Paper I-4

ADAPTING TO CLIMATE CHANGE: EXAMPLES FROM THE NETHERLANDS

H.P. RITZEMA

Wageningen University and Research Centre, Wageningen, the Netherlands

ABSTRACT

The coastal zone comprises only 3% of the earth's surface, but contains a disproportionately high amount of its assets. Coastal areas include all those areas where the tidal processes are capable of affecting man's activity or of being influenced by man. Coastal areas differ greatly depending on their location, geo-physical conditions, climate, tidal range and cultural differences. Throughout the world, coastal areas have been and are being developed. These developments will continue as food production will need to be doubled in the next 25 years. Drainage and flood protection are needed to make these low-lying lands suitable for agriculture or other land uses. Climate change may also call for more control: sea levels are rising, precipitation patterns are shifting, and rainfall events may become more extreme. Higher water levels and increasing runoff from built-up areas require additional storage. Coping with natural climate variability is nothing new and adaptation and risk assessment are well known strategies in coastal lowland development that can be used to respond to climate change. Higher water levels and more space for water will fundamentally change the way our coastal lowlands are being managed. Appropriate conservation, adaptation and mitigation actions need to take place in the context of sustainable development. In the Netherlands, adaptation measures focus on the water management system as well as the spatial planning. The selection of adaptation measures, mainly depends the type of land use. For the three major types of land types, i.e. the low-lying peatlands in the western part of the country, the higher sandy soil areas in the east and south-east and the marine clay areas in the reclaimed polder areas, adaptation measures, for both agriculture and nature, adaption strategies are discussed are discussed.

INTRODUCTION

The coastal zone comprises only 3% of the earth's surface, but contains a disproportionately high amount of its assets (Schultz, 2001; Huntington, 2002). Coastal zones accommodate 60% of the world's population, a figure set to increase to 80% by 2050. As a result, 2/3 of those cities in the world with a population of more than 1.6 million people are found in coastal areas. It contains ports and harbours for international trade and a major portion of the world's prime agricultural land, together accounting for 25% of global primary productivity. Coastal areas have a great ecological value, offer recreation and tourism and provide habitat for many endangered species and, at the other hand, are the source of 90% of the world's fish catch. Tidal areas include all those coastal areas where the tidal processes are capable of affecting man's activity or of being influenced by man (Simm *et al*., 2003). This roughly extends tidal areas between the following limits: (i) on the seaward side up to the limit of conventional construction or dredging activity (typically of the order of 30 m water depth) and (ii); on the landward side up to the limit of the action of the sea, including all those areas that might be subject to flooding by seawater and up all estuaries and rivers to the tidal. Tidal areas differ greatly depending on their location, geo-physical conditions, climate, tidal range and cultural differences.

Throughout the world, tidal areas have been and are being developed. The initial development is generally for agriculture, often in combination with flood protection. These developments will continue as food production will need to be doubled in the next 25 years (Molden, 2007). This will be required to meet the needs of the expanding population and the expectation of this growing population for a higher standard of living. It is estimated that, whilst the major part of increase will need to come from already cultivated land, 10% of the increase will have to come from newly reclaimed lands (Van Hofwegen and Svendsen, 2000). These lands will be required partly to compensate for loss of agricultural land by urbanisation and industrialisation, erosion, desertification and partly to compensate for reduction in yields by waterlogging, salinisation, environmental considerations or degeneration of existing irrigation and drainage systems. The development focus in tidal areas is, however, gradually moving to ports, harbours, transportation routes, industries, aquaculture, housing and recreation facilities. Reclamation of these areas may sterilise their availability for such uses as waste disposal, abstraction of construction aggregates and other materials and as the location of renewable energy generators such as wind turbines. At the same time, these developments threaten their valuable natural resource functions. On this basis, the burden of guaranteeing sustainable development must be shared locally and globally for the wise use and conservation of tidal areas (Convention of Ramsar). Doing nothing is not an option.

Development of tidal areas is closely linked to the availability of fresh water: a finite and vulnerable resource, essential to sustain life, development and the environment (Part et al, in press). Development should be based on the Dublin principles. In tidal areas, fresh water is needed to reclaim saline land for agriculture, to irrigate new agricultural land, to create and maintain fresh water lakes, etc. The quality of fresh water resources is threatened by the various (land) uses, e.g. non-point source pollution by intensive agriculture, point-source pollution by untreated wastewater from industries and households and salt water intrusion.

