi*[2], which generally means to have been brought into contact by personal communication of a common acquaintance. This sort of approach can seldom be substituted by prior notification - even if this is done by telephone and supported by a letter of recommendation. In review it can be concluded that the most valuable information gained, came off interviews through *guanxi* at location in China.

Altogether 14 interviews were undertaken in October 2003. The interviews were made with experts in the field of sea-level rise and ministerial representatives. The interviews took place with representatives of the national level in Beijing and representatives of the local level in Shanghai. Furthermore, research results were exchanged with a group of scientists engaged in data and information gathering in the coastal zone in Tianjin. With their help major decision-making structures were mapped and analysed with the means of common qualitative analysis methods within the social sciences. The list of interviewees cited in this paper is provided in Appendix 2. Throughout the text information from interviews is marked by name and personal communication.

2. Adaptation – defining conceptual and organisational frameworks

Before taking a look at China's exposure to sea-level rise, it now follows a definition of organisational frameworks - that are used as a basis for this paper's analysis - and a short discussion on important adaptation issues.

There is a range of assessment frameworks that are utilised to shed light on the type of adaptation and the conditional environment in which it is applied. General assessment frameworks often include the objective of measuring either the adaptation itself[3] or the success of conceptual frameworks[4]. The search for measurability led to a number of indicator-based approaches[5]. Some of these also formally include institutional aspects, but seldom specify how these were going to result in reasonably quantitative data (Ehler, 2003).

This paper follows the argument that institutions are forming politics. An assessment of the institutional level is taking research further to one specific and decisive core of conditions affecting all assessment frameworks. Certainly, all other approaches that, for instance, focus on economic aspects are as essential- as economic incentives are part of

[1] The DINAS-COAST project produced a global model on sea-level rise and integrated socio-economic with natural scientific approaches. The EU-project number is (EVK2-2000-22024).
[2] These are relation-networks that form a main aspect of Chinese culture. Also compare section 3.
[3] Compare Tol et al., forthcoming; UNFCCC, 1999; Nicholls and Leatherman, 1995b, for different foci; and Wheaton and MacIver, 1999; Smit et al., 1999, for more theoretical approaches.
[4] Compare De Groot and Orford, 2000; Nicholls and Leatherman, 1995a; Pernetta and Elder, 1992, for CZM, Bruce, 1999, for disaster management; Walsh et al., 2004, for urban planning; Klein et al., 1999, for general guidelines; Tol, 2003, for a discussion on trade-offs between adaptation and mitigation approaches.
[5] Compare Handmer et al., 1999; Adger and Kelly, 1999, for vulnerability indicators; UNFCCC, 2000, for technical indicators; Olsen, 2003, for CZM indicators; Darwin and Tol, 2001, for cost indicators.

this politics -, but rather form a parallel stream of analysis. However, this stream is to some extend interrelated, i.e. a country's economic system is related to its political system. However, the example of China shows that there is potential of the political system seemingly inconsistent with the economic system that is in reality developing. The approaches that focus on management systems apply concepts such as vulnerability, resilience, or adaptive capacity. These also have an overlap with institutional approaches. This paper argues that the latter is fully part of the former. Institutional organisation and change is inherent in the concept of adaptive capacity. In return governmental and adaptive capacities are to a large degree dependent on institutional structures and organisational frameworks. Especially with the example of climate change, this means, that adapting to new situations requests institutional change to take place. As such a change is the easier the smaller the actual change in organisational structures is, it is meaningful, to seek existing organisational frameworks that are capable of incorporating these challenges.

Both groups of frameworks – conceptual ones and organizational ones - imply policy issues. Again, even if the institutional dimension of organisational frameworks is only a minor part of assessment frameworks, it is indeed a very significant one. The best conceptual framework is bound to fail or work insufficient, if policy formulations are not clear and/or the organization of institutions is hampering it put into practice. As Scharpf (1991) formulated: "Given institutional conditions cannot fully determine policy choices" but they may "define a set of constraints limiting the set of feasible choices" (p.54). Table 1 illustrates the contribution of political system analysis for adaptation assessment.

Frameworks:	**Conceptual** assessment frameworks					**Organizational** framework
	e.g. ICZM framework	Adaptation management framework				Adaptation as a task
Scale of analysis:	Concept of ICZM	Concepts of e.g. vulnera-bility, resilience or adaptive capacity	Integrated environ-mental assessment	Cost-benefit analysis	Manage-ment analysis	**Institutional** analysis
Core questions or areas of investigation:	e.g.: is ICZM in country X sustainable	e.g. interrelation of adapta-tion and social vulnerability	Specific sectors or areas, e.g. MPAs	e.g. what are the incentives to pursue adaptation	e.g. testing general guidelines	Role of **institutions** in organizational frameworks
Methods:	e.g. indicator system	e.g. indicator system	e.g. indicator system	Economic analytical tools		Analysis of **integration** of adaptation into ICZM, disaster management or water management
Contents related to adaptation:	Mostly no adaptation discussion	e.g. adapta-tion **policy**	e.g. time frame of adaptation	e.g. costs of adapta-tion	Iterative steps of adaptation	**Policy** of institutions towards adaptation, **constraints** of adaptation due to institutional organization and **responsibility jurisdiction**
Non-climate or institutional factors:	X	X	(X)	X	X	**X**
Related systems:	Integrated manage-ment system	Integrated research and manage-ment system	Natural area manage-ment system	Economic system	Adaptation manage-ment system	**Political** system

Table 1: Contribution of political system analysis to adaptation assessment

In the conceptual assessment framework adaptation therefore counts as a framework itself, i.e. planning and implementation are both defined as integrated within the broad objective of how to serve adaptation. Within the institutional analysis, however, adaptation is defined as a task within another (conceptual) framework of organisation, e.g. integrated coastal zone management. Therefore, institutional analysis within an organisational framework is more specific in spatial and assessment scale, best based on empirical material and may only address one problematic impact, e.g. sea-level rise. While concentrating on this assessment level it is possible to highlight coordination constraints of institutions at the organisational level and problems concerning policy planning and implementation. In taking a focus on the overall organization of climate change adaptation in a country it offers a different perspective within the range of non-climatic conditions that are generally proposed. This paper aims at including institutions in order to enrich the discussion on general concepts to adapt to climate change.

2.1 Adaptation - issues

A main group of authors engages in formulating groups of adaptation measures and theoretically underpin them. These approaches are for example sorting adaptation measures into emergency, strategic or tactical (Arthurton, 1998). Widely known is the distinction between protection, accommodation and managed retreat (IPCC, 1990; Munn et al., 1996; Nicholls and Klein, 2000; Klein et al., 2003; Neumann et al., 2001). This paper adopts the definition by the IPCC (1990) with the exception that Integrated Coastal Zone Management (ICZM) is not considered an adaptive response itself but a framework. Hence, managed retreat is the prevention of development as well as the planned abandonment of structures. Accommodation is concerning constructions as well as land use modifications and also requires long term planning. Li et al. (1999) make some recommendations for accommodation in flood control construction ranging from the construction of houses on high pillars to the segmentation of flood retention basins into smaller units to prevent basins to be inundated fully and this way limiting the economic loss. Protection measures consist of hard structures such as dikes, sea walls and similar engineering structures. Soft measures include beach nourishment, but also the creation and/or protection of natural systems, such as dunes, mangrove areas and wetlands.

Olmos (2001) reflects the various definitions of adaptation, adaptability and adaptive capacity.[6] The double exposure of climate change and globalisation effects is an additional aspect in assessing adaptive capacity (Olmos, 2001). A potential win-win situation – economic gains through globalised economic structures and less vulnerability to climate change impacts through a wise adaptation concept – is at stake and threatened by maladaptation in the vulnerable delta regions in China[7].

Only a few studies mention the different scales, policies may be applied at. These are mostly understood as the global, (sometimes regional, too), national and local scale. For the PRC this paper looks at the national, regional, and local scale, as international cooperation also within the Asian-pacific region are not decisive on the inner-Chinese

[6] He further lists the numerous related terminologies, such as vulnerability, resilience, resistance and susceptibility that were taken up by Klein and Nicholls (2001), Klein et al. (2003, after Dovers and Handmer, 1992) and partly by Handmer et al. (1999).

[7] For maladaptation and definitions of under- and over-adaptation please refer to Willows and Connell, 2003.

institutional organization. This was further a reason for undertaking interviews at the national and local levels.

The literature also takes the interrelation of poverty and vulnerability into account (Adger and Kelly, 1999). Whereas Olmos (2001, after O'Brian and Leichenko, 2000) speaks for a regional approach of assessment here in order to capture the poverty distribution within a country, Handmer et al. (1999) mention the uneven distribution of adaptive capacity between and within countries. They stress the importance of the lower levels, when stating that humans are strongly adaptive on the global scale, but exposed more severely on the local level with many more aspects taking a significant role there, e.g. human behaviour, institutional capacity and culture. In order to reduce vulnerability, they, too, see the need for the underlying socio-economic causes to be addressed; otherwise the major task would be to respond to disasters and uphold the institutional stability.

