As the threat of flood and pressure on resources seemingly increases, how has the north European attitude to the coastline and water altered? What effect has our relationship with water had on the landscape and in the future how can we make this relationship become more environmentally and economically sustainable?

Abstract

This paper will consider how human responses to the threat of flood have historically had an effect on the landscape and review the latest developments with respect to flood alleviation proposals. It will consider how these flood alleviation proposals can provide an opportunity for landscape architects with imaginative and sustainable ideas to become part of the solution.

The paper will focus on coastal flooding, but also consider the estuarine environments and fluvial flooding which are interlinked with the coast and which are affected by rising sea levels.

Northern Europe will be the primary focus of the paper, which will consider the history of flood alleviation and developments in Europe, with special regard to the UK and the Netherlands. The history of the people of these regions is interwoven with humans' relationship to water and the sea. As sea levels rise, these regions, which are heavily populated, now have to respond and adapt to this new threat.

The paper will discuss how poor practice still exists, for example, the continuing development on flood plains and the difficulty encountered by the public perception to some schemes. Furthermore, any existing or proposed scheme will be influenced by a variety of other factors such as the economic benefits versus cost and consideration on the effect of a scheme on wildlife, ecology and biodiversity. The paper will also consider the effect of governmental policies and regulations, and whether these need to change. As with much current development, sustainability will also be a key consideration.

The paper will consider current threats and practice within the Netherlands and the UK and look at some new innovative flood alleviation ideas.

The paper shall conclude that the persistent threat of flood, combined with increasing population pressures, mean that human responses to the threat need to be innovative and immediate. Coastal regions remain a desirable location to live, work and play and as such there is an opportunity for Landscape Architects, in association with other professions, to develop a variety of innovative flood alleviation projects which will leave a lasting mark on the landscape.

Development of flood defence in the Netherlands

Currently around 25% of the Netherlands lies below sea level and 65% of the country is under threat of flooding from the sea and rivers[1]. The Dutch have lived with this level of threat from water throughout their history and as such their culture and personality can be

[1] Wesserlink, A.J., Bijker, W.E., de Vriend, H.J., and Krol, M.S. (2007) "Dutch dealings with the Delta" *Nature and Culture* Autumn 2007, v2 i2, p188(22)

said to be interlinked with the water. The Dutch responses to living with water have affected the landscape they live in. We will see that the Dutch responded to the threat as perceived at any particular moment in time, but that each decision had an outcome that affected future generations, which they in turn had to adapt too. This cycle of having to respond to the choices of previous generations exists to the present day, and highlights the necessity for our current decisions in respect of flood alleviation to be adaptable.

The Dutch historian Willem van der Ham identifies four periods of Dutch water management[2]:

1. *The natural state.* This is where the landscape was shaped by formative water forces where torrential rains created peat mires and streams and the force of the sea shaped coastal regions. The first inhabitants started settling on the high areas which had naturally formed, but the frequency and unpredictability of flooding meant that this was a precarious existence.
2. *The defensive state.* As the peat mires rose in height and population numbers grew the opportunity and need for the landscape to be cultivated increased. The inhabitants started to intervene in the landscape, via drainage, to create arable land and, importantly, to protect themselves against flooding by raising existing high ground. These interventions had unintended consequences, however, for instance the drainage of fields and creation of canals led to subsidence in the land and a relative rising of the sea level, which meant that the probability of flooding increased and the twelfth and thirteenth centuries[3] saw several large scale devastating floods. These floods led to the realisation that drainage alone was not sufficient and a series of dikes were created enclosing areas of land, known as polders.
3. *The offensive state.* The seventeenth century saw economic and technological advances spur the start of large scale reclamation projects and the creation of vast numbers of polders. Wesselink et al (2007) state that the national outlook changed from "living with water" (through drainage) to "protecting from water" (through dikes). These reclamation projects were integrated with developments in the concept of the ideal landscape and led to the creation of a rational geometric land division.

Geometric Dutch landscape (image from http://www.fredhoogervorst.com/photo/22424/)

[2] van Buuren, M. (2008) "The Netherlands and its never-ending dialogue with the water" *45th IFLA World Congress: Transforming with Water – Congress Guide*

[3] Wesserlink, A.J., Bijker, W.E., de Vriend, H.J., and Krol, M.S. (2007) "Dutch dealings with the Delta" *Nature and Culture* Autumn 2007, v2 i2, p188(22)

Technological advances continued and in the nineteenth century large scale reclamation of parts of the sea and intervention along the Dutch coast occurred. This period also saw the creation of canals linked to the natural water system and the utilisation of the water for transport and military defence. This 'offensive state' period continued into the twentieth century, with the last polders in the IJsselmeer only being completed in 1968.

