



## SEA of river basin management plans

*incorporating climate change*

Larsen, Sanne Vammen; Kørnø, Lone

*Published in:*

Impact Assessment and Project Appraisal

*DOI (link to publication from Publisher):*

[10.3152/146155109X480367](https://doi.org/10.3152/146155109X480367)

*Publication date:*

2009

*Document Version*

Accepted author manuscript, peer reviewed version

[Link to publication from Aalborg University](#)

*Citation for published version (APA):*

Larsen, S. V., & Kørnø, L. (2009). SEA of river basin management plans: incorporating climate change. *Impact Assessment and Project Appraisal*, 27(4), 291-299. <https://doi.org/10.3152/146155109X480367>

### General rights

Copyright and moral rights for the publications made accessible in the public portal are retained by the authors and/or other copyright owners and it is a condition of accessing publications that users recognise and abide by the legal requirements associated with these rights.

- Users may download and print one copy of any publication from the public portal for the purpose of private study or research.
- You may not further distribute the material or use it for any profit-making activity or commercial gain
- You may freely distribute the URL identifying the publication in the public portal -

### Take down policy

If you believe that this document breaches copyright please contact us at [vbn@aub.aau.dk](mailto:vbn@aub.aau.dk) providing details, and we will remove access to the work immediately and investigate your claim.

# SEA of River Basin Management Plans: Incorporating Climate Change

*Sanne Vammen Larsen, Ph.D.-student, Aalborg University/Ramboll A/S, Denmark*

*Lone Kørnøv, Associate Professor Ph.D., Aalborg University, Denmark*

## **Abstract:**

In 2000 the European Parliament and the European Council passed the Water Framework Directive (WFD) to be implemented in the Member States, among these Denmark. The consequence of the directive is that river basin management plans (RBMPs) shall be prepared which, according to European and Danish legislation, are subject to a strategic environmental assessment (SEA). A seemingly important environmental factor for the water sector is climate change and especially the changes it causes to the water environment. However, based on an argument of an inadequate knowledge base regarding climate change impacts, the prospect of Danish authorities including climate change in their SEAs of RBMPs is weak. In this paper the connections between climate change and water are reviewed. As a result it is suggested that climate change needs to be considered in three ways in SEA of RBMPs: in terms of mitigation, adaptation and baseline adaptation.

Key-words: Strategic environmental assessment, river basin management plans, water framework directive, climate change, mitigation and adaptation

## **1. Introduction**

There is growing focus on climate change and the potentially significant consequences on nature and human-beings. Today it is attempted to counter climate changes both through mitigation of any further releases of greenhouse gasses and through adaptation to the changes already happening. According to the report of Working Group II in the third assessment from the Intergovernmental Panel on Climate Change (IPCC), mitigation is defined as “*an anthropogenic intervention to reduce the sources or enhance the sinks of greenhouse gases*” and adaptation as “*adjustment in natural or human systems in response*

*to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities”* (McCarthy et al. 2001, 990, 982).

The need for adaptation is widely acknowledged today. Adaptation as a strategy complements the mitigation strategy and as stated by the IPPC in the summary for policymakers of their Fourth Assessment Report; *“adaptation will be necessary to address impacts resulting from the warming which is already unavoidable due to past emissions”* (IPCC 2007, 19). The EU commission in their white paper on climate change adaptation, state that ...*“we must take adaptation action to deal with the unavoidable impacts”*, and emphasise among others the water sector (Commission of the European Communities 2009).

There is international consensus that mitigation and adaptation of climate change is relevant for inclusion in impact assessment processes at both project and strategic levels of decision making in different sectors (Byer and Yeomans 2007; Duinker and Greig 2007, Wilson and Piper 2008). The Organisation for Economic Co-operation and Development (OECD) states that climate change adaptation needs to be better integrated in development and that environmental assessment is an appropriate entry point for information on climate change mitigation and adaptation, both at planning and project levels (OECD, 2006). OECD (2006) claims that guidelines for impact assessment need to be broader and also consider the impacts of the environment on the project. The EU in their white paper on adaptation also focuses on the need for developing guidelines and best practise on how to integrate climate change in EIA, SEA and spatial policies (Commission of the European Communities 2009). Internationally there are more and more examples of national practical guidance on how to incorporate climate change into EIA and SEA, for instance in the UK and Canada (Levett-Therivel Sustainability Consultants 2007; The Federal-Provincial-Territorial Committee 2003). In Denmark, the Danish International Development Agency, underlines the importance of performing screenings of climate change impacts in both developed and developing countries, and that one of the necessary activities would be addressing climate change impacts in SEAs and in EIAs (DANIDA, 2005). Further, the Danish climate change adaptation strategy, outlines a need for assessment of whether the current regime for environmental assessment, including SEA

and EIA, is sufficient, seen from a climate change perspective, or if changes should be made. At the same time a need for guidance for practitioners on incorporating climate change in SEA and EIA is underlined. (Danish Government 2008, 30)

There is growing awareness of the need to mainstream both climate change mitigation and climate change adaptation in EIA and SEA. The awareness also covers the SEAs performed within the water sector, and this article strives at contributing with reflections on how to include climate change in the specific case of SEA of RBMPs in the Danish context.

## **2. Research Methodology and Scope**

Section 3 and 4 further introduce to the subject of the paper: section 3 presents the European WFD and SEA, as well as their interconnections. Section 4 discusses the issue of incorporation of climate change in SEA of RBMPs, and also presents the reasoning for the focus on Denmark as well as an elaborated purpose of the paper. Section 4 utilises telephone interviews with a representative of each of the seven Danish state environmental centres. The interviews were carried out in January 2008, and the interviewees were employees either responsible for the SEA or working on the RBMP. The interviewees were appointed by the centres themselves, as those they considered best capable of answering questions regarding the SEA of the RBMPs. In Section 5 an analysis of the connections between climate change and the water environment are presented, and in Section 6 this analysis is used to draw up a framework for the inclusion of climate change in SEA of the RBMPs. Finally in Section 7 conclusions are drawn.