Development of tidal areas will also be affected by systemic changes such as population growth and those arising from climate change, e.g. the predicted sea level rise and increases in storminess (Van Schaik *et al.*, 2003). To make development sustainable, it should meet the needs of current generations without compromising the ability of future generations to meet their needs and aspirations (Bruntland, 1987). Sustainable development is often conceptualised as having three dimensions: (i) Environment; (ii) Economy and; (iii) Society (Global Water Partnership, 2003). These three dimensions can be symbolised as overlapping circles with a triangle in the centre representing sustainable development ('*triple bottom line concept*'), based on three overriding criteria: (i) Economic efficiency in water use; (ii) Equity, and; (iii) Environmental and ecological sustainability. In tidal areas, the principles on Integrated Coastal Zone Management (ICZM[1]) and Integrated Water Resources Management (IWRM) are consistent with sustainable development. ICZM and IWRM are both processes that promote the co-ordinated development and management of water, land and related resources, in order to maximize the resultant economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems. Public participation in decision-making and access to information and to justice should be guaranteed (United Nations Economic Commission for Europe, 1998). Capacity building plays an essential role in this (Global Water Partnership, 2003).

Drainage and flood protection are needed to make the low-lying tidal areas suitable for agriculture or other land uses. As soon as these lands are drained the process of irreversible subsidence commences. This subsidence is a well-known and hard-to-overcome constraint to the development and use of coastal lowlands, threatening the long-term sustainability. The dilemma is how to strike a balance between two contrasting needs, namely, intensive drainage in order to optimize land use and less intensive drainage to avoid irreversible damage to these fragile eco-systems. Climate change may also call for more control: sea levels are rising, precipitation patterns are shifting, and rainfall events may become more extreme. Higher water levels and increasing runoff from built-up areas require additional storage. Coping with natural climate variability is nothing new and adaptation and risk assessment are well known strategies in coastal lowland development that can be used to respond to climate change. Higher water levels and more space for water will fundamentally change the way our coastal lowlands are being managed. Appropriate conservation, adaptation and mitigation actions need to take place in the context of sustainable development. Innovative solutions, e.g. floating roads, buildings and structures, buildings on piles, etc., are required. It should be remembered, however, that subsidence cannot be completely arrested; it is the price one has to pay for utilising coastal lowlands. In this paper, adaptation and mitigation experiences from the Netherlands are discussed.

The Netherlands, a low-lying country in West Europe (50^o - 54^o N and 3^o - 8^o E), consists of delta's and former flood plains of the rivers Rhine, Meuse and Schelde (Colenbrander, 1989). The total territory, including inland lakes, estuaries and territorial waters, is 42,000 km^2. The land area (34,000 km^2) mainly consists of alluvial deposits and about 25% of the country lies below mean sea level. In the absence of dunes and dikes more than 65% of the country would be flooded at high sea and high river levels. The western part has an elevation varying between 0 and 5 m below Mean Sea Level (MSL) and has little relief except for the coastal dunes. The lowest point north of Rotterdam is some 7 m below MSL. In the western parts of the Netherlands, reclamation of the peat areas started around 1000 A.D. (Ven, 1996 and Van der Molen, 1982). As the areas were elevated above the river levels, drainage by gravity was possible. The water levels, which were controlled by sluices, could be maintained at a depth that allowed arable crops to be cultivated. Because of the subsidence of the peat layers, however, the drainage deteriorated and, in the fifteenth century, arable cultivation was gradually replaced by grassland. Nevertheless, the land continued to subside, and new techniques were needed to drain the areas. From the sixteenth century onwards, windmills were widely used to pump out the drainage water, thereby maintaining a good drainage base, but consequently increasing subsidence. Subsequently, the drainage base has been lowered from time to time, and nowadays, instead a few metres above mean sea level, these areas are now several metres below it. The continual subsidence process, in combination with the predicted sea level rise threatens the sustainable use of tidal areas (Figure 1). To sustain the use of tidal areas, innovative solutions to control and counterbalance the never-ending subsidence are required, e.g. controlled drainage, floating roads, buildings and structures, buildings on piles, etc. These solutions need to be based on the principles of '*wise use*'. '*Wise use*' is defined as use for which reasonable people, now and in the future, will not attribute blame (Joosten and Clark, 2002). In this paper, the challenges for the development of tidal lands are discussed based on these '*wise use*' principles.