4. *The managerial state*. This phase was the result of greater land usage and population pressures in the Netherlands. Partly as a result of the previous interventions such as drainage of coastal wetlands, as well as inland areas, the Netherlands had locked itself into a situation where land continued to subside and dikes continually had to be raised. Therefore the interventions now required in the landscape and water systems, in order to manage the distribution of the water, allow larger river transportation and so on were increasingly drastic. Although the interventions and improved technologies had reduced the frequency of flooding, the intensity of reclamation and land use meant that should a serious flood occur the potential consequences had heightened. This threat was realised with the great flood of 1953, which covered over 2,000 square kilometres of land and resulted in 1,835 deaths. The 1953 flood led to the Delta Works plan, which brought the estuaries of the south-western Netherlands under human control and saw a further dramatic change to the landscape. The coastline was shortened by 700kilometers and a number of freshwater lakes were created. The estuarine region of the southwest of the Netherlands was lost and its character indelibly changed. This project is a prime example of humans believing they can control nature. The only tidal outlets not closed off were those which provided access to Rotterdam and Antwerp harbours and on these waterways the dikes were strengthened. The Delta plan was implemented over the next thirty years, culminating in the Oosterschelde storm-surge barrier. This barrier was originally intended to be a regular dam,
5. however during the 1970s public concerns arose about the ecological damage being caused by the Delta plan and a barrier which could open and allow tidal movement was proposed. This proposal, though much more costly, was accepted and the barrier opened in 1986, the highlight of the 'managerial state' of Dutch water management.

The series of damns built as part of the Delta Works plan following the 1953 floods. Image taken from http://www.deltawerken.com/23

The Netherlands is still in this 'managerial state', however a new threat is emerging, new considerations and priorities arising and once again the decisions of past generations are having an impact which need to be factored in to any current decisions.

It has become apparent that the Delta plan had unintended ecological consequences which have caused conservation and water quality problems. These problems are primarily as a result of the loss of the dynamic processes which occur in estuarine environments based around river and tidal flows. As a consequence, 1998 saw a new phase for the Delta plan, called 'Fourth Memorandum on Water Management'[4] with a stated goal of restoring and strengthening the natural processes based around the ebb and flow of separate water systems.

Coupled with the new policy aim is the need to deal with the threats caused by climate change, an expanding population and associated pressures. It is estimated that as a result of climate change sea levels around the Dutch coast will rise between 65cm and 130cm by 2100, and that increased rainfall will in turn create higher peak discharges from the rivers Rijn and Maas.[5] The consequences of climate change are therefore threatening the major river ports of Rotterdam and Antwerp as well as coastal areas.

Furthermore, the increasing levels of rainfall are causing waterlogging problems in the low polders and putting the finely balanced water management system under strain. The water is also becoming saltier, particularly in coastal regions and subsidence of the peat areas is increasing.

As a result of the current threats a new Delta plan is required where traditional methods of Dutch water management and flood defence may no longer be suitable. The most famous of the new proposals was the 1997 policy entitled 'Room for the River', which I will discuss in further detail below.

Room for the River – A new phase of Dutch water management

'Room for the River' is the Dutch response to the threats from water posed in the 1990s and it marks a significant cultural shift in Dutch thinking[6]. It is a series of 39 projects being implemented along the River Rijn (Rhine) aiming to create more space for water whilst providing safety and increasing spatial quality and the quality of the river landscape, by integrated design. It has the potential to make a significant impact on the Dutch landscape.

The seeds of this new policy came from a vision entitled Plan Stork developed by De Bruin et al in 1987[7], which had a goal of combining nature development with flood protection. This vision, however, was never implemented with some small scale exceptions. This was to change following the flood events of 1993 and 1995 when it became apparent that the

[4] Adriaanse, L. & Hoekstra, J. (2009) "Designing a Safe and Sustainable Rijn-Maas-Schelde Delta" *Topos 68 p.69-75*

