Implications of Accelerated Sea-Level Rise (ASLR) for Belgium:

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General overview

The Belgian coast (65 km long) is situated at the southeastern end of the North Sea. It is subject to high physical energy through the combined effect of sea currents, tides and wind. The Belgian coast could be defined as a mesotidal wind dominated clastic coast with a tidal amplitude of 4 to 5 m. Predominant winds are from the west, storms are usually accompanied by winds from the southwest, west or northwest. It is a rather linear coast with a shallow offshore band characterised by many gullies and offshore bars. Its natural coastal defence system consists of 3 parts, namely the fore shore, back shore and dunes. This is a mobile structure that remains in dynamic equilibrium with gulfs, climate, wind and sediment characteristics, in this case, sand (MVG, 1993). Its economic importance is mainly a consequence of beach tourism and agriculture in the low-lying polder areas. The combined economic activities from tourism, fishing and harbours produce an added value of about 2.66 billion Euro (Allaert, 1996). Agriculture was not included in this calculation. At present, the Belgian coastal plain is mainly influenced by human induced factors, about 60% of the coastline has some form of coastal defence structure (De Wolf, 1996 in WL, 2000). The latter would inhibit the establishment of a new dynamic equilibrium should sea level rise; there is simply no space to accommodate for a possible transgression. The coastal plain is defined landward by the topographical contour of 5 m TAW (TAW: the Belgian reference level), and extends seaward, up to 1,500 m from the lowest observation point on the shore (MVG, 1993; WL, 2000). Maintenance and investments of coastal defence structures as well as the monitoring of beach and dune pollution raises costs to about 25 million Euro (pers. comm. P. De Wolf). In this discussion the sea-harbour cities of Antwerp and Gent situated along the river Scheldt have been included in the coastal zone as their importance for Belgium/Flanders economy can hardly be overestimated.

Factors influencing national resilience/vulnerability to impacts of sea-level rise

Future impacts of sea-level rise could include:

1. permanent inundation of the low-lying coastal plain,
2. loss of the (currently protective) beach,
3. increased inundation hazard,
4. salt water intrusion, and,
5. the breaching of protective dikes that could lead to the progression of the coastline landward up to a maximum of 20 km.

To tackle these possible impacts, the Belgian coastal plain is already largely protected by man-made structures along its coastline. These can be subdivided in hard defence structures and soft protection measures. In the first group, there are sea-dikes, dikes, groynes, Longard system, sluices, etc. Soft protection measures that have been applied to the Belgian coast include beach nourishment at different points along the coast, as well as the installation of an underwater berm, sand berms on fore shore, underwater screens, temporary or permanent wind screens, beach scrapings, planting osier hedges etc. (MVG, 1993). On the other hand, some phenomena contribute to decreasing the current level of protection afforded by the measures mentioned above. Tourism leads to high population pressure on the coastal zone, and can result in the degradation of natural dune vegetation. The construction of harbours can seriously interfere with natural dynamic equilibrium. For example around Zeebrugge, this has lead to considerable erosion on the eastern side of the harbour. Moreover, extraction of fresh groundwater present in the dune fields, lowers the water table, and can promote sand instability. The latter can in turn have an adverse effect on dune vegetation. Erosion along the Belgian coastal plain has lead locally to the steepening of foreshore profiles, as it is the case in the central part (between Nieuwpoort and Blankenberge).

Existing efforts towards assessment of vulnerability and associated problems and their results

During the past 25 years, concern about rising sea level, increasing coastal erosion and the growing significance of coastal economy has lead to a more or less permanent monitoring of a series of coastal parameters. The possibility of a breaching of the first natural coastal defence system (*i.e.,* the natural dune fields) was calculated for the different sectors of the Belgian coastal zone and an indicative figure for breaching periodicity was calculated. Return periods of potential breaching range from 1 in 1,000 years for the most vulnerable parts to 1 in 40,000 years for the least vulnerable parts (Verwaest *et al*., 1998 in WL, 2000). The overall aim of the man-made coastal defence structures is that they should withstand a storm with a return period of 1,000 years. At present, however, the largest part of the coastline is protected for storms with a return period of 100 to 250 years. In some cases, the existing protection structures would only withstand storm return periods as short as once in every 50 years.

The nature of the predominant winds is measured at three points along the Belgian coast since 1977. A cautious prognosis for the future indicates a possible change of 2 degrees to the north. The behaviour of gulfs is measured with 6 buoys, from which it was deduced that storms are associated with gulfs coming from the west to the north. Tidal currents have a northeastern direction for spring tides, a southwestern direction for neap tides (MVG, 1993).

Tide observations cover in places periods from the mid-nineteenth century (1835 to 1853 and 1927 to 1998 for Ostende, 1932 to 1998 for Nieuwpoort and 1932 to 1998 for Zeebrugge) to the present. These indicate a linear increase of High Water (HW) level by 2 cm, Low Water (LW) by 1.5 cm and Mean Sea Level (MSL) by 1 cm per decade (Van Cauwenberghe, 1999). No significant accelerated sea-level rise has so far been measured, although compared to earlier centuries, a definite acceleration trend has been observed (WL, 2000). In Antwerp, tide measurements of the river Scheldt are recorded and analysed for the period between 1891 to 1990. During this period, a 0.56 m increase in MHW, a 0.24 m decrease in MLW and a 0.8 m increase in TA have been observed. Further, an increase in the number of storm tides has been recorded. It should be mentioned, however, that these trends are the primarily the consequence of rising MHW and TA-change. Changes in MLW and MHW are in great part due to dredging activities. The higher peak discharge recorded for the river Scheldt is partly caused by growing urbanisation.

The very nature of the low-lying polders is cause for concern. Most of this area has a clay-peat composition the surface of which can be significantly lowered with over pumping and drainage measures. Drainage also influences the flow and the distribution of fresh, brackish and salt water in coastal aquifers. An ongoing study is focussing on the impact of sea-level rise on fresh-salt water distribution. Sea-level rise is expected to indirectly result in diminishing fresh water supplies. Fresh groundwater extraction works within the wide dune belt located west of Nieuwpoort are already threatened by saltwater intrusion. Northeast of Nieuwpoort, saltwater seepage will increase in the polder areas behind the narrower dune belt. In a very recent study (Schoeters and Vanhaecke, 1999 in WL, 2000), the effects of a doubling of the CO_2-content when no policy measures were taken, lead to the following conclusions for Belgium. The mean air temperature will rise by 2 to 2.5 ° C, on average the minimum temperature will rise more than the maximum temperature and the temperature will rise more in winter than in summer. Storm frequency may rise by about 30%. Rainfall will decrease by about 3% or remain the same during summer, whereas in winter it is expected to increase by 10%. Projected regional sea-level rise is thought to be of the order of 40 to 70 cm by 2100.

The way forward to respond to sea-level rise

The Waterways and Maritime Affairs Administration presently includes a 60 cm sea-level rise by the next century when planning future coastal protection structures. As indicated above strengthening coastal defence structures is a very urgent matter for some cities. Ostende is such an example. There, current proposals suggest the creation of a backshore beach, which would relieve the current inadequate sea wall of most of its protective task. A general tendency in coastal management is to use soft protection measures rather than hard protection measures. The latter has the advantage that adjustments to changing circumstances can be implanted more easily.

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