CLIMATE CHANGE PREDICTIONS

Recent observations confirm that the climate is changing (European Environment Agency, 2008). In North-western Europe, which its maritime climate, the key past and projected impacts and effects are:

- sea-level rise;
- increase in winter precipitation;
- increase in river flow;
- higher risk of coastal flooding.

The Netherlands have always been subject to sea level rise (Figure 1), but the rate of global mean sea-level rise has increased to 3.1 mm/year in the past 15 years. For the coming decades the predicted increases are considerable higher: between 0.65 and 1.3 m in 2100 and between 2 to 4 m in 2200 (Delta Committee, 2008). Change in precipitation show variability across Europe. In the wet northern part the precipitation has increase between 10 to 40% during the 20th century, but in some parts in the drier southern Europe decreased up to 20%. The intensity of the precipitation extremes such as heavy rain events has increased in the past 50 years, and these events are projected to become more frequent. On the other hand, dry period in summer are also projected to increase, aggravating the impacts on, among others, water availability (for agriculture, nature, households and industry) and subsidence. The rise in temperature will result in decreasing river flows in summer and increased flows in winter. For the River Rhine, the projected peak discharges will increase from current 16 000 $m^3 s^{-1}$ to 18 000 $m^3 s^{-1}$ in 2100.

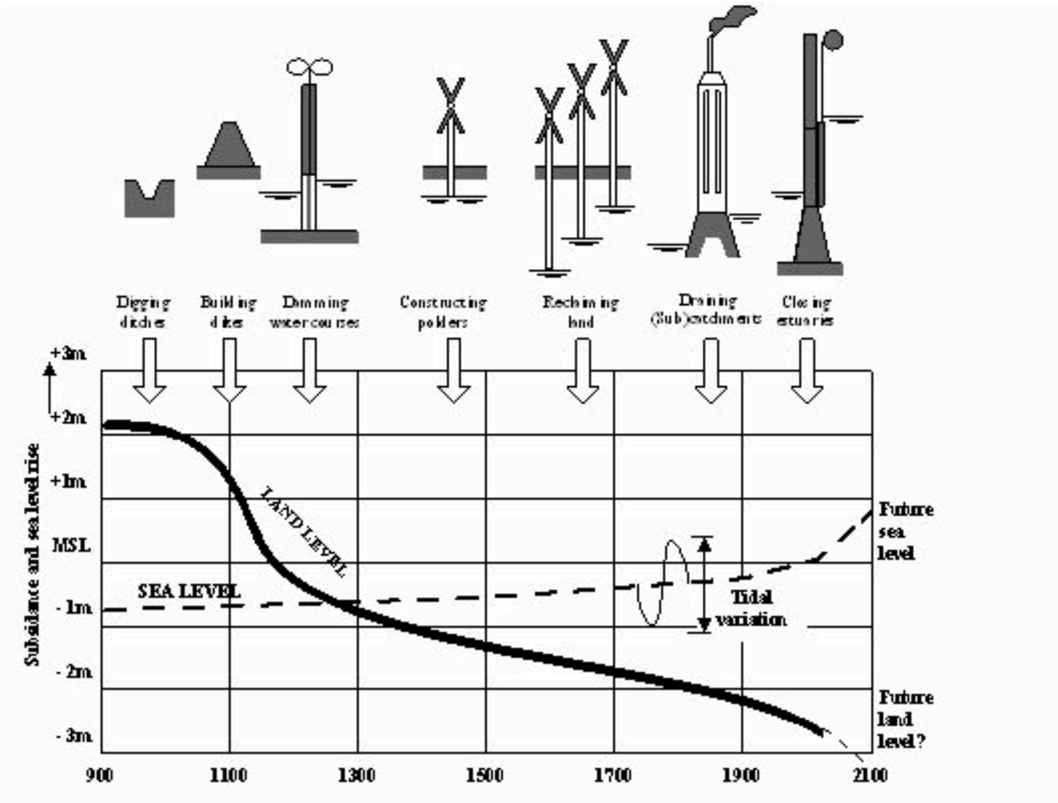

Figure 1. Subsidence, in combination with sea level rise, has always challenged the Dutch water sector (Schultz, 2005).