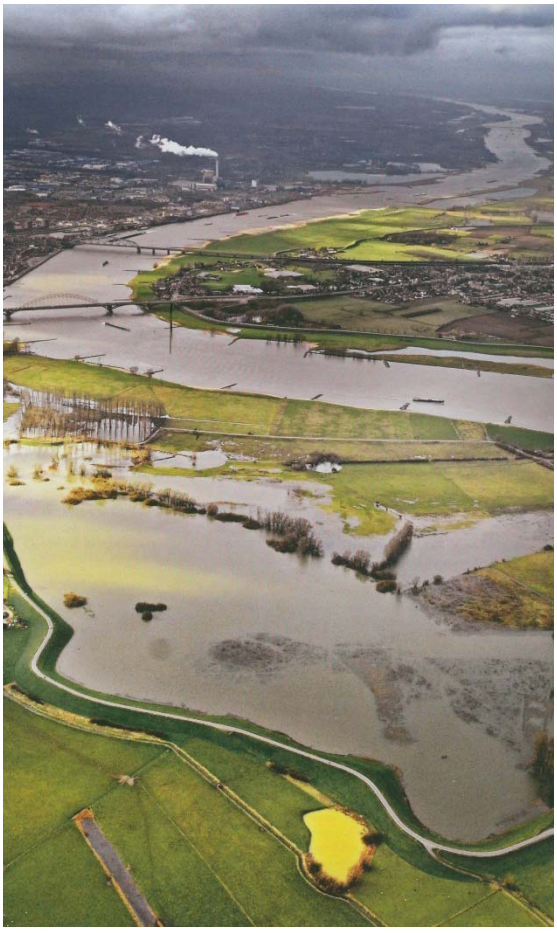
[5] Adriaanse, L. & Hoekstra, J. (2009) "Designing a Safe and Sustainable Rijn-Maas-Schelde Delta" *Topos 68 p.69-75*

[6] van Buuren, M. (2008) "The Netherlands and its never-ending dialogue with the water" *45th IFLA World Congress: Transforming with Water – Congress Guide*

[7] Wesserlink, A.J., Bijker, W.E., de Vriend, H.J., and Krol, M.S. (2007) "Dutch dealings with the Delta" *Nature and Culture* Autumn 2007, v2 i2, p188(22)

current Dutch system of water defence was at its limits and the concept of Plan Stork was incorporated into the 1997 national policy of 'Room for the River'. The policy did not come into effect however for almost another decade, following years of research and promotion of the concept captured by the government slogan that "The Netherlands lives with water".

The Dutch Parliament, approved the 39 projects in 2006, under a package of measures called the Spatial Planning Key Decision (SPKD)[8]. The SPKD was given a budget of €2.3 billion and is the first large scale adaptation project of its kind. Its primary objective is flood protection by 2015, accompanied by improved environmental quality of the river basin and increased spatial quality i.e. an improvement in design aesthetics, conservation, accessibility and so on. It is seen as a major shift in Dutch water management as for the first time the project involves suppressing the Dutch instinct to raising the dikes and increasing defences. It should be noted, however, that some defences will still be raised.



Ooy Polder, Room for the River (image from Topos 68)

As well as the traditional strengthening of some of the defence's each of the 39 projects involves two or more solutions from six safety initiatives, which are:

1. Relocating dikes to allow more room for higher discharge
2. Constructing flood by-passes through flood plains

[8] Sijmons, D., (Netherlands State Advisor on Landscape) (2009) "Room for the River" *Topos 68* p.60-68

3. Stripping topsoil from flood plains
4. Lowering existing groynes
5. Creating 'green rivers' between dams to act as special water reservations in extreme conditions, whilst supporting regular land-use for the majority of the time.
6. Removal of obstructions such as obsolete bridges and piers, thus helping to reduce the mean high water level.

One example of how decisions need to be integrated and adaptable is a key project to 'depolder' the Noordwaard, an arable region which will be given over to the river for creation of a large nature reserve and fresh water tidal area. The areas will retain land-uses such as dairy farming and where possible arable farming, in locations which will only occasionally be flooded.

On the surface of it this project could be truly remarkable in shaping future flood defences and moulding a new landscape. There are those in Dutch society, however, who have serious reservations about the Room for the River project. Wesselink et al (2007) comments that for some engineers and cynics the government acceptance of Room for the River is merely a money saving exercise by politicians who lack the political will to invest the required sums to adequately defend the Netherlands from flooding. This argument is not conclusive however, because in 2006 the estimated cost of bring the dikes up to the legal standard was €1.6 billion i.e. less than that allocated to SPKD.