There exists extensive research into barriers and motivation for climate change considerations, hereunder climate change adaptation (see e.g. Adger et al. 2008; Blennow and Persson 2009; Næss et al. 2005; Smit and Pilifosova 2001). Smit and Pilifosova underline in the IPCC report on climate change from 2001 that “*Adaptation to climate change and risks takes place in a dynamic social, economic, technological, biophysical, and political context that varies over time, location, and sector.*” (2001, p. 895). The adaptation capacity therefore depends upon a range of interrelated factors like e.g. economic resources, technology, infrastructure, knowledge, institutions etc. The scope of this article does not cover in-depth analysis of whether or not climate change is

incorporated in the RBMPs and SEAs, and the factors that determine this. Rather the scope is limited to dealing with how climate change can be considered in the SEAs.

### **3. The Water Framework Directive and Strategic Environmental Assessment**

In 2000 the EU issued *Directive 2000/60/EC of the European Parliament and of the Council of 23rd October 2000 establishing a framework for Community action in the field of water policy*, also known as the Water Framework Directive. The purpose of the directive is “to establish a framework for the protection of inland surface waters, transitional waters, coastal waters and groundwater”, through setting up a framework for river basin management planning in Member States. The directive dictates preparation of RBMPs, containing environmental goals for all surface- and groundwater within the water district, and a programme of measures in order to reach these goals. The ultimate environmental goals in the directive are to prevent deterioration of water quality and to achieve good water quality by 2015. (Directive 2000/60/EC 2000)

The WFD was implemented in Denmark through national legislation (*Miljømålsloven*) in 2003. According to this legislation, the Danish state is obliged to prepare the RBMPs for the Danish water districts (LBK nr 316 2004). In practise the work is divided so that the overall RBMPs will be prepared by the state’s seven national environmental centres, while the 98 Danish municipalities will prepare action plans, containing specific directions for the implementation of the RBMPs within their geographical area (Danish Ministry of the Environment, n.d. 5, 10).

SEA in accordance with *Directive 2001/42/EC of the European Parliament and of the Council of 27 June 2001 on the Assessment of the Effects of Certain Plans and Programmes on the Environment* (SEAD) and the resulting Danish *Law on Environmental Assessment of Plans and Programmes* from 2001, applies to both the state RBMPs and the municipal action plans. In the WFD it is also stated by the Commission that the SEAD needs to be taken into account during implementation (Directive 2000/60/EC). The purpose of the Danish law on SEA is to “secure a high level of environmental protection, and contribute to the integration of environmental considerations during the preparation and adoption of plans and programs, with a view to advancing sustainable development,

*by ensuring that an environmental assessment is performed for plans and programmes that may result in significant environmental impacts*". The SEA is performed by public authorities with participation by the public, and forms part of the decision process concerning the plan or programme. (LBK nr 316 2004; LOV nr 250 2009)

Research into the connections between SEA and the WFD has been made by Carter and Howe (2006), who point out a range of linkages between the directives. They point to the fact that SEA has to be applied to the RBMPs, and that the RBMPs should be used in making SEAs in other areas (Carter and Howe 2006). They further find common requirements between the two directives, including the collection of baseline data, assessment, mitigation, monitoring and consultation, reporting processes and public participation. That both directives share a common goal of sustainable development and have overlapping procedures, are reasons for growing consensus that an integrated approach when applying SEA to RBMPs is beneficial (Deasly and Preston, 2007; Carter and Howe, 2006). Integration as a strategy is also in line with the SEAD, which aims to avoid duplication (Directive 2001/42/EC, Art. 4(1), 5(2) and 5(3)).

A RBMP is a type of plan likely to have significant effects on the environment, which are assessed in a SEA. This includes impacts on flora, fauna, surface water, groundwater etc. Climate change is also relevant in this regard, because it can be characterised as a potentially significant effect on the environment stemming from human actions, such as RBMPs. Screening and scoping within SEA, though, is not only based upon an assessment of how the RBMP may affect the environment. How the environment affects the plan is also a matter which determines whether a plan is subject to SEA or not, and what should be within the scope of assessment. According to the SEAD, one of the "*criteria for determining the likely significance of effects referred to in Article 3(5)*" is "*environmental problems relevant to the plan or programme*" (Directive 2001/42/EC, Annex 2). In other words: it can be judged that a RBMP in itself might not have significant impacts on climatic factors it is rather climate change that has significant impacts on the RBMP. E.g. extreme wet or dry years may significantly affect the hydrological and aquatic systems and thereby be a determining factor for the achievement of environmental objectives laid down in the RBMPs. These couplings are explored further in Section 5.

#### **4. Strategic Environmental Assessment, RBMPs and Climate Change in Denmark**

In spite of the above mentioned issues, it has been decided in Denmark that climate change will not be taken into consideration in the first generation of RBMPs. This decision has been made by the Danish Ministry of the Environment. The Environment and Planning Committee of the Danish Parliament has asked the Danish Minister for the Environment, how adaptation to climate change was incorporated in the implementation of the WFD. In August 2007 the answer was given that climate change was not to be a specific issue in implementing the WFD, because “*the present technical basis for such assessments is not sufficient*” (Danish Ministry of Environment 2007). The issue of lack of knowledge about climate change is one of the barriers specific to climate change adaptation, which is discussed by Adger et al. (2009). It is argued that limited knowledge need not be a barrier to adaptation, although it is often presented as such (Adger et al. 2009). Whether insufficient knowledge has been the only barrier for The Ministry of Environment to exclude climate change in the RBMPs can not be assessed in this article.