Handmer et al. (1999, after Handmer and Dovers, 1996) also state that adaptation may require massive political and social change, whereas Olmos (2001, after Kates, 2000) stresses that economic and social change reduces traditional adaptation methods. China is indeed a country facing significant change in the future out of a number of reasons. Social change is most central to all existing and evolving problems, such as increased unemployment and social insecurity. Economic change is already taking place and often it is generating social change directly. However, political change has so far only occurred as limited administrative reform. Handmer et al. (1999, after Land and Water Resources Research and Development Corporation, 1998) acknowledge though that in comparison with technical and scientific barriers "social, economic and especially institutional barriers are […] more resistant to change" (p.272). As Olsen (1991) states after Krasner (1988): "Major change is […] less likely the more an institution is integrated into a larger political order so that changes in one institution require changes in several other institutions" (p.102). This speaks for the incorporation of adaptation into existing frameworks and such limiting the institutional change required to a minimum. The fact that this way the traditional adaptation methods may be reduced is only marginal to China, where development is rapid and especially within the coastal zone adaptation to sea-level rise has a strong bias towards protective measures.

2.2 China's exposure to climate change impacts along the coast

The capacity to adapt is differing from country to country and from region to region within national boundaries. It is defined through a place's vulnerability in the sense of geomorphology and socio-economic exposure. Another aspect is a country's experience in coastal protection and the general political will to approach the problem of sea-level rise. Generally, climate change is perceived as a challenge for the future by Chinese meteorological experts. The effects of global warming are closely monitored and predictions address especially the impacts on the water cycle system, as floods and droughts are already a major problem constraining food and water security in China (People's Daily, 2003a).

Whereas for most floods in China "prolonged, widespread and intensive rain storms are the main causes", the coastal areas are particularly "subject to damages caused by typhoon-related flooding and tidal surges" (World Bank, 1999). Most typhoons make landfall in the South-eastern parts of the coast in the areas of Fujian and Guangdong,

with rates of 21.6% and 37.6%, respectively[8] (Han et al., 1995). Altogether China was struck by about 40% of the typhoons in the Asian-Pacific region in the period from 1949-1997[9] (Xinhuanet, 2003a). A list of regions affected by typhoons until 1997 including number of victims and economic losses is provided by Li et al. (2000). Considering data gathered by EM-DAT (2005) the number of storm disasters from 2000-2005 is higher than for a compatible period in the preceding decade. In comparison less people got killed, but many more had been affected already.

Sea-level rise is a threat that is identified differently on diverse levels of impact. The global sea level has risen at least 10 cm within the last century (Nicholls, 2003) – this defines it as a global phenomenon. But as indicated above the more severe and demanding impacts are taking place at the local level – which defines sea-level rise as a local problem and a significant challenge to lower than national administrations. Additionally, research shows that global warming will have a sustainable impact on the sea-level. Even if global CO_2 emissions would be ceased immediately the time lag in the oceans' reaction to global warming would still lead to an impact until 2050 (Walsh et al., 2004). The latest predictions by the International Panel on Climate Change (IPCC) show an increase of up to 88 cm of sea-level within this century (IPCC, 2001a). Therefore, the threat of more severe temporal flooding and inundation along the coasts is real and irreversible. Adaptation to this threat is the only option.

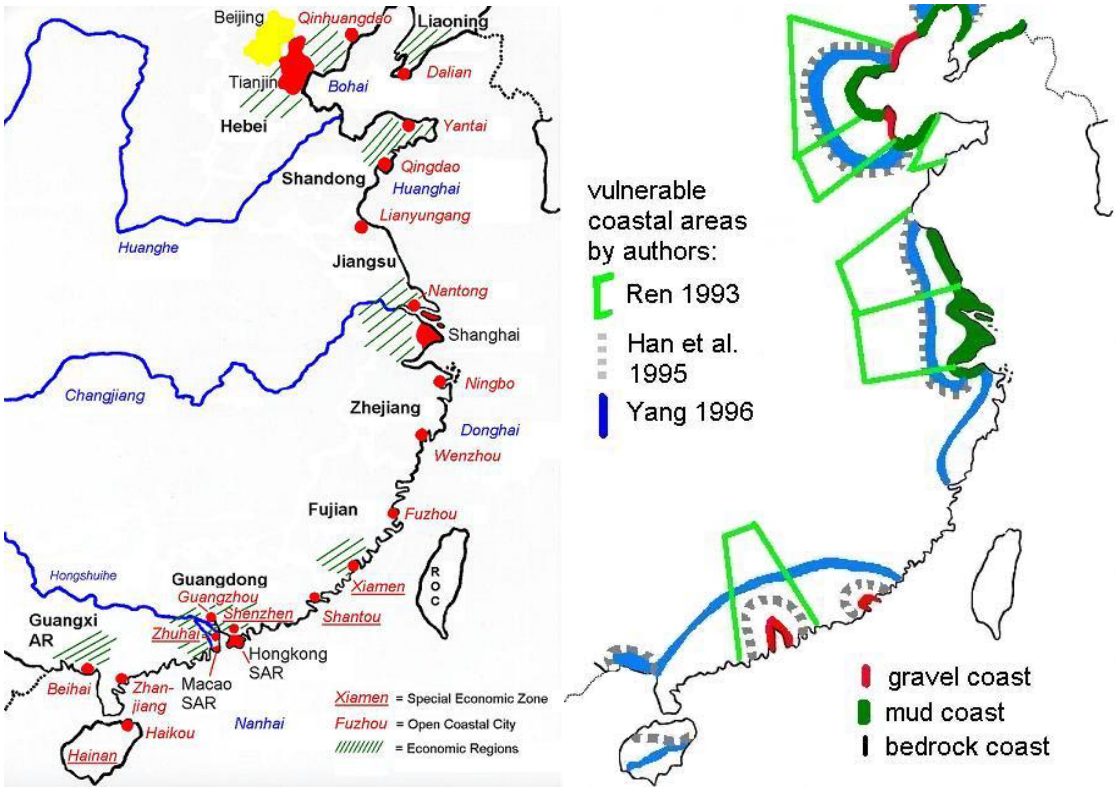

Figure 1: China's economic regions and the vulnerability of the Chinese coast to sea-level rise as defined by various authors

Within a geomorphologic context the three main river deltas in China are most vulnerable to sea-level rise (Du, 1993; Zhang, 1997). These are the Changjiang (Yangtse) with the municipality of Shanghai at its mouth, the Huanghe (Yellow River)

[8] For regional landfall rates of 415 typhoons of the period 1939 to 1992.
[9] For 347 landfalls in China of 753 Asian-Pacific typhoons.

in the North China Plain and the Zhujiang (Pearl River) with five major cities in its coastal area (these are Guangzhou (Canton), Shenzhen, Zhuhai, Aomen (Macao) and Xianggang (Hong Kong)). Figure 1b shows the deviation of regions defined as vulnerable by authors for Ren (1993, cited after Du, 1993), Han et al. (1995) and Yang (1996). Strikingly, the larger areas defined as vulnerable coincide with the economic regions defined by the government in figure 1a. There is also a tendency of the vulnerable zones becoming larger, the more recent the studies are. A reason for this may be that the perception of vulnerability has increasingly integrated economic values. As several cities with a population of several million and even mega-cities are situated in the river mouths, this is of importance. Latest Chinese studies calculated losses of up to 655.6 billion RMB for a 1 m increase of sea-level at the price level of 2000 (Du and Zhang, 2000). Table 2 shows the highest calculated losses in regions of already high economic importance and equally high development potential.

Region	**Predicted losses for a 30 cm rise (2000) in RMB**	**Predicted losses for a 30 cm rise (2030) in RMB**	**Predicted losses for a 1 m rise (2000) in RMB**	**Predicted losses for a 1 m rise (2030) in RMB**
Zhujiang Delta	22,6 Billion	56 Billion	104,4 Billion	262,5 Billion
Changjiang Delta with Jiangsu coast and North Zhejiang coast	3,8 Billion	9,6 Billion	655,6 Billion	1599,5 Billion
Huanghe Delta with Bohai and Laizhou coast	109,4 Billion	274,6 Billion	118,1 Billion	296,5 Billion

Table 2: Calculated losses in Chinese delta regions as impacts from sea-level rise of 30 cm and 1 m for the price level from 2000 and an estimated price level for 2030 in RMB. The inundated area was calculated on the grounds of the highest experienced flood level (after Du and Zhang, 2000)

Global sea-levels are called eustatic and together with local conditions of land mass subsidence or uplift yield the relative sea-level rise at a certain location (compare Moore at al., 1996; Nicholls and Leatherman, 1995a). These local sea-levels are measured in time series at local stations over a certain period and provide a mean sea-level that filters out higher frequencies and seasonal variations. Long-term variations of wave, tide and wind effects are included though. Projections are generally made on the relative sea-level adding expected impacts of tectonic trends and anthropogenic activities, e.g. groundwater overpumping that may cause subsidence. The relative sea-level rise rates along the Chinese coast differ significantly for some local stations (Wang, 1993). Partly this is due to a limited number of accessible, long-term time series data for monitoring stations (personal communication Zhao Xitao)[10]. However, a mean sea level rise of 1.4 mm/year has been observed at 48 coastal tidal observatories (Guo et al., 1995). According to Wang et al. (1995) the local sea-level rise rate ranges from -1.2 to 3.6 mm/year. Additionally, the average change in sea-level per sea region varies from 2 mm/year at the Bohai Sea, 1 mm/year at the Huanghai Sea, and 2.7 mm/year at the Donghai Sea to 2.1 mm/year at the Nanhai Sea (Tian and Ma, 1997, after Tian et al., 1993) (compare figure 2).

[10] There are over 200 tidal stations providing data, but only 10 have longer records of several decades.