Another argument against the project is that the objective of 'spatial quality' is so vague that it could be used to try and get finances from other government departments or lead to endless periods of no action whilst the 'spatial quality' was debated. Furthermore some polders which would have previously been protected under flood defence schemes have now been built on under SPKD. The Dutch government defended these decisions under the argument that the Netherlands lives with water and as land pressures increase there is a need to be innovative in their dealings with water. To which the chairman of the Rijkswaterstaat responded that "Room for the River is becoming Room for the Builders".[9]

Development of flood defence in the UK

The development of flood defences in the UK has differed from that in the Netherlands, but the situation and threats facing the UK are now similar to those facing the Dutch and some of the current favoured solutions are remarkably similar. The key difference between the UK and the Netherlands is that UK flood defences have mainly had to focus on coastal areas, without having to be as concerned as the Dutch about the inland water systems.

In 1999, according to the UK Environment Agency, 30% (17 million people) of the population of England and Wales lived within 10 kilometres of the coast and 2.5 million people (and increasing) live in a coastal area below 5 metres sea level. One third of the coastline of England and Wales has some form of shoreline protection,[10] usually these are hard engineered structures, ranging from simple earth embankments to the Thames Barrier.

[9] Wesserlink, A.J., Bijker, W.E., de Vriend, H.J., and Krol, M.S. (2007) "Dutch dealings with the Delta" *Nature and Culture* Autumn 2007, v2 i2, p188(22)

[10] De La Vega-Leinert, A.C. and Nicholls, R.J., 2008. Potential implications of sea-level rise for Great Britain. *Journal of Coastal Research,* 24(2), 342-357. West Palm Beach, Florida.

The evolution of flood defences in the UK has seen an overriding theme of continued building of traditional sea defences. Initially sea walls were built solely to protect ports and harbours. The Victorians, however, then started building large scale sea walls at coastal resorts throughout the UK, in order to protect tourist and commercial developments[11]. As coastal development, both residential and commercial continued around the UK so did industrial developments near estuaries. All these developments required flood and erosion protection and the response was always to build a sea wall of some form.

One of the most famous sea walls in England, at Dawlish, Devon. Image from http://www.dawlish-seawall.com/page14.php

What was unknown to the engineers at this time was the effect sea walls, piers and such like were having on the UK coastal landscape. These developments were preventing long shore sediment movement and starving other strips of coastline of sediment and nutrient replenishment. As in the Netherlands this has had unintended ecological consequences. The attitudes of society throughout this time, especially in the nineteenth century, have made the problem worse by viewing natural resources/systems as commodities to be exploited. Our desire to have control over these natural systems has led to many of our current problems.

Our collective education and knowledge has increased and during the 1970s, linked with a general growing environmental awareness, there was a realisation of the dynamic nature of coastal habitats. Despite this increased awareness of the dynamic nature of the coast, hard engineering i.e. the maintaining and building of sea walls persisted as the solution to the question of coastal flooding.

Even in the present day activities such as leisure sailing has increased demand for marina's which can be found in almost every major estuary in England[12], generally all of which have hard engineered structures protecting them, further preventing sediment movement along the coast, thus starving beaches.

Another historical problem affecting the UK has been that decisions were always taken locally, with interested parties only looking to protect their section of coastline with little

[11] French, P. W. "The changing nature of, and approaches to, UK coastal management at the start of the twenty-first century" *The Geographical Journal,* Vol. 170, No. 2, June 2004, pp. 116-125

[12] French, P. W. "The changing nature of, and approaches to, UK coastal management at the start of the twenty-first century" *The Geographical Journal,* Vol. 170, No. 2, June 2004, pp. 116-125

regard for the affect this would have elsewhere. This kind of decision-making failed to recognise that the sea does not recognise parish boundaries or local authorities.

French (2004) highlights a key example of where hard defences' prevention of sediment movement, coupled with local decision-making is having a negative impact down shore. The south coast of England sees an easterly movement of sediment along the shore, however the continued development of harbours and marina's by various councils along the south coast have prevented this movement, resulting in the westerly facing coast at Dungeness, Kent, facing serious erosion problems. This is a potentially serious development because this area is home to two nuclear power stations.

The 1990s, however, started to see a different kind of decision-making process, as well as new responses to the threat of coastal flooding. The UK saw the start of soft defence techniques such as beach feeding, managed realignment and abandonment of some defences. I will look at this new philosophy in further detail below.

There are two main threats facing the UK with respect to the threat of flooding, one is the continued development on flood plains, both coastal and fluvial, and the other is climate change.