In Denmark the work with the RBMPs has begun. Basic analyses have been published by the state environmental centres, and the planning process has started with an initial public hearing, in order to gather ideas and input from the public and other authorities (Danish Ministry of the Environment n.d.). The state environmental centres are also performing the SEA of RBMPs, but this work is only just getting started, and it has not yet been decided how climate change will be handled in SEA of the RBMPs. The SEA of state RBMPs might show up to be a driver for including climate change despite the announcement from the Ministry of Environment. The state environmental centres have published an overview of the issues that were brought up in the initial public hearing. From this overview it can be seen that the state environmental centres, during the period of public hearing, have received input concerning climate change. It is also stated in the overview that this does not change the decision to not include climate change in the RBMPs. (Danish Ministry of the Environment 2008) However, the state has not officially excluded climate change from the SEA of RBMPs, and it appears from conducted telephone interviews with the national environmental centres, that four of the seven interviewees believe that climate change will in some form be included in the SEA of the RBMPs.

This context of the exclusion of climate change as an issue in the RBMPs in Denmark stresses the importance of addressing climate change in SEA of the RBMPs. This makes Denmark an interesting case, and provides motivation for this article. The question addressed is therefore how climate change should be taken into account in the forthcoming SEA of RBMPs in Denmark? To address this question a framework of ways in which climate changes should be considered in the SEAs of RBMPs is proposed.

## **5. Connections between Climate Change and the Water Environment**

In Section 3 it is stated that SEA not only covers the effects of a given plan on the environment, but also any effects of the environment on the plan. Following from this, both contributions of the RBMPs to climate change and influence of climate change on the RBMPs should be taken into consideration in the SEA of RBMPs. This article focuses on the impacts of climate change over hydrology, water resources and water environment. The influence of climate change on plans is an area not previously dealt much with in the Danish context and in connection with water environment in SEA. In order to understand how climate change influences the RBMPs, an overview of the influences of climate change on the water environment is required.

It is stressed, among others by UNEP (2007, 120), that: *“Climate change is expected to exacerbate pressure, directly or indirectly, on all aquatic ecosystems.”* For example, in the fourth assessment by the IPCC is stated that *“There is high confidence that some hydrological systems have also been affected through increased runoff and earlier spring peak discharge in many glacier- and snow-fed rivers, and effects on thermal structure and water quality of warming rivers and lakes”* (IPCC 2007, 2). The linkages are further underlined in the IPCC Technical Paper VI Climate change and water from 2008: *“Observational records and climate projections provide abundant evidence that freshwater resources are vulnerable and have the potential to be strongly impacted by climate change, with wide-ranging consequences for human societies and ecosystem”* (Bates et al., 2008, 3). When reviewing the research field, there are several publications on the effects of climate change on water in the Danish context, for instance Sonnenborg et al. (2006), and Danish Ministry of Finance et al. (2007). These also point to a range of impacts of climate change on water.



In Figure 1, a simple causal model of probable negative effects of climate change on the water environment in Denmark, and northern Europe in general, is drawn up. The model shows the temperature rise and other climate change, implications of this for water, consequences for the water environment, and effects on the environmental baseline represented by the environmental factors included in the European SEAD.

It should be noted that water and climate change is interconnected in complex ways, and does not exist in isolation but must be seen in its context of socio-economic and environmental conditions (Bates et al. 2008). Furthermore global differences exist and are observed, in parameters like surface temperature and precipitation impacting the hydrological cycle and hydrological systems differently between continents and regions and within regions (Bates et al. 2008; Eisenreich 2005, 30). The observations of climate change also varies within Europe e.g. showing significant variations between northern and southern Europe, indicating that the southern part will be more negatively affected with warmer and drier climate (EEA 2004; McCarthy et al. 2001). The model presented does not provide a comprehensive picture of the climate change processes affecting the water environment but illustrates some important couplings between climate change and water relevant for impact assessment through SEA. The model is based on a literature study of predictions of climate change in Europe primarily relying on the contribution of Working Group II to the Third Assessment Report of the IPCC (McCarthy et al., 2001) and the Technical Paper of the IPCC on Climate Change and Water (Bates et al., 2008). Further, a European study on climate change and water adaptation prepared for the European Environment Agency by Footit and McKenzie (2007) is used, as well as Danish studies such as those by Sonnenborg et al. (2006) and the Danish Ministry of Finance et al. (2007). The effects on the environmental baseline are not based on the literature study, and should be regarded as illustrative examples rather than an exhaustive survey.