The combined effects of the projected increase in sea levels, land subsidence and increased river discharges will significantly increase the risk of flooding. In 2008, the Government of the Netherlands requested a independent committee (the 'Delta Committee') to present advice on protecting the coast and the entire low lying part of the Netherlands against the consequences of climate change. The issue is whether arrangements can be made so that over the very long term the Netherlands can be climate proof: safe against flooding, while still remaining an attractive place to live, to reside and work, for recreation and investment. The Delta Committee has formulated following twelve recommendations for the short and medium term (Delta Committee, 2008). The committee recommend a 10-fold increase in the level of safety against flooding for the most vulnerable areas and the policy, legal and financial implications of this increase safety factors. They give recommendations for the period till 2050 and additional measures for the period up to 2100. In the following sections, examples are presented how risk-assessments are made and the infrastructural challenges that have to be met to overcome the never-ending subsidence process.

RISK OF FLOODING

For each province in the Netherlands, risk-assessment maps have been prepared for a number of risks or disasters that can occur/happed (Table 1). These risk-assessment maps are available on internet (www.risicokaart.nl, in Dutch): every individual, company etc, can consult these map as they present information over risky situations, locations where risky activities take place, etc. Figure 2 is an example for areas that are prone to flooding: the flooding depth is given. The user can select the degree of detail, he/she can zoom in up to the level of a municipality, street, company, risky location, etc, by using the postal code.

Table 1. Type of risk that can be show on the risk-assessment maps

Type of risk/disaster	Details show on the map
Accident with hazardous materials (combustible, poisonous, explosive)	Companies that store, process or produce hazardous materials Transport of these materials
Accident with a nuclear facility	Companies or transport that use nuclear material
Airplane crash	Airports
Accident/ calamity on water	Water ways and harbours
Traffic accidents on land	Roads and railroads
Accident in a tunnel	Underground tunnels
Collapse of high-rise buildings	Geological features
Fires in high-rise buildings	High-rise buildings
Panic in large public gatherings	Exhibition/fairground
Flooding	Flood-prone areas
Ecological disaster (fire, etc).	Nature reserves

The risks of flooding are small, as most dikes and embankments in the Netherlands have been designed and constructed based on frequency of occurrence of up to 10 000 year, but the consequences can be severe. Each province and municipality has the legal obligation to prepare emergency scenario maps for each and every possible risk. One of the major problems is that, because the risks of flooding are small, inhabitants of flood-prone areas, do not take government advice in case of emergency serious enough. A recent study shows that about 25% of the population is ignoring a advice of the local authorities to stay at their homes in case of a emergency (Figure 3).

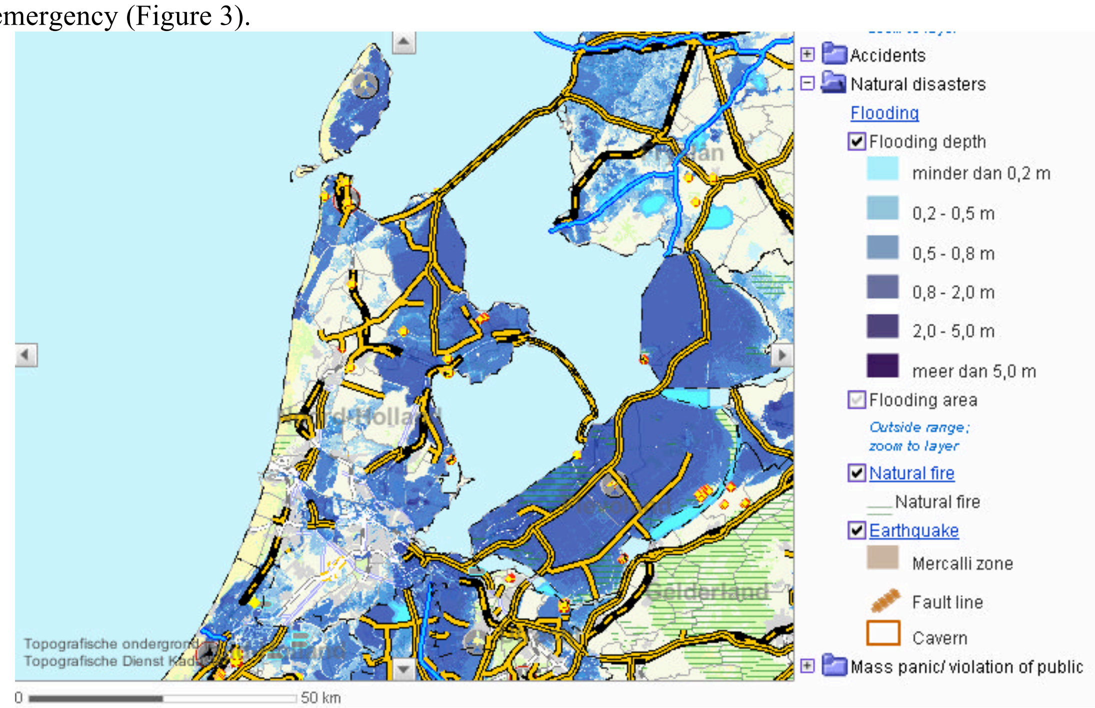

Figure 2. For each province in the Netherlands risk-assessment maps can be consultant on the internet: example of flood-prone areas in the North-west of the Netherlands