In 2005 Defra stated that *'Climate change is expected to lead to hotter, drier summers and warmer, wetter winters. Rainfall is expected to increase in the winter and to rain harder when it does rain in the summer, leading to worse and more frequent flooding. Sea levels will further rise as polar ice caps melt, increasing flood risk to coastal areas.'*

Many low-lying coastal areas in the UK, particularly around estuaries are ever more susceptible to flooding. De La Vega-Leinert (2008) cites research by Nicholls and Wilson (2001) around the coast near Broadlands in Norfolk, where the sea-level rise is estimated to be between 16cm and 71cm by 2050. Should the actual sea-level rise be at the high end of this estimate then the chance of a 100 year event flood would become a 5 year event flood (at the low end it becomes a 50 year event flood).

Increasing sea-levels are also impacting significantly on the threat of river flooding, with much of Britain's floods happening in coastal segments of rivers during high tides.

A further problem is coastal erosion, especially around the southern and eastern coasts of England, where areas of coastal retreat are as much as two meters per year. This problem is exacerbated by the impediment of long shore sediment movement, as discussed above.

Land slip caused by coastal erosion in Humberside on the eastern coast of England, photography by Tony Waltham, image from http://www.art.co.uk/products/p1866223329-sa-i4235878/tony-waltham-coastal-erosion-with-active-landslips-in-glacial-till-holderness-coast-humberside-england.htm

French (2004) argues, however, that continuing development on our coastline and how past and current developments interfere with the natural processes of the coast is a greater threat than climate change. Furthermore, the cycle of development and defence is a vicious circle where one necessitates the other. As in the Netherlands where past decisions have affected the landscape and natural processes this is also the case in the UK. Our desire to master nature and defend our socio-economic and cultural activities from the sea have now "increased our vulnerability by limiting our capacity to co-evolve with the variability of natural processes"[13] i.e. our continued building of sea defences and building on flood plains has resulted in the natural systems being unable to adapt or be dynamic when required.

Remarkably, however, the UK continues to develop on flood plains and coastal areas. Although the Environment Agency has the power to object to proposed developments planning authorities are not bound by their recommendations. For instance, planning authorities have ignored advice from relevant advisory bodies to allow the Thames Gateway development in the Lower Lea Valley for 40,000 homes on an existing flood plain[14].

With regard to the current situation in the UK French (2004) concludes, "*existing defences will not last forever, and for each and every defence structure in the UK the time will come when managers have to consider replacing, upgrading or abandoning these structures. Upgrading may be sustainable in the short term, but is unlikely to be so in the longer term. As sea levels rise and wave forces increase, problems of coastal erosion will become greater… The coastline cannot be held in its current position indefinitely. In many cases, the position of the UK coastline is purely related to a Victorian engineer's whim to build a sea wall where he did. Perhaps the biggest challenge for coastal managers, therefore, is accommodating these natural agencies of change. It is important that as many options as possible remain open, and this includes the ability to retreat inland*."

In his conclusion the theme of adaptability in any future flood defence planning is again a central concept, as we saw with the Netherlands and as we will see again within this paper.

Soft defence techniques and integrated coastal management in the UK

Although the concept of soft defence techniques such as managed realignment already existed, many observers have credited The Earth Summit in Rio De Janeiro in 1992 as a key driver behind the change in policy. This summit had two key outcomes in the UK, firstly it advocated integrated and structured management of coastlines, as opposed to solely local decision making, and secondly that any policy or development must be sustainable.

The 1990s saw the introduction of 39 Shoreline Management Plans (SMP) around the coast of England and Wales, with the boundaries based on factors such as the movement of sediment. This was an important advance as it meant that the coast was no longer looked at within strict local administrative areas.

[13] Bateman, I. J., et al. "Coastal management for sustainable development: analysing environmental and socio-economic changes on the UK coast." *The Geographical Journal* 164.3 (1998): 269. *Academic OneFile*. Web. 8 Aug. 2011.

[14] Brennan, R. "The North Norfolk Coastline: A Complex Legacy" *Coastal Management, 35:587-599 (2007)*

It was intended that the SMPs would be living documents which evolved and were adaptable, however they initially had four strategic options*: do nothing; retreat the line; hold the line;* or *advance the line.* By 2006 it might appear that little had changed when Defra outlined four key shoreline management policies: *hold the existing defence line; advance the existing defence line; managed realignment;* or *no active intervention*.

Although the basic policies are similar there had in effect been one key change, that the realisation that any action taken needed to be region wide and decisions taken by one SMP could affect another area and furthermore that even national responses were not always appropriate. After 1999 therefore, a lot of guidance came through Europe and was then channelled through Defra to the SMPs.