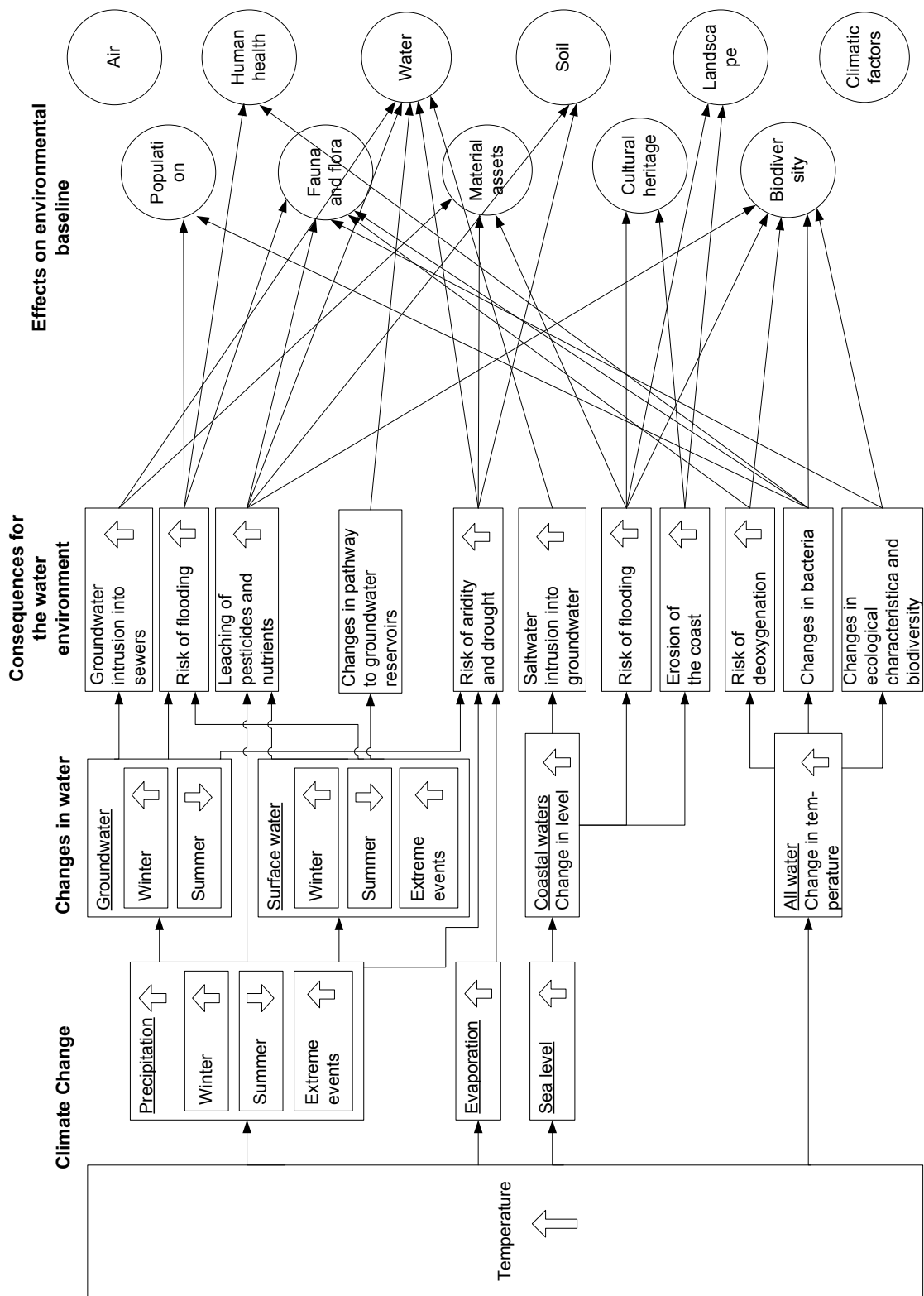


Figure 1 Model of the effects of climate change on the water environment.

In the following paragraphs, the four steps of Figure 1 will be reviewed.

The model illustrates different climatic factors, and how climate change makes these factors vary. *Precipitation*, as the main driver of variability in the water balance over space and time, is affected by climate change through varying its patterns of occurrence and by changing the state in which it produces (Arnell and Lui 2001). A warmer climate is expected to increase extreme precipitation as compared to the mean (Bates et al. 2008) and heavy precipitation has already been observed across Europe (Klein Tank and Können 2003). *Evaporation* is the other major influencing factor over hydrology. Based upon observations it is found that global land evaporation closely follows variation in land precipitation (Qian et al. 2006). Evaporation is expected to increase almost everywhere (Bates et al., 2008) due to higher temperatures (Eisenreich 2005). Further *sea-level rise* is projected for the coming decades, with substantial uncertainties and geographical variability (Bates et al. 2008, 28).

As shown in the model in Figure 1, projected changes in climate lead to changes in water. The changes in water in Denmark and Northern Europe in general, cover changes in both surface and groundwater systems with e.g.:

- An annual increase in runoff for surface waters of approximately 5-15 % up to the 2020s and by 9-22 % up to the 2070s (Alcamo et al., 2007), and increases in flow seasonality (Arnell, 2003) and extreme events (Sonnenborg et al. 2006, 67).
- Changes in the level of groundwater, with significant geographical and seasonal variation. In Denmark overall higher groundwater production and level is predicted. (Sonnenborg et al., 67)
- A rise in the level of coastal water as a result of the rise in sea level (Danish Ministry of Finance 2007, 11).
- Higher temperature in all waters (Bates et al., 2008).

The projected changes in waters all have potential consequences for the water environment, as illustrated in Figure 1. The consequences of the higher level of groundwater include increased risk of groundwater intrusion into sewers (Danish Ministry

of Finance 2007, 31). The seasonal increase in surface water and groundwater as well as increase in extreme events also increases the risk of flooding, northern Europe being one of the regions most prone to a rise in flood frequencies (Bates et al., 2008; Sonnenborg et al. 2006). The consequences also cover a risk of aridity and drought due to the seasonal low water levels combined with the increase in evaporation, and more extreme events (Sonnenborg et al. 2006; Danish Ministry of Finance 2007). The higher precipitation and increase in surface run-off, combined with reduced frost may increase the leaching of pesticides and nutrients from cultivated fields (Bouraoui et al., 2004; Sonnenborg et al. 2006, 70; Danish Ministry of Finance et al. 2007, 30). Changes regarding the groundwater may cause the water to flow differently to the groundwater reservoirs (Sonnenborg et al. 70). The higher level of coastal waters can lead to an increased risk of saltwater intrusion into groundwater, and together with an increase in flooding and storms to further coastal erosion (Eisenreich 2005, 33). The higher temperatures might increase the risk of deoxygenation (Danish Ministry of Finance et al. 2007, 10; Footit and McKenzie 2007, 16). It might also change the bacteria environment with an increase of toxic cyanobacteria in lakes (Eisenreich 2005) as well as bacteria in drinking water (Danish Ministry of Finance 2007, 30), and change the ecological characteristics and biodiversity with e.g. increased species richness in northern Europe freshwaters (Bates et al., 2008).

