CLIMATE RESPONSIVE SPATIAL RESEARCH BY DESIGN - A CASE STUDY ANALYSIS ON THE COASTAL AREA OF FLANDERS

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In search of alternative adaptation strategies for the Belgian coast

Low-lying coastal zones are highly vulnerable to climate change and coastal protection attracts special attention within adaptation planning. The Intergovernmental Panel on Climate Change (IPCC) defined an international framework describing three strategies within coastal adaptation practices; *protect*, *retreat* and *accommodate* (IPCC CZMS 1990; Klein and Tol 1997). In Flanders the Coastal Division of the Flemish government recently developed the Master Plan for Flanders Coastal Safety to assure the necessary protection until 2050 (Afdeling Kust 2011). This master plan lists different measures, e.g. elevated dikes and beach nourishment, all within the *protect* strategy.

The *protect* strategy focuses on reducing risks, but as climate change and sea level rise continue (Nicholls, Hanson et al. 2006) each intervention in light of risk mitigation will eventually be outdated. The *retreat* strategy reduces vulnerability by removing existing structures and activities. Nevertheless, utilization of the coast increased dramatically during the past century (Nicholls, Wong et al. 2007). The *accommodate* strategy focuses an increased flexibility. This research, which took place within CcASPAR, concentrates on compartmentalization as tool to create flexibility at a local scale. Research by design is applied to explore the concept, to analyze its feasibility at the Flemish coast and to nurture the public debate on climate adaptation.

Climate related challenges at the Belgian coast

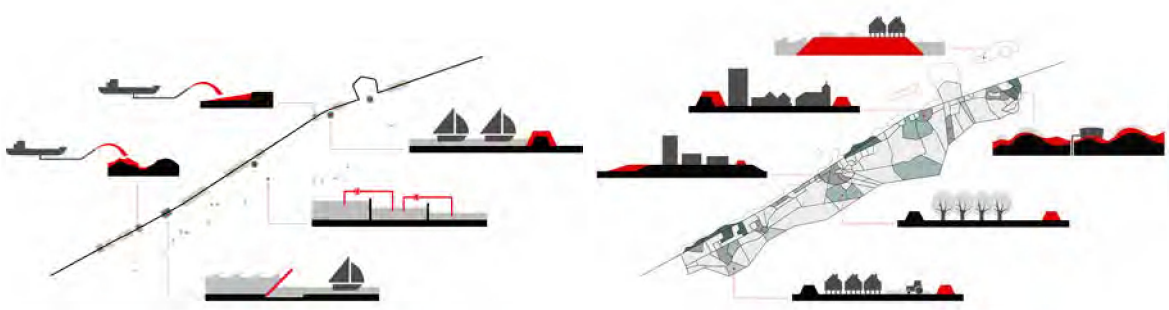
Sea level rise dominates the international literature and debate on climate adaptation in coastal areas (Nicholls, Wong et al. 2007). Belgium is no exception as current adaptation policies are restricted to maintaining coastal safety. As the coastal zone is an interface between land and sea, it is indeed vulnerable to coastal erosion and flooding during storm at sea. At the Belgian coast, sea level rise will raise water levels near the current coastline. This will cause higher waves and increases the impact of a storm at sea. At the Belgian coast sea level rise by only one meter would cause waves up to four meters (Reyns, Verwaest et al. 2011). In addition, climate induced coastal erosion would cause loss of beaches by 17 to 50 percent by the year 2100 (Van der Biest, Verwaest et al. 2009).

However, the coastal region is also threatened by impacts within the coastal zone and its hinterland (Nicholls, Wong et al. 2007). Local changes in precipitation might cause pluvial flooding, drought and salinization in the low lying area called 'polders'. As Yser and (drainage) channels link hinterland and coast, alterations in precipitation further inland might cause fluvial flooding. The whole range of climate impacts (e.g. drought, flooding) needs to be addressed when adapting to climate change.

Besides this multitude of climate impacts, the recent increase of human activities renders coastal zones extra vulnerable to climate change (Nicholls, Wong et al. 2007). In Belgium, two periods marked the coastal area and its landscape. During the 11th and 12th century, agriculture was a driver for land reclamation (Verhulst 1966; Verhulst and Gottschalk 1980). Pumps, channels and river embankments were constructed to transform the landscape. Until the beginning of the 19th century, the dune area stayed scarcely inhabited, but attracted many tourists during the past two centuries. This lead to a strong urbanization that was backboned by the development of a tramway, road (called Royal Route) and dyke along the coastline (Van Acker 2011). At the moment, the Belgian coast is by far the most urbanized coastal region within Europe (Eurosion, 2004) and consists of

an ageing population, caused by increasing retirement migration (Safecoast, 2008). Up to 88 percent of the Flemish coastline is protected by dykes and beach nourishment (Eurosion, 2004).