Further plans were then created for estuaries (EMPs) and for large scale Coastal Zone Management Plans (CZMPs), which aimed at promoting sustainable management of UK estuaries and coasts. Unfortunately, however, SMPs, EMPs and CZMPs are still only strategic documents and are non-statutory and as such planning authorities and local councils can ignore their recommendations.

Tollesbury Flats in Essex was one of the first sites chosen for managed realignment, it had the dual aims of reducing the cost of coastal defences as well as achieving environmental and conservation goals. In 2003 Watts et al undertook a study of the site to ascertain whether the project had been successful and they concluded that the scheme had helped to protect the coast from erosion and improved the local eco-system.[15]

Tollesbury Flats Salt Marsh, image from http://www.uea.ac.uk/~e130/Tollesbury.htm

By the late 1990s soft engineering techniques such as managed realignment and beach nourishment were widely accepted by policy makers as the ideal. Proponents claimed that managed realignment of estuarine habitats, with the aim of restoring wetlands and salt marshes, could play a key role in coastal defence, whilst also restoring and maintaining biodiversity.

[15] Watts, C.W., Tolhurst, T.J., Black, K.S., and Whitmore, A.P. (2003) "In situ measurements of erosion shear stress and geotechnical shear strength of the intertidal sediments of the experimental managed realignment scheme at Tollesbury, Essex, UK" *Estuarine, Coastal and Shelf Science* Volume 58, Issue 3, November 2003, Pages 611-620

It was also widely regarded to be a cheaper option than continually raising and restoring traditional sea defences, the cost of which was substantial, for instance in 1998 the UKs coastal defences were maintained at £300m per annum[16]. Leafe (1992) calculated that a realignment programme for Northey Island in Essex cost £22,000 as opposed to the cost of maintaining the existing line of defence estimated at between £30,000 and £55,000. A 1996 report by the Climate Change Impacts Review Group (CCIRG) concluded that whilst traditional protection was currently economically preferable for some areas, the number of areas where managed realignment was desirable increased as sea-level rise predictions increased.

Although planners, coastal scientists, ecologists and policy makers now accepted soft techniques as a key tool in flood defence and coastal management, one key group did not – the public. Public perception to many coastal realignment schemes was often one of "giving in to the sea". Brennan (2007) highlights the example of the Kelling to Lowestoft-Ness SMP which advocated managed realignment and no other active intervention. These policies would mean some people would lose their land and homes to the sea. Other proposals have not been as angrily met, but in this instance the local communities had not been adequately consulted or compensated and as such they felt as though they had been abandoned to the sea. The reality is however, that the Norfolk coastline has been retreating for centuries and planners now recognise it is unrealistic to maintain the coastline as it currently is. This highlights that more work is required for such policies to be fully accepted.

Now, as the twenty-first century progresses more questions have been raised about soft management techniques, with many being concerned that many schemes are being implemented without a full understanding of the wider implications. For instance, questions have been raised about the actual effectiveness of salt marshes and other natural habitats as sea defences.

Furthermore, their success as sustainable regenerated natural habitats has also been queried with some studies (Blackwell et al 2004) suggesting that realignment schemes have been linked to the remobilisation of stored pollutants in estuarine water and saline intrusion into adjacent water tables.

Brennan (2007) also cites Ledoux (et al 2005) in raising financial doubts over the cost of managed realignment. Ledoux acknowledges that although managed realignment is initially cheaper than traditional sea defence, those schemes already in existence are becoming increasingly complex and costly to manage and maintain.

With all the doubts about soft management techniques, however, it should be noted that the other options i.e. doing nothing or maintaining existing sea defences also have various drawbacks. This means that for future flood defence schemes some value judgements will be required, for instance natural habitats and biodiversity or arable land? Coastal development with the threat of flood or no future coastal development? Wetland areas for birds, as regulated for by the EU, or further port and shipping developments as required by business?

[16] Bateman, I.J., et al. "Coastal management for sustainable development: analysing environmental and socio-economic changes on the UK coast." *The Geographical Journal* 164.3 (1998): 269. *Academic OneFile*. Web. 8 Aug. 2011.

Coming together of UK and Dutch flood defence philosophies

We can see from the above that in both the Netherlands and the UK there has been a realisation that humans need to live with water as opposed to simply controlling it. There has also been a realisation that previous interventions have hampered natural dynamic processes and as such any future policies need to be adaptable and dynamic.