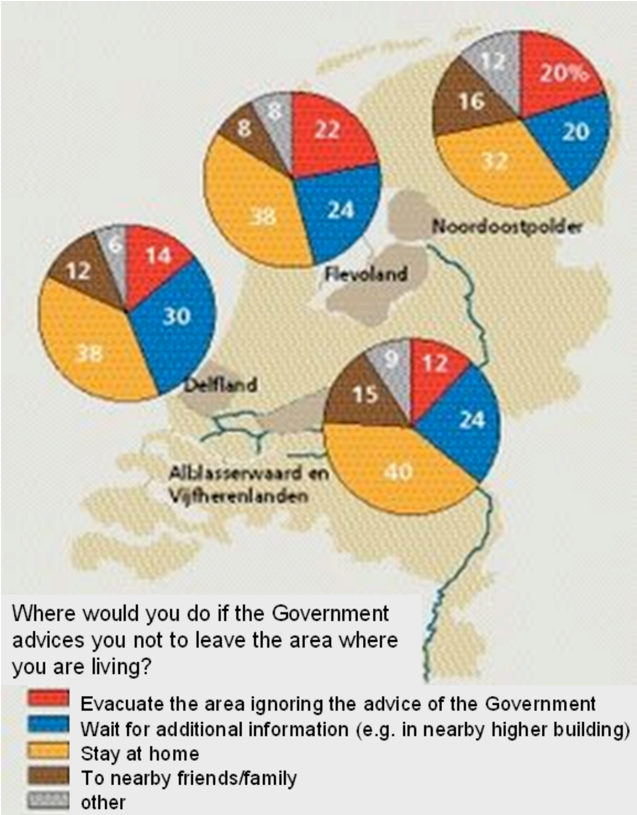

Figure 3. Response of the local population (in %) of an advice of the local government to leave the area where they are living in case of an emergency (Source: University of Twente, Department of Psychology & Communication of Health & Risk).

INFRASTRUCTURAL CHALLENGES

The process of never-ending subsidence has major repercussions on the construction of roads, structures and residential and industrial buildings, i.e. (Figure 4):

- uneven road surfaces require more frequent maintenance and result in decreased safety of users;
- shallow watertables result in damage to foundations of buildings and structures;
- uneven subsidence results in misalignment of underground power cables, water and gas mains;
- uneven subsidence reduces the lifespan of sewerage systems;
- subsided pavements, parking lots, farmyards, compounds and gardens create flooding problems and reduce the accessibility to homes and offices.

Figure 4. Problems associated with building on peatland, examples from the Netherlands: flooding (left); subsidence of roads (middle), and; subsidence of sewerage mains (right) (Deltaris, 2008)

Sustainable solutions for permanent structures on soft (subsiding) soils should be based on the principles that the ground pressure of structures should not exceed the bearing capacity of the soil (for loads of relatively short duration) or that the on-going consolidation of the soil layer under these structures is approximately equal to the total, unavoidable, subsidence of the surrounding area. The practical consequences of these principles are that the overburden pressure should be very low (e.g. for peat soil with a water table of 0.50 m the overburden pressure should not exceed about 2 kPa or 200 kg/m^2). There are several options and methods available to reduce subsidence or to live with it, e.g.:

- for on-farm transport, vehicles with very wide tyres on normal equipment or using wetland tracks to lower the ground pressure are suitable (DID, 2001);
- in the design of foundations for structures, light and buoyant materials such as polypropylene, compressed peat or floating structures can be used;
- forces consolidation by using vertical drain pipes or dewatering drains;
- reinforces soil foundations using geotextiles, mixing peat with cement or using biotechnology processes;
- flexible connections between cable or sewerage systems and houses, roads and bridges;
- flood-proof foundation and building techniques (Figure 5), i.e. foundations on piles, floating buildings, building on artificial mounds (a method used in the northern parts of the Netherlands for more than thousand years), etc. (Fit, 2006; Poot, 2004, Schultz, 1992 and Ven, 1996), etc.