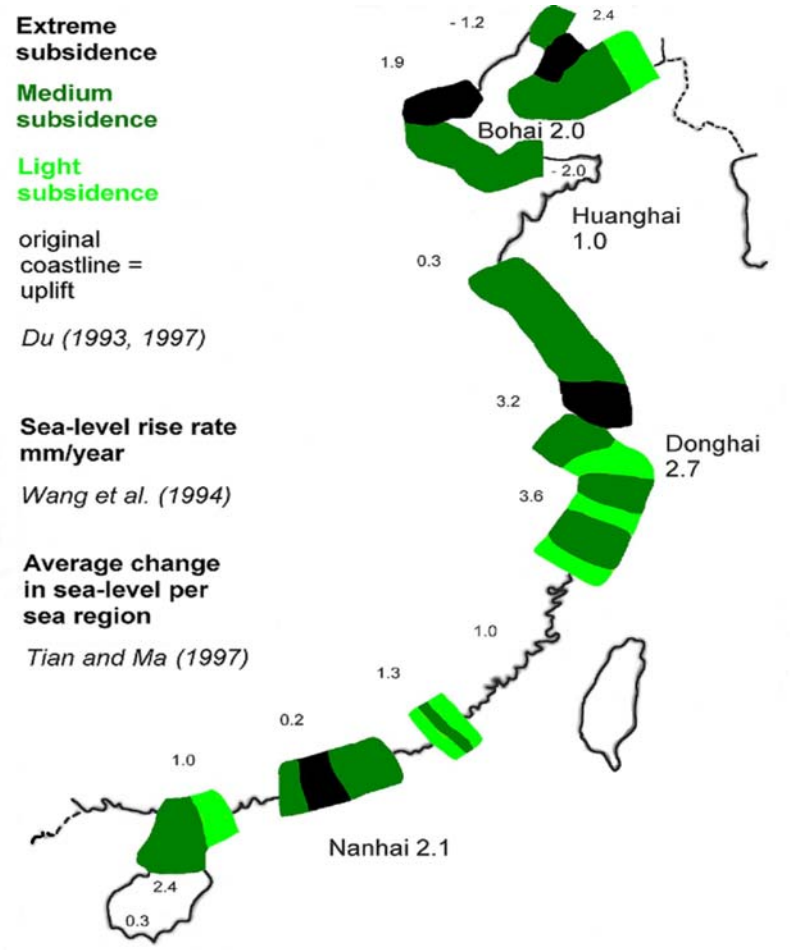

Figure 2: Areas of subsidence and uplift, local sea-level rise rates along China's coast and average sea-level changes per sea region (after Du, 1993, 1997; Wang et al., 1994; Tian and Ma, 1997)

The estimated data of sea-level change differ through human intervention into the sensible coastal system (compare Han et al., 1995). The sea-level rise is accordingly defined as either tectonic or human-induced (Nicholls and Leatherman, 1995a). Figure 2 shows the coastline with areas of extreme subsidence to light subsidence and uplift after Du (1993, 1997). Past subsidence rates vary significantly. For instance Li et al. (2000, after ESD-CAS (Earth Science Division, Chinese Academy of Sciences), 1994) present a reduced ground subsidence rate in Shanghai for the period of 10-15 mm/year for the period 1993-1998 compared to 110 mm/year for the period of 1957-1961. Hence they predict a relative sea-level for the Changjiang with taking the experience of "strict coastal zone management" (Li et al., 2000) into account. Although it is evident that Shanghai's subsidence due to ground water extraction is not under control (for a dike breach incident caused by subsidence compare Xinwen Chenbao, 2003; China Youth Daily, 2003a + b; People's Daily, 2003b; China Daily, 2001) and partly even increases because of sediment compression caused by high rise building construction (personal communication Zhao Xitao; UNESCAP, b; Sinosphere, 2004; China Daily, 2003b), this is seldom acknowledged. The data for future subsidence due to ground water extraction in delta regions are therefore very optimistic (Wang et al., 1995). They are also not secured by appropriate measures yet. An emphasis is put on protecting groundwater resources (SOA, 2001) through choosing other sources where possible, generally cutting down water consumption and refilling water aquifers. The latter only provides for 20% of withdrawn water though (personal communication Wei Zi Xin and Mao Wei

De). Additionally, calculations by the Agrometeorological Institute (AI, 2003) show that even areas that are now considered as subject to considerable uplift will still feel the impacts of sea-level rise by 2050. This shows the strong interrelationship of natural phenomena and human intervention along the coast. It is also a reason for taking a closer look at activities within the coastal zone further down.

2.3 Adaptation to sea-level rise in China

Generally, adaptation to sea-level rise consists of several optional measures. Most prominent is the protection through hard structures such as dikes and sea walls. Alternatives are so-called soft structures and strategies of accommodation or managed retreat (Klein et al., 2001; IPCC, 2001b). Chinese researchers discuss all of these options and often distinguish into engineering and non-engineering measures according to traditional flood control systems (Zhu, 2000). The latter is understood mainly as the strengthening of the legislation and research, the prevention of inter-sectoral problems, and improvement of forecasting systems. For coastal protection alternative options to hard structure protection are mostly neglected[11]. For instance, costs for a 500 km dike to prevent losses from a 1 m sea-level rise for the North China Plain were estimated with an equivalent of 370 Million US$. This is a mere 0.82% of the protected province's GNP. Han et al. (1995) therefore recommend dike building as largely feasible[12]. Another reason for concentrating on hard structure protection is China's high population density and the enormous economic importance of the coastal region (personal communications Zhao Xitao, Du Bilan and Mao Wei De). Hence, protection measures are also most preferred for future adaptation planning. Nonetheless the adaptation by protection still leaves large populations at risk from flooding caused by tropical storms and similar events (Nicholls and Leatherman, 1995b)

Coastal Provinces	Length of mainland coastline (km)	Length of sea dikes for mainland coastline (km)	Length of sea dikes reached set standard (km)
Liaoning	2000	846	26
Tianjin	152	152	-
Hebei	421	297	20
Shandong	3121	858	65
Shanghai	171	171	243
Jiangsu	950	726	600
Zhejiang	1840	1905	680
Fujian	3324	1084	300
Guangxi	1083	782	-
Guangdong	4314	4080	692
Hainan	1500	260	46
Whole China	18876	11161	2672

Table 3: Hard structure flood protection measures along the Chinese coast (after Du and Zhang, 2000)[13]

[11] A notable exception is coastal planning in Xiamen. Classical hard structure engineering measures are complemented by soft measures of beach nourishment and the utilisation of beach vegetation. Additionally, a considerable wide set-back zone has been installed in some areas of the island that were newly used for settlement (Cheng et al., 2002).

[12] For the Zhujiang delta Yang (1996) calculates an average annual input in dike building of 0.12% of the GDP, which equals 3,5% of the local government expenditure. Du and Zhang (2000) provide more recent calculations on dike costs for all major river deltas and different basis assumptions regarding the water levels assumed.

[13] Only construction along the mainland coast is considered.

Table 3 shows the high density of hard structures along the Chinese coast. Nonetheless, the Chinese protection standard for vast parts of the coast is calculated with a 20-50 year flood-return-period and therefore is lower than the standards in Europe or the U.S. (personal communication Li Kungang; IPCC, 2001b; World Bank, 1999). This is in part contradicting official reports that inform of heightened flood control measures and raised awareness of climate change issues in China. For instance, Shanghai's local government reacted to a series of studies to sea-level change in the Shanghai area through formulating adaptation measures with regard to the inputs of urban expansion and engineering projects on agriculture in the Changjiang region (Chen and Zong, 1999)[14]. Apart from this, Shanghai's dikes have been subject to heightening throughout the last years, but the expected sea-level rise has not been taken into account (personal communication Ms. Xu). It can be concluded from this fact, that the problems of subsidence and coastal construction very close to the waterfront have been the main reasons for the dike restoration. Generally, Shanghai's dike system is perceived as functioning well and limiting economic losses through typhoons to a low level, despite the city's location in a particularly vulnerable zone (compare Li et al., 2000).

Apart from this, there is an unbroken trend to develop the coast through land reclamation. According to the Regional Programme for Prevention and Management of Marine Pollution in the East Asian Seas (PEMSEA, 2003) 10.5 Mio ha of tidal lands have been reclaimed since the middle of the 20th century. The gained land areas are primarily used for construction projects. Another reason for reclaiming land is the increasing shortage of cultivated land especially in the Changjiang delta (Chen, 1998; Nicholls and Leatherman, 1995b). The lands reclaimed are often sensible wetland areas that also naturally serve as a flood protection. Likewise offshore coral reefs serve as a natural protection and the damage and extinction of 80% of Hainan's reefs has already nearly resulted in the destruction of a local village (PEMSEA, 2003). However, land is not only reclaimed by the government, the number of tidal lands and sea areas irregularly claimed "by some institutions and individuals for the creation of shrimp ponds and other coastal development projects" (PEMSEA, 2003, p. 54) is rising. In some cases this private land reclamation is tolerated by the government. Nonetheless it poses a problem regarding the building and maintenance of a comprehensive flood control system using hard structures (personal communication Li Kungang).

In contrast, strategies of managed retreat are very seldom discussed in China. An exception is the temporary evacuation of flood-prone areas. But this is only practiced for inland river floods so far, like they occur almost annually in China's river deltas. The high organisational input is only profitable with low expected losses in the areas evacuated; therefore this strategy has been limited to rural areas (personal communication Mao Wei De). Apart from that, resettlement policies in China are defined as comparable modern and lacking not theoretical but rather implementing capacity (Woort, 1994). It is the compensation schemes that are mostly criticised as they are often not measured against previous living standards. Another constraint is embezzlement of disaster management funds (China aktuell, 2004).