All the consequences for the water environment can affect the environmental baseline of a SEA. The model in Figure 1 illustrates the environmental parameters included in the SEADs environmental concept and baseline. As shown climate change impacts on the water environment potentially has effects on almost all environmental parameters.

It should be noted that the simple model in Figure 1 has a number of limitations, as stated in Table 1.

<b>Model limitations</b>	
It does not include reasons for temperature rise	It does not include human interference
It does not depict geographical variations	It does not represent a course of time
It does not show complexity of multiple stresses	It does not include feedback mechanisms

Table 1 Limitations of the model in Figure 1

The model shows that climate change can have a number of consequences for the water environment, and in turn a number of effects on issues such as population or biodiversity, which are part of the baseline for SEA. As stated in Section 2, any effects of climate change on water environment are relevant for consideration in SEA of the RBMPs, and when coupling this with the information in Figure 1 it appears that the effects of climate change are important factors to consider in SEA of RBMPs. This will be used in the following discussion in Section 6.

## 6. Including Climate Change in SEA of RBMPs

When viewing climate change in relation to SEA of RBMPs three issues gain attention. These are summarised in Figure 2 and addressed in the following sections.

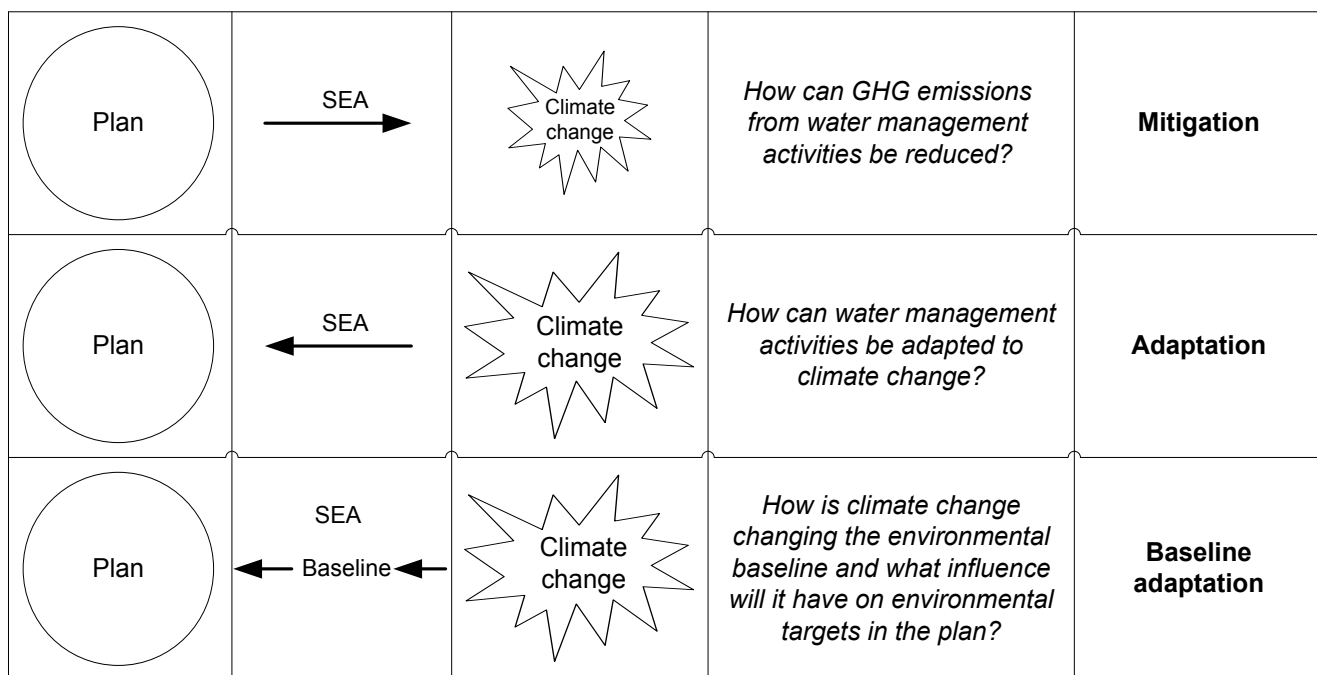


Figure 2 Framework for considering climate change in SEA of RBMPs

In the following, adaptation refers to the planned type of adaptation taken in advance, to either minimise or off-set negative climate change effects.

### Mitigation

As stated in Section 3, SEA assesses the effects on the environment from implementing a plan, and thus the effects on climate change. Implementation of the RBMPs will be in the form of water management activities that should lead to an improved water environment. This means that SEA of RBMPs should include any contribution from these proposed water management activities to climate change through assessing the resulting greenhouse gas emissions. On the basis of this assessment, mitigation measures can be suggested, as a measure to prevent further climate change.