It is also noticeable how policies in each country have influenced the other, for instance as well as 'Room for the River' another proposal in the Netherlands for a new Delta plan was the 2003 document 'The Delta in Sight'. Its main aims were to implement safety measures, improve water quality and improve opportunities for agriculture, fishing and tourism. It aimed to accomplish this by restoring natural processes which would encourage sedimentation and the development of salt marshes, which in turn would provide coastal protection i.e. the proposal was very similar to the soft management techniques advocated in the UK.

In 2004 in the UK Defra produced a policy document entitled "Making Space for Water", which was obviously influenced by the key Dutch shift in thinking outlined above. Furthermore, Defra have now widened this field and produced a policy document entitled "Making Space for Nature."

Other innovations in flood defence and design

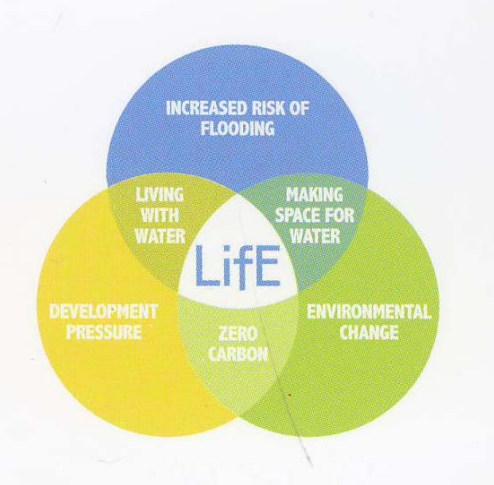
LifE (Long-term initiatives for flood-risk Environments) Project UK

In the UK the Defra created a Flood and Coastal Erosion Risk Management – Innovation Fund as part of its Making Space for Water programme. The fund has the following stated aim to "*to improve future flood and coastal erosion risk management, by promoting innovative approaches that contribute towards development of more holistic and sustainable policy making in the future*."[17]

Some of the concepts within LifE are similar to the themes already discussed such as the need for adaptability and acceptance of the dynamic nature of natural processes. In its handbook LifE states that it wishes to encourage development that will be adaptable to future flood risk changes by integrating three holistic approaches:

1. *Living with Water*. Acceptance that climate change is likely to increase flood frequency and severity and adapting our culture to accept and live with this.
2. *Making Space for Water*. Thus allowing natural processes to occur by providing space for water, whilst reducing our reliance on traditional defences.
3. *Zero Carbon.* The third approach to LifE is a move away from the methods discussed above and aims to integrate our need for defence with our need to create sustainable energy. For instance by taking advantage of the water to create tidal energy.

[17] The LifE Handbook (2009) "Long-term initiatives for Flood-risk Environments", Bracknall: HIS BRE Press



LifE (Long-term initiatives for flood-risk Environments) Project UK

The LifE handbook separates the river landscape into three zones, upper, middle and lower catchment, where the lower catchment is the coastal and estuarine habitats liable for flooding. As well as detailing information on how to identify flood sites, types of flooding and how climate change might effect a site it also offers advice on how sustainable design might be integrated into development proposals. Example case studies are also provided for each of the catchment areas.

Throughout the LifE handbook two key theme's reoccur which we have already seen previously in this paper: adaptability and integration. LifE should be of interest to Landscape Architects, because it advocates a holistic approach to design and is concerned with 'space' and quality of life, areas which are a Landscape Architects natural fit and area of concern.

In the lower catchment (an estuarine environment susceptible to tidal flooding) example, we see possibly the biggest shift from the long-standing policy of defence and keeping the sea out. Here whilst the guidance still advocates some traditional defences they are moved back from the river edge and integrated with a policy of making room for flood waters via wetland regeneration and the creation of tidal docks. Also any development plans are on the basis that the defences will be breached, therefore those buildings that are most vulnerable can be water compatible. Again these are all areas which should interest and provide opportunities for Landscape Architects.

In the example of Littlehampton (a lower catchment area) a regional strategy for the River Arun would be implemented based on the LifE principals. Lagoons and flood storage areas are created away from the town and land is given over for flooding between tides, this landscape has other benefits such as the creation of intertidal habitats, mud flats and grazing marsh. These sites in turn can be used for renewable energy sources and water based recreation and amenity facilities, which is another key theme for any future flood defence proposals i.e. integrated design to take account of multiple land use.

Explaining the project in TOPOS 68 *Water: Resource and Threat,* Robert Barker and Richard Coutts conclude that, "*with more pressure to deliver more homes to higher environmental standards, on less land, the need to create more integrated planning to maintain or improve standards becomes important. When combined with the need to adapt to the effects of climate change, the need for multi-functional land and buildings becomes*

essential. Making space for water, energy and play will become a central theme for new development and redevelopment throughput the 21st century."