[14] The proposed adaptation options include engineering measures such as the dredging of river channels, the renewal of pumping facilities, and the construction of a flood barrier in the Huangpu mouth. But also the development of new crops that are tolerant to higher ground water tables as an accommodation measure is considered.

2.4 Perception of sea-level rise in China

Since the 1980s the problem of global climate change is predominantly perceived in academic circles in China. This is partly rooted in the IPCC's requirements to measure the current climate conditions and monitor their changes before formulating future predictions for diverse regions of a country on the basis of these data (IPCC, 1990). During the last ten years the Chinese government participated in international negotiations and a number of bilateral research projects and regional cooperation have been supported (compare China Climate Change Information Network (CCCIN), Agrometeorological Institute (AI)).The establishment of the Chinese IPCC bureau in Beijing and official websites that make China's vulnerability to climate change and adaptation options an issue[15] is a promising development. Nonetheless, the broad public is only hesitantly informed by the government. The state-controlled media present selected facts (Guangming Ribao, 2002) and often focus on representative dates and events, such as the World Meteorological Day (China Daily, 2003a). Some newspaper articles though are taking up the issue and provide institutions and motivated researchers with a platform to present their findings[16]. In comparison to the challenge rising sea-levels pose information is still scarce. According to the population's generally limited participation in political decision-making, there is no trace of real share in responsibility by the coastal population when adaptation options are decided upon.

Until today the Chinese government has not proclaimed an official strategy how to respond to the threat of sea-level rise. Only on the provincial level a discussion of approaches is pursued (personal communication Du Bilan) that is generated at the local level (Zhujiang Water Resources Network, Appendix 1, and compare Du et al., 1997a) as studies of the Zhujiang and Changjiang Deltas show. Some projects with international support by the World Bank also take up the rising sea-levels as an issue, but do not extensively address adaptation options (compare Chen and Saito, 2004, for the Changjiang Delta). The SOA publishes a Sea-level Rise Bulletin (SOA, 2001) every two years and sea-level rise has been subject to a project proposal within the China Ocean Agenda 21 (SOA, 1996). Yet, the Chinese government has not explicitly named a responsible agency so far.

However, large dams have an impact on the silt transportation to the coast, human activities of groundwater pumping and high rise building construction lead to ground subsidence. Further, land reclamation and destruction of tidal wetlands is ongoing, and the impacts of sea-level rise - such as backwater effect, salination and erosion – already set in and coincide with human settlement close to the shore. With the current situation along China's coast and the sea-levels rising more than usual, Zhao Xitao speaks of a "Damocles-Sword" hanging above China (personal communication). The problems are well known and partly experienced for decades. Also the countermeasures are widely discussed in international circles. But the organisation of adaptation to sea-level rise has been neglected so far. This paper argues that also the institutional framework in which adaptation is placed is of importance. This will be the focus of the following analysis.

3. Potential organisational frameworks supporting adaptation

The successful implementation of a concept is dependent on numerous conditions that influence its processing within management structures. For one part it is essential to

[15] These websites are by the CCCIN, launched in Oct 2002 (China Daily, 2002b), and by COIN.
[16] Compare Xinhuanet, 2002, 2003; Nanfang Zhoumo, 2002 (Zeng W.); Science times, 2002 (Yao W.J.).

clearly define the jurisdiction of the various institutions involved in a system. Institutional power structures play a major role in this context. Within the Chinese culture these are supplemented by *guanxi*, informal relations and network structures (Heilmann, 1999)[17]. Other factors seen as important for the success of a concept are a functional legislation and a high public participation in decision-making processes. Conceptual assessments have so far focused on coastal zone management (Awosika et al., 1993; World Bank, 1993) arguing that flood control is a sector – although "rarely specifically related to the coastal zone" – that has direct impacts (Awosika et al., 1993). For China this approach will be discussed further down.

As there are no institutions explicitly named to be responsible for the adaptation to sea-level rise in China, a further discussion on specific adaptation options is difficult. Theoretically these could be drawn from responsible institutions for expected coastal disasters. Figure 3 shows the deviation this analysis had to take in order to map responsibilities.

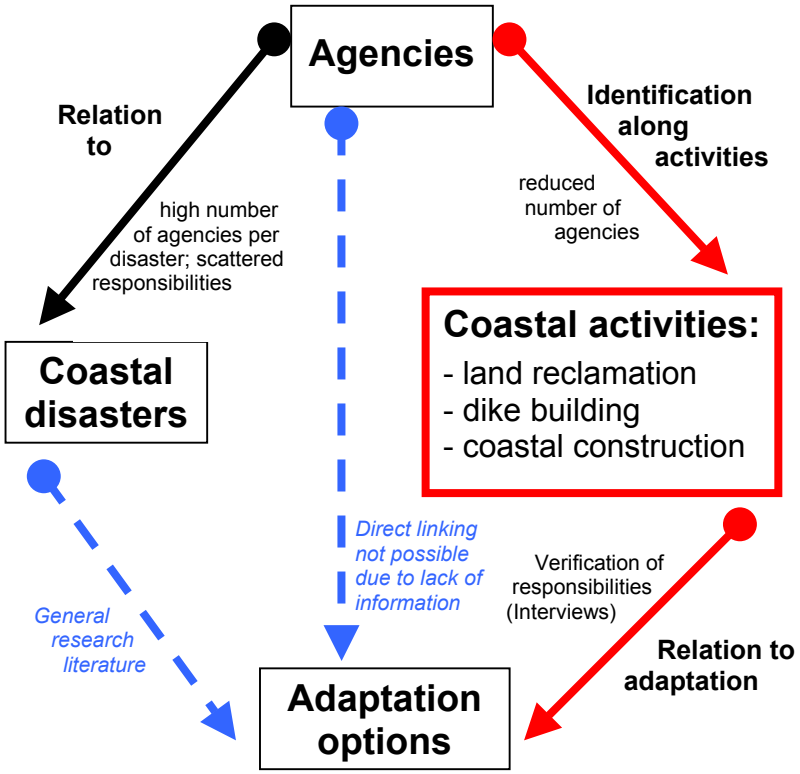

Figure 3: Analysis' path

For planning and implementing adaptation to sea-level rise not only the (integrated) coastal zone management concept is readily available. Other possible concepts are disaster management, an integrated management of climate change or management structures inherent in specific sectors that have a high input in existing flood control or land use planning. In order to identify these potential sectoral-based frameworks an analysis of institutional implication for coastal activities, such as dike building, land reclamation and coastal construction follows. The major focus is on decision-making and financial responsibility.

[17] China is not the only culture that knows this phenomenon, but in China these are much more relevant in every-day life than e.g. in western cultures.

3.1 Identifying institutions and ministries related to coastal activities

Frameworks of coastal zone management and disaster management already exist in China, and their capability of integrating adaptation to sea-level rise will be discussed further down. But first the political agencies involved in activities that change the natural character of the coasts are identified. In order to do so, activities with an impact on flood protection and vulnerability of coastal regions are investigated: dike building, land reclamation and coastal construction in general. Dike building as a major hard structure is the predominant flood protection measure along the coast in China. Land reclamation is currently undertaken as a means of extending the coastal regions for development purposes. Although land reclamation measures could also be used as a means of environmental protection. Through a parallel set-back of human habitat or through land use that is less vulnerable to sea-level rise it can function as an adaptation option of accommodation (land use change) or even minor managed retreat (prevention of development). This is not the case in China. Reclaimed land is almost always used for development of construction, a matter that is also subject to intra-institutional displease (personal communication Mao Wei De). Certainly, coastal construction is formally controlled by several agencies to harmonise with e.g. flood protection plans (compare Zhujiang Water Resources Network, Appendix 1), but as long as no adaptation plans for sea-level rise exist, either on the local or as a guideline on the national level, rather short-term economic incentives are shaping the decisions in the coastal zone.

Institutions	Order	Decision-making, permission	Planning	Assess-ment, research	Imple-menta-tion	Moni-toring
Ministry of Water Resources	——— ++++++++	——— ◆◆◆◆◆◆◆ ++++++++	——— ++++++++	++++++++	——— ++++++++	++++++++
State Oceanic Administration		◆◆◆◆◆◆◆				++++++++
Ministry of Land and Resources		———		———		
Local Government	——— ++++++++	◆◆◆◆◆◆◆ ++++++++	◆◆◆◆◆◆◆ ++++++++			
National Government		◆◆◆◆◆◆◆ ++++++++	++++++++			

——— land reclamation ◆◆◆◆◆◆◆ coastal construction ++++++++ dike building

Figure 4: Involvement of Chinese ministries and governmental levels in land reclamation, coastal construction and dike building

Figure 4 shows a high participation of the Ministry of Water Resources (MWR) or its equivalents on the local (provincial and county) levels for all three exemplary coastal activities. The MWR bears the responsibility for land reclamation, meaningfully supported by the Ministry of Land and Resources (MLR) or their equivalents on the

local levels. For instance, the MLR has the responsibility for feasibility studies and decides on the area's use. The local level government has merely the function of initiation, i.e. it orders a new piece of land. This forms a contrast to general decisions on coastal construction which are much more influenced by the local government. Only if large projects are at stake also the national level government or one of its ministries has to approve. Further institutions that are taking part in the process of approval are the MWR and the State Oceanic Administration (SOA) on the provincial level. Caution is needed when interpreting the list of nominally participating governmental bodies, as they only marginally reflect power distribution among the institutions. The power structures in effect are generally too complex, especially the informal ones. However, the high occurrence of some agencies can be seen as a relatively high potential of influence in decision-making.