This way of considering climate change in SEA of RBMPs is illustrated in the first horizontal line of Figure 2. Examples of issues where mitigation could be relevant for the RBMPs include (Examples inspired by Madsen et al. 2007):

- Reduction in greenhouse gas emissions related to hydro dams (location, power density, flow rate etc.).
- Reduction in greenhouse gas emissions due to less energy consumption for pumping water
- Reduction in greenhouse gas emissions in connection to changes in waste water treatment

Climate change mitigation does not immediately appear to be essential in relation to the measures relevant for the RBMPs, when viewing the suggestions made in the Danish pilot study from Odense (See Madsen et al. 2007, 61). However, it is of course relevant when suggesting any measures, to consider possible effects on climate change.

### **Adaptation**

As stated in Section 3, SEA should also assess the impacts of climate change on the plan. As stated in Section 5, climate change can have multiple effects on the water environment, and because water is the issue dealt with in the RBMPs, it is clearly relevant to assess how climate change will affect the issues dealt with in the RBMPs. Consequently the plan, and thus the water management activities, can be adapted to any unavoidable effects of climate change, through adaptation measures.

Examples of adaptation measures relevant for inclusion in the RBMPs are (Examples inspired by Madsen et al. 2007):

- Reservoirs and dykes, emergency flood reservoirs, preserved areas for flood water, coastal protection infrastructure etc. to protect against floods.
- Tending of water bodies, e.g. crop cutting in streams and restocking of fish spawn
- Buffers around streams in urban areas to reduce the potential negative consequences of future heavier runoff.
- Constraints on activities e.g. agricultural and industrial procedures
- Increased capacity e.g. in wastewater treatment
- On the supply-side e.g.: impound rivers to form in-stream reservoirs, wastewater reuse etc.
- On the demand-side e.g.: water conservation, reduction in leaky water systems, water pricing etc.

These are much the same as the measures relevant for the RBMPs itself, only used to adapt to a changing climate. Such integration, of adaptation measures into the plan of water management activities, can help to improve society's resilience to climate change. This is illustrated in the second horizontal line of Figure 2.

### **Baseline adaptation**

As shown in Figure 1, climate change results in effects on almost all of the environmental factors in the baseline. This has implications for SEA of RBMPs, because it makes the baseline, to which we are comparing the effects of the plan, change independently of the implementation of the plan. This should be taken into consideration, because the baseline according to the SEAD should include "*the relevant aspects of the current state of the environment and the likely evolution thereof without implementation of the plan or programme*" (Directive 2001/42/EC 2001, Annex 1). Examples of how climate change changes the baseline, or the ecological status, and makes this dynamic and uncertain, are e.g. changes in the water temperature and dissolved oxygen or changes in the aquatic fauna and flora (Wilbye et al. 2006; Footitt and McKenzie 2007). This means that when setting the baseline, the changes caused by climate change should be included. This makes setting the baseline a challenging task. The effects on the baseline also in turn influence the setting

and achievement of the environmental targets of the plan. Goals are ideally set to be ambitious yet realistic based on the predictions of the baseline, thus if the baseline is very unpredictable, the goals might prove to be either unrealistic or not ambitious enough. This issue is illustrated by the third horizontal line in Figure 2. This third approach in the model is by the authors termed baseline adaptation.

The issues of adaptation and baseline adaptation are closely linked. Baseline adaptation is a precondition for adaptation; if no predictions are made about the future climate changes then it does not make sense to talk about adapting to these. An assessment of literature on this subject indicates that most experience is gathered in the field of mitigation of greenhouse gases, while less stems from adaptation and baseline adaptation. This is supported by Levett-Therivel Sustainability Consultants (2007), focusing on mitigation and adaptation, but stating that *“Adaptation measures are unusual in that they require consideration of how climate changes are likely to impact on plans and programmes”* (Levett-Therivel Sustainability Consultants 2007, 5). An investigation of the actual experience with adaptation and baseline adaptation in Denmark is not conducted in this article but can be the subject of further research.

## **7. Conclusion and discussion**

In this paper the upcoming SEA of RBMPs in Denmark is discussed, with a focus on incorporation of climate change. It is shown that climate change can have a range of impacts on the water environment ultimately influencing the environmental parameters in the baseline for SEA. The main contribution of the paper is a framework consisting of three ways in which climate change should be considered in SEA of RBMPs:

- mitigation of climate change
- adaptation to climate change
- adaptation of the baseline

This is intended to serve as a help for authorities in their work with SEA of the plans stemming from the WFD.



It is seemingly expedient for the Danish municipalities to consider climate change in the SEA of RBMPs. However, even when the benefits of adapting to climate change are obvious this is not certain to actually lead to consideration of climate change in planning and action (O'Brien et al. 2006). A range of issues can act as barriers, one example of these is a lack of certain knowledge about climate change, which is the barrier pointed out by the Danish state in the case of the RBMPs. Other examples of potential barriers to adapting to climate change are: unfavourable economic conditions, diverse values, certain beliefs and perceptions of climate change, lack of awareness of climate change, lack of resources or skills, technical feasibility and innovation, regulatory and institutional context and the presence of other important pressures (O'Brien et al. 2006; Adger et al. 2009; Arnell and Delaney 2006).

Another challenge is related to the assessment of climate change, which is a cumulative effect. Assessment of cumulative effects is an obligatory and important part of the SEA process. However, building upon earlier experience with SEA tackling cumulative effects, this might be a challenging task. The literature on cumulative effects shows limited cumulative assessment and management in IA practice (Baxter et al., 2001; Ross, 1998; Duinker and Greig, 2007; Therivel and Ross, 2007). Ecosystems, as the ones assessed in the SEA of RBMP's, are complex and adaptive to climate change. To be manageable there is a risk for stakeholders and policy makers to describe such complex systems in a reducible way (Costanza, 2000). E.g. like the Danish case with out-scoping climate change due to lack of knowledge. According to post-normal science, complex systems must not be described in such reducible way (Funtowicz and Ravetz, 1993, 1994).

