Scenarios for Adaptive Flood Management in Horsens Fjord, Denmark

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Introduction (HJ)

Horsens Fjord is a Danish fjord located on the east coast of Jutland. It is a shallow and eutrophic estuary with an area of 46 km^2 and mean water depth 2.9m. The catchment of Horsens has an area of 517 km^2 and 75% of the area is agriculture. The area has two mean creaks, named Bygholm å and Hansted å, as well as other small streams.

Coastal areas are especially vulnerable to Climate Change (IPCC, 2007). The sea level rising may bring more and more flash flood to the coastal area. The fjord witnessed severe flood in 2006, when sea level rose to 1.76 m above normal. The extreme rainfall events will bring pressures to the local drainage system as well.

This project is aiming to build scenarios for adaptive flood management in the coming 20 years for Horsens Fjord, based IPCC emission scenario A2. The climate situation is shown in Table 1. Two adaptive water management (AWM) scenarios for flood protection are proposed. Here we assume the main threaten in future is flash flood from sea. We did not consider river flood, and neither the ground water quality.

Table 1 Climate changes by 2100 under IPCC scenario A2

Temperature	+3°C	Precipitation	+15%
Wind	+4%	Extreme event	Increase
Storm strength	+10%	Sea level	+1 m

Scenario building (BP & HG)

Scenarios

Developing scenarios require definition of thematic, spatial and temporal boundaries, as well as key variables, including driving forces and impacts, as well as their relations. Moreover, critical uncertainties towards the future have to be taken into account. Climate change is expected to increase the frequency and intensity of floods then adaptation measures have to be developed, for flood adaptation our group proposes two scenarios (Figure 1). For building scenarios the following uncertainties were taken into account: precipitation, weather extremes, sea level rising and socioeconomic development.

The scenarios explore the possibilities of building large dikes or reservoirs near the coastal side of Horsens district can guarantee safety in the future to prevent flood risk of people. Another example can be given by the low cost still flood risk adaptation by implementing early warning system. But there is one more suggestion dfor stakeholders to restrict infrastructure in the cities of Horsens.