With regard to the primary participation of the MWR in dike building and a minor responsibility of the SOA for monitoring this likewise points to a rather limited sphere of influence for the latter. Further, dike building is to a high degree the jurisdiction of the local governmental level. The national level is mostly involved through the financing of protection measures. Every local government has an interest in having the costs covered by the national government in Beijing. For this purpose a proposal is passed up, first to the provincial government then to Beijing. In case the national government rejects to co-finance, because it does not consider a dike at the proposed position as a national priority, the provincial government can carry some of the financial load; but its contribution will be much lower than the support from Beijing (personal communication Li Kungang).

The overall participation of the MWR in the coastal activities looked at is the highest. Therefore, apart from Coastal Zone Management and Disaster Management frameworks, China's water management structure and especially the sub-national level River Basin Committees will be further investigated.

3.2 Coastal Zone Management in China

With a mainland coastline of 18 000 km and three main river deltas with large or even mega-cities situated in them China is particularly threatened by sea-level rise. Regarding the organisational framework of Coastal Zone Management China's institutions are less prepared for an integrated approach than generally expected (Lau, 2005). The situation in China is in parts similar to the situation of other countries regarding, for instance, the impacts of erosion of sand beaches on the tourism industry or, generally, the salination of coastal ground and surface water resources (Oliver, 1996). However, the hierarchical political system and a clear preference for economic interests in decision-making yield developments, that may influence the adaptation to sea-level rise in a negative way. The concept of Integrated Coastal Zone Management usually relates to the concept of sustainability that supports economic development while guaranteeing environmental protection. In China the implementation of ICZM is subject to institutional constraints and at this time cannot be considered an adequate framework to encompass adaptation strategies in a meaningful way.

Successful coastal zone management generally depends on a number of organisational conditions, which have been, for example, formulated by the World Coast Conference in 1993 (WCC, 1993). These conditions attempt to create a functioning legislation to protect the coastal areas and to establish a possibly independent implementing agency

for coastal zone management or upgrade the jurisdiction of an already existing administrative body. Generally, a major aim is a high participation level of stakeholders and the coastal population in decision-making procedures. The implementation of such guidelines becomes difficult as soon as a country's political system is not fully supporting it. For instance, when stakeholder participation is only partially admitted and terminology becomes redefined. This is the case in China, where public participation is rather conditioned as awareness raising in the sense of public education. Additionally, the definition of stakeholders in China deviates from the general understanding, as they are often intermingled with political administration and mostly depend on protégés (Lau, 2005).

Regarding coastal legislation, there has been a high commitment within the last ten years to adjust existing laws to the new conditions (Jiao et al., 2000; State Council of the PRC, 1992, 1998, 2001). Nonetheless, China's legislation is still far from being independent in the sense of separation of powers, and this way the mere existence of laws do not yet routinely lead to their adequate use. Additionally, the draft of the national coastal management law never emerged from the interagency review, due to the "lack of clarity on operational modalities" (PEMSEA, 2003, p. 22). This is interpreted as follows: The "proposed law would affect the entrenched interests of concerned agencies in coastal areas" (PEMSEA, 2003, p. 23). Apparently, sectoral interests prevented a binding legislation and the necessary political will to overcome this situation is still lacking.

The responsible agency for coastal zone management is the State Oceanic Administration (SOA). It is predominantly the positioning of this agency within the political hierarchy that is decisive for its capacity and performance (compare also Awosika et al., 1993). Although its tasks have regularly increased in number since 1989, administrative reforms lowered its position in the hierarchy. Figure 5 shows these developments of changed dependencies in overview.

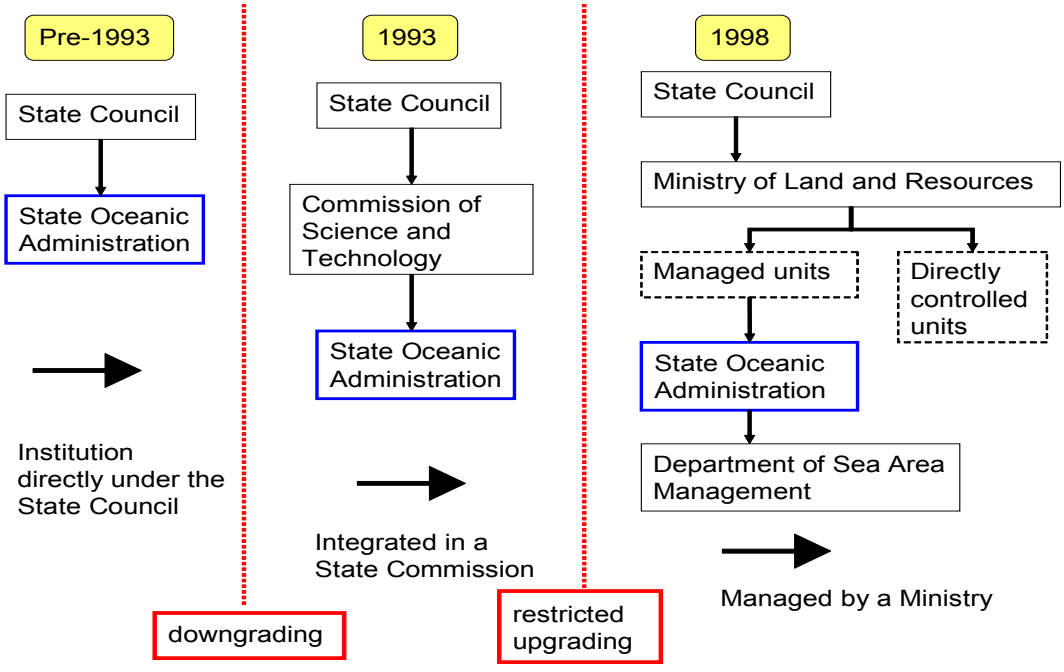

Figure 5: State Oceanic Administartion - structural development (Lau, 2005)

As important as the institutional power of an agency within the political structures is the distribution of responsibilities among all bodies participating in activities in the coastal zone. Inter-institutional discrepancies are highlighted through an analysis of each program of potentially involved ministries and administrative agencies. Figure 6 shows significant overlaps in jurisdiction on the basis of the agencies' self-defined tasks and responsibilities. The x-axis illustrates these responsibilities for the SOA. The y-axis shows on the left hand side (italics) the six agencies that are listed as cooperating partners by the SOA. The right hand side shows agencies with potentially overlapping or similar functions in the coastal zone (compare Lau, 2005).

CZM related organs / SOA Tasks	*MLR*	*Department of Fishery –MOA*	*SEPA*	*NBF*	*MST*	*CAS*	MSA –Min. of Communica-tion	DPC	ETC	NTA	MOC	MWR
CZM rights and Laws		X	X				X	O				
Marine Resources	X	X	O		O	O	A	A	A		O	O
Marine environmental protection	X	X	O	X	O	O	X	A	A	O	A	O
Disaster Mitigation	O		X		O	O	X				O	O
Marine zoning	X	X	O	O		O	X	O	O	O	A	
Coastal zoning	X	X	X	X	O	O	X	X	X	X	X	O
(X=jurisdictional overlap; O=co-operation; A=potential conflict)												

Figure 6: Agencies' responsibilities in coastal zone management in China (Lau, 2005)[18]

Figure 6 also illustrates another constraining aspect of coastal zone management in China. Within the SOA's jurisdiction the coastal zone is limited to the marine part. In contrast, the land part is under jurisdiction of the Ministry of Land and Resources (MLR) that manages the SOA since 1998. Figure 6 shows that a re-definition of the coastal zone in its natural sense as a highly sensible transition zone between land and ocean would only increase overlaps in responsibilities. Therefore, coastal zone management in China needs a more comprehensive reform in order to efficiently address coastal problems. This also forms a major argument against incorporating adaptation measures into a coastal zone management system in China, as major overarching reforms are currently not envisaged. Still, Yang (1996) is setting CZM in as a method of adaptation parallel to those of retreat, accommodation and protection. Alongside a study series for the Zhujiang River on sea-level rise impacts (compare China Ocean Information Network a, b, c), Yang's study forms one of the scarce frameworks for specific areas that are available in the literature.

[18] Y-axis f.l.t.r.: Ministry of Land and Resources, Ministry of Agriculture, State Environmental Protection Agency, National Bureau of Forestry, Ministry of Science and Technology, Chinese Academy of Sciences, Maritime Safety Administration, Development and Planning Commission, Economic and Trade Commission, National Tourism Agency, Ministry of Construction, Ministry of Water Resources.

3.3 Disaster Management as an alternative framework

China is also subject to other climate change induced impacts along the coast. These impacts include increased storm frequency and intensity. Coastal storms also produce temporary flooding and are a major cause for disaster loss in the region already. Disaster management is another organisational structure that may be capable of integrating adaptation to sea-level rise. In order to assess this, the structures of current disaster management in China have to be analysed according to the group of disasters, which occur within the coastal zone and therefore spatially interact with future climate change impacts in this region. Furthermore, the agencies involved in disaster management will be under investigation.

China is a country hit quite frequently by natural disasters. In 2003 overall losses of 188.6 billion RMB (22.7 billion U.S. $) occurred (Xinhuanet, 2003b; People's Daily, 2003c). China's awareness of natural disasters is relatively high. The country also participates in the IDNDR (International Decade for Natural Disaster Reduction) effort (Acca21, 1997; People's Daily, 2000; ADRC, 2005). The China National Committee for IDNDR formulated the National Natural Disaster Reduction Plan of the PRC that came into effect in 1998. The plan is set as a long-term objective and therefore development aims at the year 2010.