This argument is also found in a general critique of environmental assessment relying on a reductionism paradigm building upon e.g. measurable indicators, simple time horizons, quantification and aggregating (Gasparatur et al, 2008). Including climate change in a non-reducible way and thereby acknowledging the complexity surrounding RBMP's calls for a shift in scoping. The scoping undertaken by the Ministry of Environment builds upon a technical model of scoping, while the complexity as presented in the article calls for a supplementing social model of scoping with stakeholder involvement in the decision making process - acknowledging the legitimacy of stakeholder attitudes towards climate

change risk. Stakeholders may have many different perceptions, values, beliefs and attitudes towards climate change e.g. different perceptions of the seriousness of climate change, the certainty of predictions, the control that society have over climate change and the time horizon for climate change to occur (Etkin and Ho 2007, Dessai et al. 2003, Lorenzoni, Lowe and Pidgeon 2005). These different perceptions may influence whether and how climate change is considered in the SEA process. This adds to the complexity of the SEA and stresses the need for a broad inclusion of stakeholders in the process, in order to prevent a too narrow consideration of climate change. Based on this there are prospects for further research into whether and why, the Danish municipalities will consider climate change in their up-coming action plans.

## References

- Adger, N., S. Dessai, M. Goulden, M. Hulme, I. Lorenzoni, D. Nelson, L.O. Naess, J. Wolf and A. Wreford. 2009. Are there social limits to adaptation to climate change? *Climatic Change*, **93**, 335-354
- Alcamo, J, M Flörke and M Marker 2007. Future long-term changes in global water resources driven by socio-economic and climatic change. *Hydrological Science Journal*, **52**(2), 247-275.
- Arnell, N W, C Lui 2001. Hydrology and Water Resources. In *IPPCs Third Assessment Report*. IPCC
- Arnell, N W 2003. Relative effects of multi-decadal climatic variability and changes in the mean and variability of climate due to global warming: future streamflows in Britain. *Journal of Hydrology*, **270**(3-4), 195-213.
- Arnell, N.W., Delaney, K. 2006. Adapting to climate change: Public water supply in England and Wales. *Climatic Change*, **78**, 227-255.
- Bates, B, Z W Kundzewicz, S Wu and J Palutikof 2008. *Climate Change and Water*. IPCC
- Bouraoui, F, B Grizzetti, K Granlund, S Rekolainen and G Bidoglio 2004. Impact of climate change on the water cycle and nutrient losses in a Finnish catchment, *Climate Change*, **66**(1-2), 109-126.

- Baxter W, Ross W, Spaling H. 2001. Improving the Practice of Cumulative Effects assessments in Canada. *Journal of Impact Assessment and Project Appraisal*, Beech Tree Publishing; 2001.
- Blennow, K. and Persson, J. Climate change: Motivation for taking measure to adapt. *Global Environmental Change*. **19**, 100-104
- Byer, P H and J S Yeomans 2007. Methods for addressing climate change uncertainties in project environmental impact assessments. *Impact Assessment and Project Appraisal*, **25**(2), 85-99.
- Carter, J and J Howe 2006. The Water Framework Directive and the Strategic Environmental Assessment Directive: Exploring the linkages. *Environmental Impact Assessment Review*, **26**, 287-300.
- Commission of the European Communities. 2009. *White paper – Adapting to climate change: Towards a European framework for action*.
- Costanza R. 2000. The dynamics of the ecological footprint concept. *Ecological Economy*, 2000; 32:341–5.
- DANIDA 2005. *Danish Climate and Development Action Programme*. Copenhagen: Ministry of Foreign Affairs of Denmark.
- Danish Government. 2008. *Strategi for tilpasning til klimaændringer i Danmark*. (Strategy for adaption to climate change in Denmark). Copenhagen: Energistyrelsen
- Danish Ministry of Finance, Danish Ministry of Defence, Danish Ministry of the Interior and Health, Danish Ministry of the Environment, Danish Ministry of Food, Agriculture and Fisheries, Danish Ministry of Science, Technology and Innovation, Danish Ministry of Energy and Transport and Danish Ministry of Economic and Business Affairs 2007. *Katalog over mulige konsekvenser af fremtidige klimaændringer og overvejelser om klimatilpasning*. (Catalogue of potential impacts of future climate change and considerations of climate change adaptation)
- Danish Ministry of the Environment nd. *Ny vandplanlægning i Danmark – Arbejdsprogram, tidsplan og høringsproces*. (New water planning in Denmark - Working Program, time schedule and hearing process).
- Danish Ministry of the Environment 2007. *Miljøministerens besvarelse af spørgsmål nr. 240 til 244 stillet af Folketingets Miljø- og Planlægningsudvalg*. (The Minister of