Figure 5. Smart solutions: floating houses (left); floating suburbs (middle), and; floating greenhouses (courtesy: Dura Vermeer)

Investment costs on peatlands are higher compared to mineral soils. In a study conducted in the Netherlands, the total investment and operation and maintenance costs for the development of a suburb of 3000 houses were calculated (Fiselier, 2006). Four alternatives were considered, a suburb built on: (i) mineral (clay) soil on which a sand layer of 0.5 m was added (a normal practice in the Netherlands to compensate for the initial consolidation), and three alternatives on peat soils, i.e. (ii) on peat without any additional sand supplements; (iii) on peat with houses built on the water, and (iv) on peat on which a sand layer of 0.5 m was added. The results indicated that the investment costs as well as the costs for O&M are considerable higher for the suburbs built on peat (Figure 6).

In addition, building on peat required significantly more space (140 ha) than building on clay (120 ha), because of the higher percentage open water needed to storage peat rainfall runoff. The difference in costs can be attributed to this larger area, the cost of building floating and/or flood-proof houses, the higher costs for roads and because in the peatland more open water courses and thus bridges are needed. Climate change, like sea level rise and more intensive rainfall, will further aggravate these associated costs. These results are in agreement with another study conducted in 54 municipalities in the Netherlands, in which the differences in operation and maintenance costs for municipalities, located on '*poor*' (mainly peat and unripe clay), '*medium*' (mainly clay) and '*good*' (mainly sandy) soils were quantified (Cebeon, 2005). The analysis showed that the costs in the '*poor*' soil municipalities are respectively 19 and 41% higher compare to the *'medium*' and '*good*' soil municipalities. Pumped drainage is only feasible for land use with a very high rates of return, e.g. horticultural crops and or agro-based industries and urbanization. Pumping becomes more economical, if storage capacity is created inside the area; these water bodies can easily take 20 to 30% of the land area, thus revolutionary solutions, i.e. floating houses, caisson foundations, flexible joints, etc. are required.

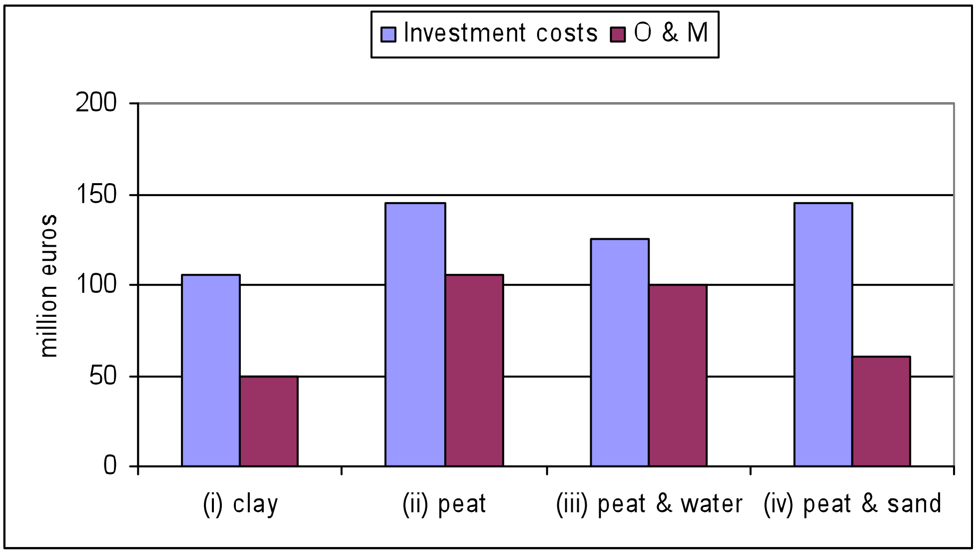

Figure 6. Investment costs and costs for O&M (capitalized costs for 2020) for a suburb built on (i) mineral (clay) soil and on peat soil (ii) bare peat soil; (iii) peat soil with floating houses and; (iii) peat with 0.5 m of sand (Fiselier, 2006).