The plan distinguishes China's areas into three regions according to their economic vulnerability to natural disasters. The coastal zone is mainly represented within region three, which includes eight provinces and municipalities along the Eastern coast[19]. Due to high population density and economic importance, the absolute quantity of direct economic loss sustained is high (compare also Nicholls and Leatherman, 1995b). On the other hand a strong economy and greater capability to fight disasters only result in medium to low percentage of direct economic loss due to natural disasters. Most effected sectors are industry, agriculture, transport and city infrastructures (China National Committee for IDNDR, 1998). The China Ocean Agenda 21 also includes a chapter on 'Natural Marine Disaster Prevention and Mitigation' (SOA, 1996). Sea-level rise is mentioned as an extraordinary threat, as it is apart from most other disasters of the coastal zone not occurring suddenly. Furthermore, the establishment of a management system for disaster prevention and mitigation is pronounced, while adaptation options should be proposed on the basis of assessments and vulnerability studies.

Within the Chinese National Natural Disaster Reduction Plan the range of disasters threatening the coastal region includes flood and water-logging, drought, typhoon, and storm surge besides earthquakes, hailstorms and subsidence (China National Committee for IDNDR, 1998). As the region is quite large, many disasters are included and a detailed distribution is not specified. In contrast, this analysis also includes disasters frequently mentioned by the general and Chinese literature on coastal zone management and climate change. The number of disaster under investigation is limited according to their occurrence along the coastline.

The disasters in figure 7 can be distinguished in two ways. The first classification option is their relation to systems. River floods are related to the water system. Floods due to precipitation and storm surges are related to the meteorological system. Accelerated

[19] Out of 11 coastal administrative units on the provincial/municipal level altogether. Not counting the Special Administrative Zones of Hong Kong and Macao.

wave activity, seawater inundation, red tides, oil spillage and marine pollution are related to the marine system. Land subsidence (natural and human-induced), erosion as well as mud slides are geological disasters.

Disasters	Impact-ing	Out-come	Accelerat-ing sea-level rise	Mutually impact-ing	Resulting from slr
Floods (river)	X			X	
Floods (precipitation)	X		X		
Storm surges	X		X		
Land subsidence – natural	X		X		
Land subsidence – human induced		X	X		
Erosion – direct / indirect		X		X	
Accelerated wave activity	X	X		X	
Seawater inundation		X			X
Dike breaches		X		X	
Environmental degradation		X		X	
Salination – soil / ground and surface water		X			X
Building collapses		X			X
Land slides (mud)		X	No relation to sea-level rise		
Red tides		X			
Oil spillage	X				
Marine pollution	X				

Figure 7: Disasters classification for China's coasts

Another classification is along their frequency of occurrence within the disaster and sea-level rise literature. Red tides, oil spillage, and marine pollution are mentioned most in literature on marine vulnerability to disastrous events (compare COIN, 1998). However, it is clear that they do not have a direct relation to sea-level rise. In contrast, seawater inundation, accelerated wave activity and storm surges are mostly discussed within the climate change literature (compare Nicholls, 2003; De Groot & Orford, 2000; Arthurton, 1998). Other disasters are generally described in geoscientific approaches, e.g. land slides and erosion. However, within sea-level rise research erosion is distinguished into direct and indirect erosion, with the latter taking place by reduced sediment transport in estuary areas (as first and second order impacts in Pernetta & Elder, 1992). Another group of disasters is formed by salination (of soil, ground and surface water), natural and human-induced ground subsidence and general environmental degradation. This group is usually not mentioned separately within the disaster literature. They sometimes form a superstructure for disasters leading to one monitored effect or they are considered to be strongly related to other disastrous effects, e.g. salination being the impact of sea-water inundation. Yet, other incidents frequently occurring, e.g. building collapses and dike breaches are also seldom specifically formulated (except for earthquake literature, compare Ye, 2001). As they are also in part related to sea-level rise, with dike breaches considerably influencing the flow direction of inundation, they are included in the following analysis.

In contrast to Ye (2001), who categorizes disasters in China into major and minor, a categorisation of disasters into a ranking was abandoned here, as it could only show the disasters' rank on a subjective human experience scale. This way only disasters with a large scale influence on an area's population (e.g. river floods) or such with a major interest by a certain group or a short term perspective are bound to be defined first rank. As this analysis emphasises the relation between disasters and sea-level rise, subjective ranking is not feasible.

In figure 7 two major qualifications are reflected. The first categorisation is that of impacting and outcome disasters. Impacting disasters are directly influencing human life's functions and other systems (ranging from the natural environment to the economic system) and are generally difficult to control. In contrast, outcome disasters have to be preceded by either another disastrous event (e.g. sea-level rise) or some (human) action generating this disaster. This becomes most clear with the example of land subsidence: the natural, tectonic one is unpredictable and uncontrollable, whereas the human-induced subsidence is generated by human activity, e.g. overpumping of ground water. Outcome disasters can generally be prevented or controlled by yet another human intervention often via another system, in our example the refilling of underground aquifers, which is a detour via the water management system. The only exception in this classification is posed by the effect of accelerated wave activity, which can be both, impacting and outcome. As an impacting disaster it is generated by (naturally) changing currents and this way is to a high degree unpredictable. In contrast, as an outcome disaster accelerated wave activity is generated by storm surge and can be protected against.

The second classification proposed is that of relevance to sea-level rise[20]. The exclusive categories are either accelerating sea-level rise, which is an active and one direction function, or the disasters offered can also be mutually impacting with sea-level rise – defining a two way function . For instance, direct erosion can have the effect of relative sea-levels rising and sea-levels rising are accelerating the direct erosion rate. The last option is a disaster to be resulting from sea-level rise, which is also a one direction function, but in this case a passive one; an example is sea water inundation. This categorization cannot be applied to land slides, red tides, oil spillage and general marine pollution, as they have no direct relation to sea-level rise.

The two categorisation options result in five groups of different combinations. Further steps of analysis gave each group a certain qualification reflecting the disaster's predictability, possibly its relation to other systems or adaptation aspects. The qualifications were hold as simple as possible in order to enable cross attribution. It showed that the more unpredictable the impact of a disaster the more superficial becomes the recommended form of adaptation. And the more related the disaster is to other systems the more diverse the adaptation options become. Also, the more often there is an accelerating relation to sea-level rise, the more likely is an adaptation approach of vulnerability reduction.

Based on literature research and other information on institutional participation (JICA, 2002, and compare Appendix 1) related agencies in China were mapped according to disasters. This way it became clear, who was responsible for disaster management. In

[20] Geophysical effects of sea-level rise are described by Nicholls, 2003; De Groot & Orford, 2000.

the following step these agencies were compared to the ones derived earlier for the agencies responsible for land use changing activities within the coastal zone (see figure 4). This step reflected on a possible integration of adaptation into existing disaster management structures. It showed that the activities, whose institutional responsibility was investigated (land reclamation, coastal construction and dike building), have a very high potential relation to the disasters of the coastal zone. No disaster was insignificant to the coastal activities, but some had a somewhat less strong potential relation, i.e. building collapses, indirect erosion, environmental degradation and salination. It should be kept in mind that a relation may also be positive. Interestingly the agencies, that are responsible for the coastal activities, had not always a direct relation to the agencies involved in disaster management. Furthermore, there were always a significant additional number of agencies involved in disaster management. Figure 8 shows an aggregated overview and furthermore gives the numbers of agencies involved in specific disasters.

agencies by disaster relation	**related disasters**	**coastal zone activities**		
		land reclamation	dike building	coastal construction
MWR, MLR + 6	floods (prec.)	**X**	**X**	**X**
MWR + 4	land subsidence (nat.)	**X**	**X**	**X**
4	Storm surges	**X**	**X**	**X**
MWR, MLR + 5	floods (river)	**X**	**X**	**X**
SOA + 3	acc. wave activity (imp.)	**X**	**X**	**X** (bridges)
MWR, MLR + 3	land subsidence (human-ind.)	**X**	**X**	**X**
MWR, MLR, SOA + 7	seawater inundation	**X**	**X**	**X**
MLR + 3	building collapses			**X**
SOA + 3	acc. wave activity (outcome)	**X**	**X**	**X**
MWR, MLR + 2	erosion (direct)	**X**	**X**	**X**
MLR + 3	dike breaches	**X**	**X**	**X**
MWR, MLR, SOA + 2	erosion (indirect)	**X**		
MWR + 2	environmental degradation		**X**	**X**
MWR + 3	salination (all)	**X**		
agencies and administrative levels by coastal activities		MWR, MLR, loc gov	MWR, loc gov, nat gov, SOA	loc gov, MWR, SOA, nat gov

Figure 8: Agencies of disaster management related to coastal activities

The disaster analysis is feasible for redefining disaster groups according to their potential adaptation. This perspective relates to the quality of disasters emerging in the coastal zone. However, the analysis' results do not show a matching responsibility of agencies. There are only two possible explanations for that. First, the institutions related to disasters are too broadly defined, as they are mainly derived from the literature and reflect only a share in responsibility without further defining the quantity. Second, the agencies' responsibilities for both groups – disasters and coastal activities – in fact do not reflect the natural relation existing between the two outcomes (of human, land use changing activities and possible disasters in the coastal zone). However, some of these disasters will be accelerated with climate change and especially the setting in of sea-level rise.