- Environments response to question nr. 240 to 244 raised by the Environment- and Planning Committee of Parliament)
- Danish Ministry of the Environment 2008. *Oversigt over generelle problemstillinger*. (Overview of general problems). Available at [www.vandognatur.dk/Emner/Om+planerne/Sammenfatning\\_idefasen.htm](http://www.vandognatur.dk/Emner/Om+planerne/Sammenfatning_idefasen.htm), last accessed 15 August 2008.
- Deasley, N.; Preston, C. 2007. *Strategic Environmental Assessment of Water Framework Directive River Basin Management Plans: Applying Strategic Environmental Assessment to River Basin Management Plans – A Scottish Perspective*. From: Workshop for EU Member States
- Dessai, S., N. Adger, M. Hulme, J. Koehler, J. Turnpenny, R. Warren. 2003. *Defining and experiencing dangerous climate change*. Tyndall Centre for Climate Change Research: Working paper 28
- Directive 2000/60/EC. 2000. *Directive 2000/60/EC of the European Parliament and of the Council of 23rd October 2000 establishing a framework for Community action in the field of water policy*
- Directive 2001/42/EC. 2001. *Directive 2001/42/EC of the European Parliament and of the Council of 27 June 2001 on the assessment of the effects of certain plans and programmes on the environment*
- Duinker, P N and L A Greig 2007. Scenario analysis in environmental impact assessment: Improving explorations of the future. *Environmental Impact Assessment Review*, **27**(3), 206-219
- Eisenreich, S J (ed.) 2005. *Climate Change and The European Water Dimension*. Report to the European Water Directors. European Commission-Joint Research Centre, Ispra.
- EEA, European Environment Agency. 2004. *Impacts of Europe's changing climate: an indicator based assessment*. EEA Report No 2/2004. Copenhagen: European Environment Agency.
- Etkin, D. and E. Ho. 2007. Climate Change: Perceptions and Discourses of Risk. *Journal of Risk Research* 10(5): 623-641
- Footitt, A and M McKenzie 2007. *Climate Change and Water Adaptation Issues*. EEA Technical Report No 2/2007. Copenhagen: European Environment Agency
- Funtowicz S, Ravetz J. 1993. Science for the post-normal age. *Futures*, 25:739–55.
- Funtowicz S, Ravetz J. 1994. Emergent complex systems. *Futures*, 26:568–82.

- Gasparatos, A, El-Haram, M and Horner M. 2008. A critical review of reductionist approaches for assessing the progress towards sustainability, *Environmental Impact Assessment Review*, 28 (2008) 286–311. Elsevier.
- IPCC 2007. *Summary for Policymakers of the Synthesis Report of the IPCC Fourth Assessment Report*.
- Klein Tank, A M G and G P Können 2003. Trends in indices of daily temperature and precipitation extremes in Europe, 1946-1999. *Journal of Climate* **16**, 3665-3680.
- LBK nr 316. 2004. *Lov om miljøvurdering af planer og programmer*. (Act on environmental assessment of plans and programmes). LBK nr 316 af 05/05/2004 (Gældende).
- Levett-Therivel Sustainability Consultants 2007. *Strategic Environmental Assessment and climate change: Guidance for practitioners*. UK: Environment Agency, Countryside Council for Wales, UK Climate Impacts Programme, Natural England, InteREAM and CAG Consultants.
- Lorenzoni, I, T. Lowe, N. Pidgeon. 2005. *A strategic assessment of scientific and behavioural perspectives on 'dangerous' climate change*. Tyndall Centre for Climate Change Research: Technical Report 28
- LOV nr 250. 2009. *Lov om ændring af lov om miljøvurdering af planer og programmer*. (Act on change of act on environmental assessment of plans and programmes). LOV nr 250 af 31/03/2009
- Madsen, H B, S E Pedersen, N D Kristensen and O T Jørgensen (eds.) 2007. *Odense Pilot River Basin: Pilot Project for River Basin Management Planning: Water Framework Directive Article 13*. Odense: Danish Ministry of the Environment
- McCarthy J, O Canziani, N Leary, D Dokken and K White. 2001. *Climate Change 2001: Impacts, Adaptation and Vulnerability - Contribution of Working Group II to the Third Assessment Report of the Intergovernmental Panel on Climate Change*. IPCC
- Næss, L.O, G. Bang, S. Eriksen, J. Veatne. Institutional adaptation to climate change: Flood responses at the municipal level in Norway. *Global Environmental Change*. **15**, 125-138
- O'Brien, K. S. Eriksen, L. Sygna, L.O. Naess. 2006. Questioning Complacency: Climate Change Impacts, Vulnerability, and Adaptation in Norway. *Ambio* 35 (2). Academic Research Library

- OECD 2006. *Putting Climate Change Adaptation in the Development Mainstream*. Organisation for Economic Co-operation and Development.
- Qian, T., A. Dai, K. E. Trenberth, and K. W. Oleson, 2006: Simulation of global land surface conditions from 1948 to 2004: Part I: Forcing data and evaluations. *J. Hydrometeor.*, **7**, 953–975.
- Ross WA. 1998. Cumulative effects assessment: learning from Canadian case studies. *Impact Assessment and Project Appraisal* 16(4):267–76. Beech Tree Publishing.
- Smit, B and Pilifisova, O. 2001. Adaptation to Climate Change in the Context of Sustainable Development and Equity. *Climate Change 2001: Impacts, Adaptation and Vulnerability*, IPCC.
- Sonnenborg, T, B Christensen, L Roosmalen, and H J Henriksen 2006. *Klimændringers betydning for vandkredsløbet i Danmark*. (Climate change impact on the water cycle in Denmark). [The Geological Survey of Denmark and Greenland \(GEUS\) Report 2006/22](#). Copenhagen: GEUS.
- Therivel, R and Ross, B. 2007. Cumulative effect assessment: Does scale matter? *Environmental Impact Assessment Review*, 27(2007) 365-385, Elsevier.
- The Federal-Provincial-Territorial Committee on Climate Change and Environmental Assessment 2003. *Incorporating Climate Change Considerations in Environmental Assessment: General Guidance for Practitioners*. Canada
- UNEP (United Nations Environment Programme) 2007. *Global Environmental Outlook – GEO 4: Environment for Development*. Nairobi: UNEP
- Wilby, R L, H G Orr, M Hedger, D Forrow and M Blackmore 2006. Risks posed by climate change to the delivery of Water Framework objectives in the UK. *Environment International*, **32**, 1043-1055.
- Wilson, E. and J Piper 2008. Spatial Planning for Biodiversity in Europe's Changing Climate. *European Environment*, **18**, 135-151.