ADAPTATION STRATEGIES IN RURAL AREAS

The rural areas in the Netherlands are divers, they can roughly be divided in three land types: the peatlands in the western part of the Netherlands, the sandy soil areas in the higher south and east of the country and the reclaimed or 'polders' areas. These land types require different adaptation strategies (van de Sandt and Goosen, 2010). The peat areas, where the rural planning is historically focused on the agricultural development, mainly day farming, are vulnerable to waterlogging and subsidence. The water management is based on the control of the (ground)water levels to reduce this subsidence. To adopt to climate change land use should, more than in the past, be geared to reduce this subsidence, e.g. raising the water levels in the canal system. Nature areas will benefit from these changes. For the agriculture, this is a dilemma as higher water levels will made the water management system more vulnerable to climate change, mainly the predicted extreme rainfall events. The intensive dairy farmers will have to be concentrated on the slightly higher and less vulnerable parts, where a clay cap is on top of the peat soils. The change in water management, i.e. the water level dictates the land use, will increase the options for multi-functional land use, e.g. recreation, nature, urbanization and water storage. This requires, however, an active role of the government through subsidies as the production capacity of the dairy farming will decrease. The areas in the south and east of the countries are vulnerable to waterlogging in the valleys of the small rivers and brooks and for drought on the higher sandy soils. In these areas land use (agriculture, nature) is mainly large scale and the water management is based on the prevailing land use. The water management system is mainly a gravity system and the adaptation measures are aiming to reduce runoff, to store water in the area itself and to regulate the outflow. In some areas, water is supplied from the main river system during dry periods in summer. The high-tech and capital intensive agriculture farms, e.g. green houses, fruit trees and intensive animal husbandry, have the means (both financial and technical) to make their production systems less dependent on this water supply. Corridors are needed to connect the nature areas, but for the rest these large-scale farming areas are not very suitable for recreation, thus the main focus will be to keep the agriculture competitive. The reclaimed areas are vulnerable to climate change: waterlogging during extreme rainfall events, drought, diseases and plagues due to higher temperatures. Fortunately, a major part of the reclaimed areas consist of large-scale farming systems with a high competiveness. Similar to the sandy areas, technical measures to reduce runoff, storage water and increase regulation of the outflow will be required. In particular the polders are vulnerable to waterlogging because of their low elevations and limitations to discharge excess water. Nature can benefit through the development of fresh-brackish water corridors, increase seepage and impolder activities. The coherence between nature and agriculture can also be enhances through an active management of the ditches and the field boundaries (to reduce runoff). These measure can help to reduce diseases and plagues.

CONCLUSION

To sustain the coastal areas in the Netherlands, innovative solutions to reduce subsidence and to live with the water are needed. The challenge is to strive for a balance between water levels allowing optimum land use and water levels minimising subsidence. Innovate solutions, e.g. floating roads, buildings and structures, buildings on piles, etc., are required to reduce and counterbalance the never-ending subsidence. Although the challenges are clear, addressing them effectively will take time. What are the best methods to use? What are the best infrastructural options to control water levels, to avoid flooding and to take care of transport needs, etc. How do you operate and maintain this infrastructure? This is a process of optimisation that, e.g. in The Netherlands and other countries in Northern Europe, has been going on for centuries (Ven, 1996 and de Bakker and van den Berg, 1982). It will only be successful if the principles and practices of sustainable '*wise use*', especially with respect to hydrology and water management, are taken into account.

REFERENCES

Bruntland, G. (ed.), 1987. Our common future: The World Commission on Environment and Development, Oxford, Oxford University Press.

Cebeon, 2005. '*Meerkosten gemeenten met een slechte bodemgesteldheid – nadere verfijning maatstaven slappe bodems in gemeentefonds*' (Additional costs for municipalities with poor soil conditions) (in Dutch). Centrum Beleidsadviserend Onderzoek, Report no. 571001-014, 61 pp.

Colenbrander, H.J. (Ed). 1989. Water in the Netherlands. Proceedings and Information/TNO Committee on Hydrological Research, The Hague, no. 37 – 96 pp.

Convention on Wetlands of International Importance especially as Waterfowl Habitat. Ramsar (Iran), 2 February 1971. UN Treaty Series No. 14583. As amended by the Paris Protocol, 3 December 1982, and Regina Amendments, 28 May 1987.

De Bakker, H., van den Berg, M.W., 1982. Proceedings of the Symposium on Peatlands below Sea Level. ILRI Publication 30, Wageningen, 296 pp.