It is difficult to integrate adaptation the way disaster management in China currently exists. It includes a large number of agencies and sectoral organisational structures (see also China National Committee for IDNDR, 1998), depending on the disaster. It is either organized top-down, e.g. flood protection, or the objective is addressed by an ad-hoc commission, e.g. oil spillage (personal communication Lu Dong Yun). The latter is no option for a long-term threat such as sea-level rise, as it needs a preventive planning approach to be implemented. Therefore the top-down approach of flood protection is the object of the following investigation. In the ongoing process of analysis the emphasis is taken away from the institutional set-up of agencies and moved to the organisational structure of implementation procedures. This way the governmental levels of implementation are more focussed upon.

3.4 Water Management and flood disasters

As natural disasters in China flooding, drought and earthquakes are most often mentioned. Typhoons, Asia's most powerful storms, are another threat, but as they always bring a high but short-termed amount of precipitation, their management is incorporated into flood defence. (Ye, 2001; Zhu, 2000). The group of disasters perceived as most important, has led to the distribution of responsibilities among a number of institutions. For the adaptation to sea-level rise the mechanisms for flood protection are most interesting. The Headquarters for Flood Protection and Drought Control (HFPDC) (China Daily, 2002a) is situated in the Ministry of Water Resources (MWR) and has the structure of a commission. The most frequent floods in China are river floods; therefore the positioning within the MWR is sensible. Other ministries participating in flood control are those, whose jurisdiction is most likely to be affected by the flooding and whose losses are likely to be the highest. These ministries are the Ministry of Agriculture (MOA), and the Ministry of Communication (MCom), that is responsible for the country's transportation infrastructure. In a severe case of disaster the National People's Army will be brought in for dike strengthening and evacuation tasks; further rescue responsibilities are with the Ministry of Civil Affairs.

Flood protection is essentially subject to the MWR, which has planning and implementation responsibilities (personal communication Li Kungang). As long as only one province is affected by flooding the local (here provincial) level bears all responsibility. In case of more than one affected province, the national government forms a commission that is led by the HFPDC. Concerning the adaptation to sea-level rise it is problematic that on the national level this agency (or the MWR) is not explicitly engaged with flooding along the coast – this is matter of the local governments. Generally, local water administrations are complex in structure and partly lack coordination mechanisms (CHS, 2004). Although dike building is also a responsibility of the MWR or its local counterparts, there is a lack of an organisational framework bundling the institutional responsibilities. Only a clear jurisdiction is building capacity to implement adequate approaches against all possible climate change related disasters along the coast – through a range of measures from reactive emergency plans to long-term planning of adaptation options.

3.5 River Basin Management and the adaptation to sea-level rise

Besides the MWR's Headquarter of Flood Protection and Drought Control the seven River Basin Commissions for all major Rivers in China form a management system on

the regional level [21]. These Commissions are situated on a sub-national level, theoretically providing them with more and inter-provincial decision powers than the water management bodies on the provincial and municipality level. Furthermore, they include a combination of departments, e.g. for water affairs, and are responsible for the assessment of construction projects within the river deltas (Zhujiang Water Resources Network, Appendix 1). Although these institutions largely exist since the 1950s (IWMI, 2005; China Daily, 2004; Wu, 1994) the legal status of the river basin commissions was not even mentioned in the water law of 1988 (Zhang und Wen, 2001). They therefore were considered as having a weak position in negotiations and decision-making (Zhang and Wen, 2001). Recommendations how to integrate River Basin Management in China have been made as early as 1994 (Hu, 1994). The flood control law formulated in 1997 is also allocating the comprehensive planning objective along river basins and regions (State Council of the PRC, 1997). But, only after the devastating floods in the Changjiang River Basin in 1998 the MWR issued guidelines how to re-organise the flood control on three levels: national, regional (per basin) and provincial (Zhang und Wen, 2001).

Since then the integration of flood control with plans from other sectors such as land use planning or urbanisation has been the focus in river basin management. In 2003 a task force of Integrated River Basin Management (IRBM) had been formed with participation of international experts (WWF, 2003). An institutional change that has been long called for is envisaged through forming a national level Integrated River Basin Management Commission that is headed by the Vice-Premier and involves all related governmental organisations (China Daily, 2004; Zhang and Wen, 2001). It becomes clear, that the river basin management is currently under significant change. Furthermore, all seven river basin commissions that already existed have a different status of development regarding their responsibilities in flood control and the number of agencies involved[22]. Interestingly, even a limitation of adaptation responsibilities to a sub-group of administrations that are responsible in the delta areas only, would include a significant number of agencies and levels involved (compare Chen and Saito, 2003).

The planned national River Basin Commission is reflecting a trend of an even more centralised organisation of management. However, experts largely agree that adaptation is a local objective. This way an integration of adaptation to sea-level rise into river basin management would also need to support the lower administrative levels. A centralised approach is meaningful from the perspective of integrating numerous administrative units (11 provinces alone for the Changjiang River Basin), but the river basin management as it has existed before also broke down to the county level. Apparently these lower levels of administration have to be adequately supported in their task of flood control especially with regular financing, as in some regions the funds for maintenance and operation are not secured and therefore many projects are in a poor condition (Zhang and Wen, 2001). If this is still the case for flood control along the river course, river basin management does not yet seem to be a suitable framework for additionally integrating the adaptation to sea-level rise. However, if a working scheme can be achieved in the near future, as the task force team of IRBM is hoping for, it

[21] The main river deltas in China are the Changjiang, the Huanghe, the Songhua, the Liaohe, the Haihe, the Huaihe and the Zhujiang. Nonetheless, the river basin commissions are distributed differently: Songhua and Liaohe share one Committee and the Taihu Lake has an own (Zhang and Wen, 2001).
[22] Compare CGIAR, 2005, for the Huanghe; Zhang and Wen, 2001; Vemula et al., 2004, for the institutional set-up of the Changjiang authorities; and Zhujiang Water Resources Network (Appendix 1) for the Zhujiang.

would be best to include coastal adaptation as soon as possible. Especially for the Zhujiang and the Changjiang mouths it would be a solution that could also take phenomena such as the backwater effect[23] into account. In general, the use of river basin management as an organisational framework has the disadvantage that not all coastal provinces would be affected by this institutional set-up. Therefore, it would still be the MWR that is in the end responsible for coastal adaptation.

The current development in institutional change of the river basin management originates in the 1998 floods along the Changjiang[24]. According to the China Daily (2002a) these floods left 4100 persons dead[25]. Today, dike strengthening may have shown positive effects already. According to EM-DAT data the number of flood incidents for the period 2000-2005 is already higher than the number for the 1990-1999 period. Nonetheless, the numbers of people killed and affected has been reduced significantly (EM-DAT, 2005). Although it is disputed if the increase in the number of such events is a direct effect of global warming and some scientists argue that it may be a repetition of circles that affected the global climate before, it is evident that such events raise awareness of mankind's vulnerability to natural causes. The manager of the Red Cross China section urged the Chinese government to improve disaster management and consciousness in affected regions and formulated that there will be no protection from concrete and steel alone against flash floods and general climate change (China aktuell, 2004). The following section discusses the potential of a management based on climate change for China.

3.6 Development of Climate Change Management in China

Since the 1980s climate change has been a research issue in China, but it also increasingly becomes an issue on the political agenda. The emphasis is put on the mitigation of CO_2 emissions, though. In 1990 a Coordination Committee on Climate Change was set up. Meanwhile its positioning has changed from the Environmental Protection Committee under the State Council to the State Meteorological Administration. During administrative reforms in 1998 the National Coordination Committee on Climate Change was established under the Chair of Zeng Peiyan of the State Development and Planning Committee (National Coordination Committee of Climate Change of the PRC, 2001; CCCIN, 2004). Major coordination groups of this cross-ministerial body are the National Development and Reform Commission, which coordinates various climate change policies, the Ministry of Foreign Affairs, that leads China's participation in international climate change negotiations, and the SOA, that leads China's participation in the work of the IPCC. The SOA is conducting major research on sea-level rise, but only marginally on adaptation options, yet. Additionally, research institutes such as the Meteorological Administration and the Agrometeorological Institute provide special disaster mitigation and global change sections.

[23] A backwater effect is setting when sea-levels are rising and the discharge of river water is hindered. The water then stows in the areas of the river mouth and causes inundation. Especially for Shanghai this effect is not to be underestimated (Wang, 1995).
[24] As has been the project of reinforcing the Changjiang dikes. The project took four years and cost 27 billion RMB for a length of 3078 km (Zhu, 2003; People's Daily, 2002).
[25] The United Nations Economic and Social Commission for Asia and the Pacific (UNESCAP) counts 1562 victims (UNESCAP, a).

Generally, at the time being there is more research on mitigation efforts going on than on adaptation options in China. A reason for this can be seen in the long-term character of sea-level rise. Mitigation efforts, such as the decrease of urban pollution, show changes in everyday life more quickly, and therefore is more meaningful to people. Furthermore, investments into new technologies are a convincing argument for local governments to rather invest into mitigation technologies than in costly adaptation measures and programs that may only be necessary in one to two decades. Hence, there is a strong division between research on sea-level rise impacts and practical implementation of (new) adaptation options. With the threat of sea-level rise being a long-term problem, this sometimes distracts from the fact, that reasonably soon alternative practices are necessary for adaptation to sea-level rise (personal communication Du Bilan). Concepts for such practices need to be formulated as soon as possible and their implementation must be firmly tied to a functioning organisational framework.