Compartmentalization as framework for technical and spatial adaptation measures
As an answer to the climate related challenges, the CcASPAR project researched a new concept: compartmentalization. Within the compartmentalization concept, the current system and its safety levels are revisited at a local scale. As all climate impacts are water related (either flooding or drought) new embankments are added to split up the coastal zone into different compartments, each with its own water management. Such division creates a possibility to rescale the adaptation debate. Whether or not coastal erosion, fluvial and pluvial flooding, drought and salinization (might) occur and whether or not this will cause problems, can be analyzed for each compartment individually. Furthermore, the system within each compartment -its land use, its socio-economic characteristics and its landscape- can be revisited separately. If one wishes to maintain the existing system, technical strategies (e.g. dyke reinforcement, new pumps and increased water supply) are in order. If not, the climate impacts could be integrated into the compartment through conditions. Such conditions are not particular destinations (e.g. floodplains) but guidelines for local land use. In this way, space and spatial measures (e.g. elevated buildings, salt resistant crops and building restrictions) become part of the climate adaptation planning.



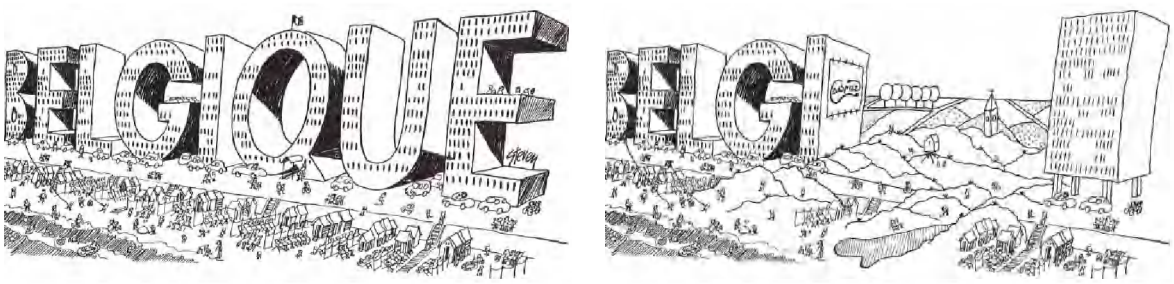
left: Masterplan for Flanders Coastal Safety (source: CcASPAR) / right: compartmentalized coast (source: CcASPAR)

Feasibility at the Flemish coast
The implementation of the proposed concept demands the development of a new infrastructural layer: a pattern of dykes. However, in the past millennium several embankments (e.g. historical dykes, roads, motorways, railways, sound and sight barriers) were built within the coastal region. Flood models, like the one developed within the Master Plan for Flanders Coastal Safety, mark that these structures already reduce the consequences of flooding. Yet, the embankments are not continuous or designed to function as dykes. The research by design within CcASPAR proposes to reuse the current framework as basis of the compartmentalization.

Benefits of the compartmentalization concept
The compartmentalization concept has several benefits and puts current developments in perspective. Firstly, the new pattern of embankments offers opportunities to balance the system and its safety levels at a local scale. As such, one can avoid implementing extreme protection measures wherever they are unnecessary or undesirable. Especially when sea level keeps rising and dyke reinforcement gets more and more expensive, this may be an important benefit. Moreover, investments can be spread over time. The proposed framework of dykes does not have to be developed immediately and the embankments might be purely theoretical. Only when the safety level is locally modified, they must be constructed.

Secondly, the compartmentalization strategy creates opportunities to *build with nature*. Several dynamic processes are now counteracted by current policies, while these processes actually insure a natural adaptation of the coastal landscape. For instance, hard

infrastructures do not only reduce the impacts of sea level rise but also cause loss of ecosystems due to coastal squeeze (Knogge 2004). By redefining the system at a local scale this natural adaptation can be put to use. For each compartment strategies can be developed that integrate the natural dynamic and the local socio-economic development.
In addition, such approach creates chances for new growth at 'underdeveloped' compartments. Finding a new equilibrium demands an innovative approach and an integrated vision on local climate adaptation and socio-economic development. Yet, once the desired equilibrium has been defined and decisions on spatial measures have been taken, investments in adaptation are no longer restricted to major infrastructures like dykes and pumps. In this way, climate adaptation, financed by the public and/or private sector, puts redevelopment of landscape and land use into motion.



left: caricature current Flemish coast (source: Steven Wilsens) / right: caricature compartmentalized coast (source: CcASPAR)

In the long-term, the urbanized coastline, which is rather monotonous at the moment, becomes a composition of traditional and alternative landscapes. This new coastal region –a collection of compartments- will be a new interface between land and sea, capable of absorbing any (climate related) impact in the long-term. As such, the compartmentalization concepts increases the flexibility of the Belgian coast as a whole.

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