Delta Committee, 2008. Working with water (in Dutch with English summary). http://www.deltacommissie.com/en/advies

Deltares, 2008. '*Bouwen op slappe bodems*' (Building on poor soils) (in Dutch:). Report no. 429980-400-0007 v01, Delft, pp: 57.

European Commission, 2000. Proposal for a European Parliament and Council Recommendation concerning the implementation of Integrated Coastal Zone Management in Europe. European Communities Documents no. COM (2000) 545f - 11322/00, Brussels.

European Environment Agency, 2008. Impacts of Europe's changing climate – 2008 indicator-based assessment. EEa Report no. 4/2008, European Communities, Copenhagen.

Fiselier, J., 2006. '*Domme locaties bestaan niet: de prijs van bouwen op veen'* (Stupid locations do not exist: building on peat) (in Dutch). ROM Magazine, Vol 23, No, 10: 36-39.

Fit, J.J. 2006. '*Drijvende woningen, op weg naar een volwassen segment van de woningmarkt*?' (Floating

homes, becoming a substantial part of the housing market) (in Dutch). MSc Thesis, Amsterdam School of Real Estate, pp: 79.
International Conference on Water and the Environment (ICWE), 1992. The Dublin Statement on Water and Sustainable Development, Dublin, Ireland, 6 pp.
Joosten, H. and Clark, D., 2002. Wise use of mires and peatlands – background and principles including a framework for decision-making. International Mire Conservation Group and International Peat Society, 304 pp.
Global Water Partnership. 2003. Sharing knowledge for equitable, efficient and sustainable water resources. Tool Box Integrated water resources management. Global Water Partnership, Stockholm, Sweden.
Huntington S., Burgess, K., Townend, I. 2002. Coastal engineering science to policy and practice. Keynote address. In: Mckee Smith, J. (Ed.). Coastal Engineering. Proceedings of the 28th International Conference on Coastal Engineering, held in Cardiff, Wales, in July 2002, Vol. I: 3-17.
Molden, D. 2007. Water for Food, Water for Life: A Comprehensive Assessment of Water Management in Agriculture. London: Earthscan and Colombo: International Water Management Institute.
Park, SH, Simm, J, and Ritzema, HP. in press. Development of tidal areas, some principles and issues toward sustainability. *Irrigation and Drainage*, (accepted 01-08-2008).
Poot, E.H. 2004. '*In 2030: ondergrondse, stadse en drijvende kassen*'(In 2030, underground, urban and floating greenhouses) (in Dutch). Vakblad voor de Bloemisterij 59 (2004): 19.Querner, E.P., 1997. Description and application of the combined surface and groundwater flow model MOGROW. Journal of Hydrology 192, 158-188.
Schultz, B. 2005. Opening address 44th International Course on Land Drainage, Alterra-ILRI.
Schultz B. 2001. 'Development of tidal swamps and estuaries.' Keynote address at 1st Asian Regional Conference at 52nd IEC meeting of International Commission on Irrigation and Drainage (ICID), Seoul, Korea.
Schultz, E. 1992. '*Waterbeheersing van de Nederlandse Droogmakerijen*' (Water management in Dutch polders) (in Dutch). Ministry of Transport, Public Works and Water Management, Directorate-General for Public Works and Water Management, Directie Flevoland, Lelystad.
Simm, J., Ritzema, H.P., Park Sang Hyun, 2003. Outline for ICID Handbook on Sustainable Development of Tidal Areas: Outline. In: Wise Use and Environmental Conservation of the Tidal Areas. Proceedings 2nd Int. Workshop on Sustainable Development of Tidal Areas, Montpellier, pp: 131-136.
United Nations Economic Commission for Europe, 1998. Convention on access to information, public participation in decision-making and access to justice in environmental matters. Aarhus, Denmark, June, 22p.p.
Van Hofwegen PJM; Svendsen M. 2000. A vision of water for food and rural development, The Hague, the Netherlands.
Van Sandt, K., Goosen, H. 2010. Naar een klimaatbestendig landelijk gebied (in Dutch). Wageningen UR, 108 pp.
Van Schaik, H, Kabat, P, and Connor, R. 2003. Conclusions and recommendations. In: B Appleton, (Ed). Climate changes the water rules: how water managers can cope with today's climate variability and tomorrow's climate change, Dialogue on Water and Climate, Delft, 94-97.
Ven, G.P., 1996. Man-made Lowlands. History of water management and land reclamation in the Netherlands. Matrijs, Utrecht, The Netherlands, 1993, 293 pp.