4. Conclusion: Short-term and long-term targets in competition - Climate Change Management as an alternative framework?

The difference between short-term and long-term planning is a crucial factor when discussing climate change. Politically China is well capable of implementing concepts that would not work in most countries, e.g. the one-child policy in order to decrease population growth. Nonetheless it shows that such decisions are made on the grounds of pressing problems and also yield an economic advantage in development policy.

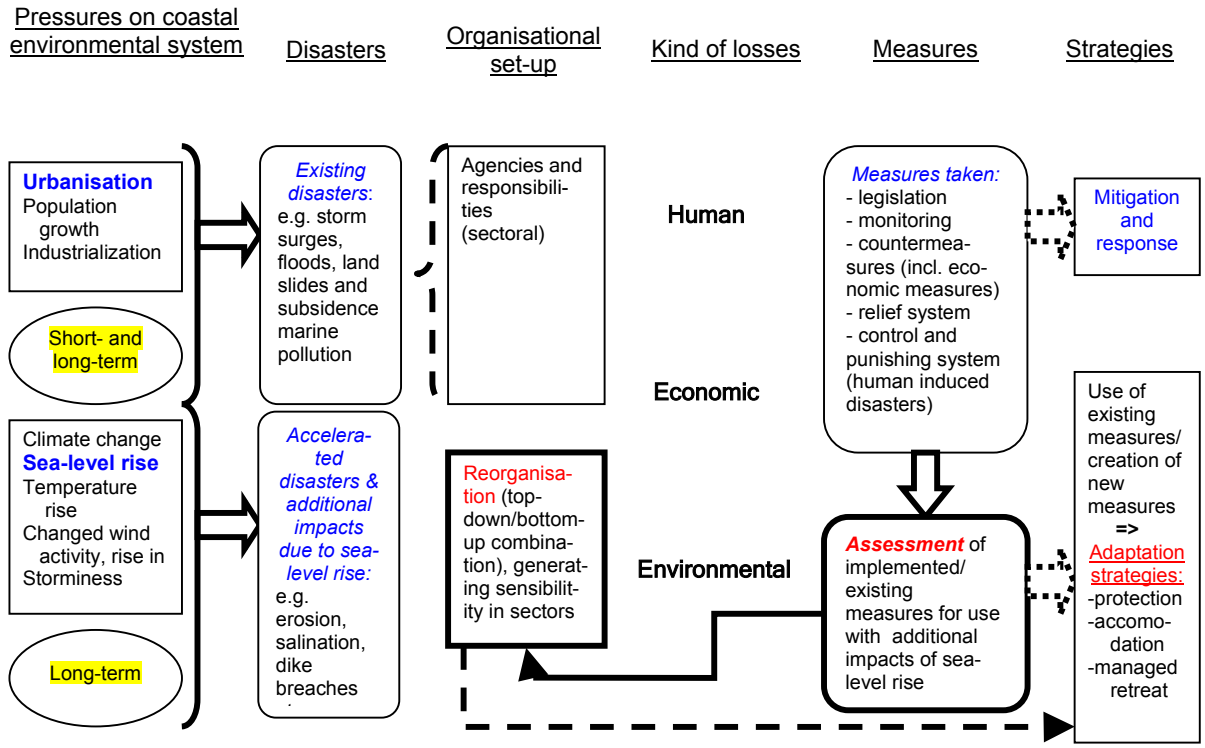

Figure 9: Changes in disaster management perception to meet the requirements for climate change and especially for the adaptation to sea-level rise

Developments within the Chinese coastal areas are laid out to be short-term, which is a reasonable approach taken the immense economic growth and expected urbanisation rate of the region (Cheng, 2002). However, the adaptation to future threats is a long-term task. A possibility to circumvent this contradiction lies in the upgrading of the MWR responsibilities for coastal development towards a comprehensive flood control along the coast. This way, the MWR would gain the jurisdiction of the practical adaptation to sea-level rise, whereas the theoretical level, including research would remain with the experienced SOA. Another possibility for the near future would be to incorporate the adaptation issue more deeply into the climate change management in China. Ding Yihui, special advisor on climate change by the Chinese Meteorological Administration, emphasised (after Yao, 2002) "that the state needs to draw out an overall strategy of adaptation and reduction", meaning a combination of adaptation to sea-level rise and mitigation of CO_2-emissions. For this purpose the National Coordination Committee on Climate Change would need to include a comprehensive adaptation plan and allocate the relevant responsibilities accordingly. This could also happen in a separate organisation for the impacts of climate change that includes the disaster management.

Figure 9 shows a path that upgrades the existing disaster management, as existing in most countries, with the responsibility for impacts climate change is posing. It is essential to include the distinction of short-term and long-term developments and reflect the fact, that most known impacts are due to be accelerated through climate change. Therefore, it is meaningful to allocate the basic structures of a framework in experiences drawn from disaster management. Additionally, the importance of long-term planning in adaptation options must be reflected by institutions' planning capacity. Although adaptation is often described as a local task, the responsibility should not automatically be allocated there. At least a national plan should exist or a national framework of organisation be provided to include the adaptation to sea-level rise. As Christie (2005, citing Ostrom, 1992) emphasises: "local-level […] resource management regimes must be nested within wider, and supportive, governance structures for such approaches to function properly" (p.220). Otherwise long-term adaptation plans run great risk to become overruled by the short-term economic decision-making. Clear concepts and functioning frameworks though may stand a chance to generate the political will needed. As China is in a phase of change it has the chance to become a country sincerely doing so.

Acknowledgements

The DINAS-COAST Project (EVK2-2000-22024) provided welcome financial support. I furthermore thank all interviewees in Shanghai, Beijing and Tianjin for their hospitality and kindness to share their experience and opinions with me. I very much benefited from early comments by Richard Tol and participants at workshops this paper has been presented at. All errors and opinions are mine.

APPENDIX 1: Websites of administrative agencies and information networks

Administrative Center for China's Agenda 21 (*Zhongguo 21 shiji yicheng guanli zhongxin*). www.acca21.org.cn (Chinese and English).

Agrometeorological Institute (of the Chinese Academy of Agriculture Science) (*Nongye kexue yuan nongye huanjing yu chixu fazhan yanjiu*). www.ami.ac.cn (Chinese and English)

Chinese Academy of Sciences. www.cas.ac.cn (Chinese and English).

China Climate Change Information Network (*Zhongguo qihou bianhua xinxi wang*). www.ccchina.gov.cn (Chinese and English).

China Earthquake Administration (formerly State Seismological Bureau). www.cea.gov.cn (Chinese).

China Gateway (*Zhongguo fazhan menhu wang*). www.chinagateway.com.cn (Chinese and English).

China Internet Information Center. www.china.org.cn (multi-lingual).

China Ocean Information Network (*Zhongguo haiyang xinxi wang*). www.coi.gov.cn (Chinese and English).

Economic and Trade Commission. www.setc.gov.cn (Chinese and English).

Maritime Safety Administration (Marine Affairs Administration). www.msa.gov.cn (Chinese).

Ministry of Agriculture (*Zhongguo nongye xinxi wang*) (China Agriculture Information Network). www.agri.gov.cn (Chinese).

Ministry of Civil Affairs. www.mca.gov.cn (Chinese).

Ministry of Communication. www.moc.gov.cn (Chinese).

Ministry of Construction. www.cin.gov.cn (Chinese).

Ministry of Health. www.moh.gov.cn (Chinese).

Ministry of Land and Resources. www.mlr.gov.cn (Chinese and English).

Ministry of Science and Technology. www.most.gov.cn (Chinese and English).

Ministry of Water Resources. www.mwr.gov.cn (Chinese and English).

National Bureau of Forestry. www.forestry.gov.cn (Chinese).

National Development and Reform Commission (formerly Development Planning Commission. www.sdpc.gov.cn (Chinese).

National Tourism Administration. www.cnta.com (Chinese and English).

People's Daily online (*Renmin wang*). http://english.peopledaily.com.cn (multi-lingual) and http://unn.people.com.cn related to www.people.com.cn (Renmin wang) (Chinese).

State Environmental Protection Administration (*Zhongguo huanjing baohu zongju*). www.sepa.gov.cn and www.zhb.gov.cn (Chinese and English).

State Meteorological Administration. www.cma.gov.cn (Chinese and English).

State Oceanic Administration. www.soa.gov.cn (Chinese).

Zhujiang Water Resources Network (*Zhujiang shuili wang*). www.pearlwater.gov.cn (Chinese).

Xinhuanet (China News Agency). www.xinhuanet.com (multi-lingual).

APPENDIX 2: List of interviewees cited

Du Bilan (retired director), *Research Unit for Marine Development and Planning (State Oceanic Administration), Beijing (Oct 18, 2003).*

Li Kungang (Director), *State Flood Control and Drought Relief Headquarters (Ministry of Water Resources), Beijing (Oct 16, 2003).*

Lu Dong Yun, *Shanghai Administration for Ocean Affairs (Maritime Safety Administration), Shanghai (Oct 10, 2003).*

Mao Wei De (Head), *Water Environment Monitoring Center (Shanghai Hydrology Administration), Shanghai (Oct 12, 2003).*

Wei Zi Xin (vice director), *Shanghai Institute of Geological Survey (Shanghai Housing and Land and Resources Administration), Shanghai (Oct 10, 2003).*

Ms. Xu, *Water Affairs Administration, International Cooperation Department, Shanghai (Oct 10, 2003).*

Zhao Xitao, *Institute for Geology and Geophysics (Chinese Academy of Sciences), Beijing (Oct 17, 2003).*

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