As with other projects, such as coastal realignment in the UK and Room for the River in the Netherlands, cost analysis of the LifE projects suggest that they are cheaper than building and restoring traditional flood defences.

Rijn-mass delta towards Antwerp docks

We have seen above how Dutch sea defences and interventions in the landscape have had an effect on the Rijn-Maas-Schelde Delta and how following the 1953 flood the Delta Project led to major works within the region. As we moved into the twenty-first century the aim of the Delta plans had shifted to take account of nature and become adaptable to changing threats i.e. there is a need for coastal flood defence systems to be dynamic and adaptable.

This is also the case further downstream. The port of Antwerp on the River Schelde is the second largest in Europe and as the flood defences at the estuary need updating so do the flood defences up river. Once again though the solution centres on adaptability, the landscape office PROAP designed a scheme which integrated multiple land use (particularly of the actual defences), spatial quality, accessibility and adaptable flood defences such as floating pontoons. Key to the masterplan was that it was not a rigid solution and it allowed room for transformation and adaptation as time passes.

Innovations

Key to the new methods of flood defence in Europe at the moment are the ideas of allowing natural processes to operate, adaptability of developments to cope with future climate change and natural processes; and integration of design and spatial quality within any such developments.

Around the world there are, however, other innovations which have been proposed and implemented such as the Biotechnical Wave and Erosion Control Structures, created by MBK Engineers, Kjeldsen Biological Consulting and LSA Associates. These structures are built from renewable natural materials and have proved to be highly successful in reducing erosion on the Sacramento-San Joaquin River in San Francisco Bay. Furthermore they have been shown to have a positive effect on aquatic and riparian ecologies.[18]

Biotechnical Wave and Erosion Control Structures, image from *Living systems: Innovative Materials and Technologies for Landscape Architecture*

[18] Margolis, L., and Robinson, A., *Living systems: Innovative Materials and Technologies for Landscape Architecture,* Basel: Birkhauser Verlag AG

The famous Dutch landscape office West 8, along with Svasek Hydraulics, came up with an innovative proposal to help protect the coast of the Netherlands, called the Blue Isles Plan. This proposal hopes to solve the duel dilemma of land pressure and rising sea levels with an innovative design and feat of engineering. The proposal is to create sand islands, each up to 150,000 hectares in size, of the coast of Belgium and Holland. It is proposed that these islands, as well as being used for development, will help protect the existing coast from increasing wave size, but more importantly the gullies will be engineered in a way that ensure the sea level will drop during north-western storms.

West 8 Blue Isles project, image from http://west8.nl/projects/happy_isles/

The recent (summer 2011) edition of The Journal of the Landscape Institute detailed a concept from Kate Orff, a professor at Columbia University Graduate School of Architecture , about introducing an oyster farm in New York Harbour, which as well as providing oysters and cleaning water, would help protect the city from any storm surges.

Summary

Our natural resources are coming under ever greater pressure and climate change is enhancing the threat from water. As detailed above, however, our existing defences will not last forever. In some places the urgency for new defences is immediate, however we have learnt from the past that inflexible defences can have unintended consequences. Increasing population demands, the increased threat caused by climate change and the realisation about the importance of natural processes to the ecological system mean that the time is ripe for practical innovative flood alleviation plans to be implemented.

It seems beyond doubt that planning for floods has transformed over the past twenty years from building traditional sea defences and raising dikes to understanding that our landscapes, especially coastal ones are dynamic, and as such allowance has to be provided for natural processes to exist with as little hindrance as can be practically possible.

It is now widely accepted that responses can no longer be local, but must be region wide and, importantly, they must be adaptable. If responses remain local and inflexible the threat of flood will increase.

Governments will be required to harmonize strategic decisions and risk maps and appropriate land use planning will be required. Advisory bodies, such as the Environment Agency in the UK, will need the power to stop inappropriate developments. Both the government and the public will also need to be flexible to a variety of solutions. The UK has a wide variety of coastal types and as such an equally wide range of possible solutions, including, where appropriate, traditional sea defences.

Those developments at the forefront of flood alleviation proposals have placed importance on adaptability, integrated design, multiple land use, spatial quality and sustainability. These are all areas, coupled with our knowledge of the landscape, where Landscape Architects can and should come to the fore. As we move forward such responses could look further afield and out to sea, where the boundary between land and sea will become blurred.

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