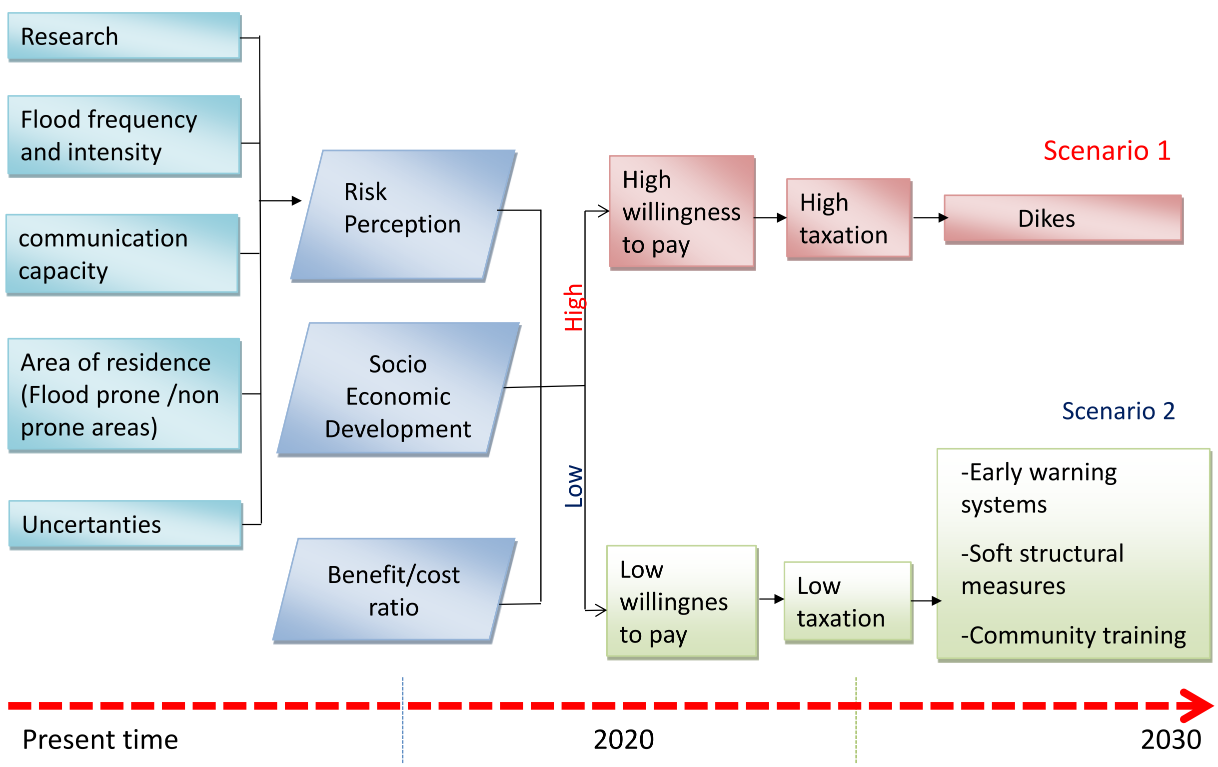

Figure 1. Scenario building for AWM in Horsens Fjord

To estimate of the adaptation strategy (Table 2) we will use back-casting approach. The assessments of the productivity of this approach are based on main big strategies which need to have an attention. One of them is risk perception

Table 2. Flood Adaptation Management Strategy for Horsens Fjord inhabitants

Flood Adaptation	High	Low
Dikes, dams	Yes	-
Storing water in the reservoirs	Yes	Yes
Warning/ disaster management	-	Yes
Legal restrictions (thematic, spatial and temporal boundaries)	-	Yes

Risk perception

The assumption of risk perception is a variable of the following factors: frequency and severity of the floods; information about future events (IPCC scenarios, hydrographic models, flood maps, etc.); capacity of the governmental authorities to communicate this information to the people and location of the inhabitants. The risk perception together with the social economic development will lead to the willingness to pay for the implementation of measures against floods which at time will define the strategies for flood adaption (scenarios).

Recommendation

This project offers future flood risk protection strategies to local communities of how alternatives of flood management to be considered; finally stakeholds may decide one of the proposed flood management adaptation strategies for the 2030 year.

Discussions (HJ)

There are large uncertainties in the future flood risks, and there could not be a universal approach to cope with any risk level of flood. Thus there is no perfect means. The adaptive water management was proposed to deal with this uncertain and complex situation (Mysiak *et al*., 2010).

The AWM adopts systematic approach and is expected to add more values to the integrated water management (IWM), an implementation cycle of 7 steps (Mysiak *et al*., 2010). Figure 2 gives a comparison of IWM and AWM. Learning process/cycle is involved in the whole process of water management, including policy cycle and management activities.

Three major barriers exist for successful implementation of the AWM: the inflexible of society system, the less resilient ecosystem and technology limitations (Mysiak *et al*., 2010), which may impose new uncertainties to the flood management in Horsens Fjord. The AWM requires highly-motivated participators. The underlining highly-changed policy may be not feasible in practice. Broadly speaking, high risk and cost from AWM in return for fairness and transparency is probably not suitable for some special cases, e.g. China, a strong government with weak public participators.

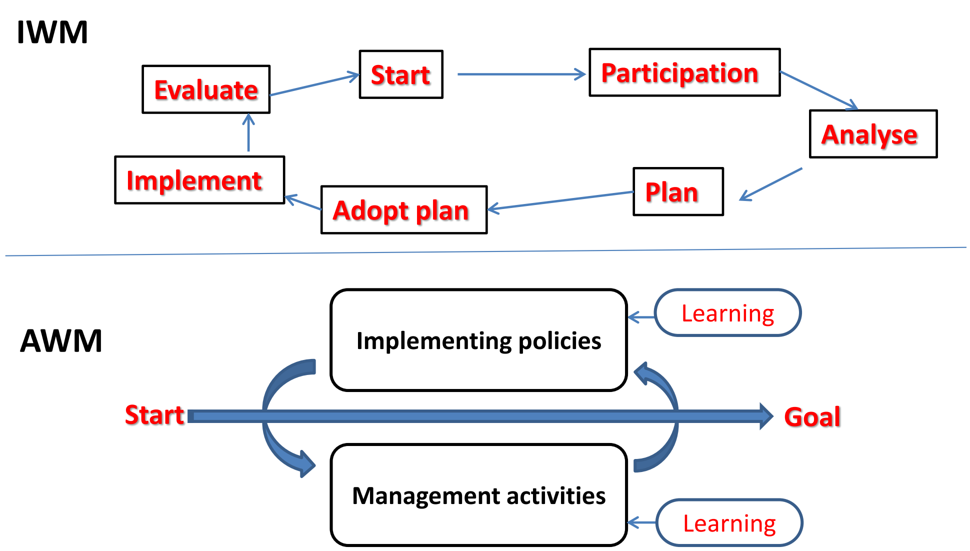

Figure 2. Comparison of integrated water management (IWM) and AWM

References

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Jaroslav Mysiak, Hans Jørgen Henrikson, Caroline Sullivan, John Bromley and Claudia Pahl-Wostl, 2010, The Adaptive Water Resource Management Handbook, Earthscan Dunstan House, pp 199.