REINVENTING THE DUTCH DELTA: COMPLEXITY AND CONFLICTS

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ABSTRACT

Delta areas have been extremely attractive for urbanisation and economic development throughout history because of the fertility of the land and the strategic position for shipping networks. Moreover, nowadays the most rapid processes of urbanization occur in delta-areas [46].Urbanized deltas can be considered as areas with a double complexity: they have to deal with the complexity of the delta, as the meeting point of rivers and sea, and with the complexity of urban patterns, as a condition and result of economic, cultural and social life. Since the 1990s, delta-areas are facing new challenges related to this double complexity. Climate-change, rising sea-level and increasing peak-discharges of rivers force planners to reconsider flood-defence strategies. At the same time, globalisation and neo-liberalism created new conditions for urbanization processes. The vulnerable position of urbanized deltas has become clear with the disastrous effects of hurricane Katrina in the Mississippi-delta in 2005. In search of sustainable strategies, authorities and planners of different delta-areas are looking to the Netherlands as a benchmark, which seemed to deal with the double complexity in a successful and sustainable way. However, instead of considering the Netherlands as an example which can be copied in other urbanized deltas, it is important to understand the Dutch delta as a result of two specific conditions: first, the specific condition of the natural dynamics of the delta itself, and second, the coincidence of the Dutch delta with the territory of the Dutch nation-state. Moreover, fundamental discussions and reconsiderations are taking place concerning future policies and strategies for flood-defence, water-management and urban development in the Netherlands. Instead of the adage 'fighting against the water', a new adage 'working with nature' is arising. This change is not only important for future safety and urban development in the Netherlands itself, but might be relevant for other urbanized deltas as well.

KEY-WORDS hydraulic engineering, urban design, land of cities, nation-state, metropolitan water-landscapes, cross-disciplinary approach

THE NATURAL FORM OF THE DELTA

A delta can be defined as the area where two different systems - river and sea - both with important influences on the morphology of the land, meet and influence each other. Processes of sedimentation, alluvium deposits and land-loss are contingent upon which system, the river or the sea, dominates. The Dutch delta is a sea-dominated delta, as a result of the meeting of a number of relatively small and medium-size rivers (Rhine, Meuse and Scheldt) and a coastal area with strong tidal currents and tidal differences, as well as formidable south-west winds and ocean currents. The importance of these special conditions is clear when we compare the Dutch delta with a river-dominated delta like the Mississippi-delta, which has a very different topography.

In many respects, the Mississippi river represents a multiple of the river Rhine: in length, depth discharges, etcetera. However, the most astonishing contrast between these two rivers concerns sediment-transport: the Mississippi carries 400 times more sediment than the Rhine and deposits, each year, roughly 170 million tons of sediment in the Gulf of Mexico.

Length	6,275 km	1,320 km
Depth - average	New Orleans: 60 m	Arnhem: 8 m
Discharge - average	16,000 m3/sec	2000 (summer) m3/sec
Discharge – extreme	48,000 m3/sec	12,000 m3/sec
Sediment transport	170 million ton/yr	0.4 million ton/yr
	Mississippi	**Rhine**

Figure 1 - Comparison data Mississippi and Rhine

(Sources: Thorne e.o. 2001; Walker 1994; Rijkswaterstaat 2005)

The result of this sediment-transport makes the Mississippi delta different from the Dutch delta. Because strong tides and currents are mostly absent in the Mississippi delta, sediments descend immediately to the bottom of the sea next to the river-mouth, forming large wetlands. This sedimentation-process creates a protective buffer against storm surge caused by hurricanes and coastal storms. However, channelling and dredging the Mississippi to improve navigation caused the sediments to be dumped further into the Gulf of Mexico, depriving the wetlands of material for dynamic replenishment and for new wetland creation. Undeniably, wetlands have thus been disappearing from the Gulf Coast at an alarming rate. Wetland loss has increased the vulnerability of New Orleans to

hurricane driven storm-surge. This process has worsened by the subsidence of the sea-bottom because of the extraction of gas and oil in the Gulf of Mexico [22]

The situation of the Rhine, Meuse and Scheldt delta is quite different. These rivers carry much less sediment, while the strong influence of tidal differences and sea currents produce another type of delta. Once arriving at the mouths of the Dutch delta, sediments are transported by tide and currents in a North-east direction, yielding a strong coastline of sandy beaches and dunes. Instead of the meandering coastline of Louisiana wetlands, the Dutch coastline is a continuous barrier, interrupted by two large river estuaries. These large inlets were created during a series of heavy storms and floods during the 14th and 15th centuries.

Behind the natural coastal barrier and between the two estuaries, natural processes created a territory of peat with ridges of clay and sand. This terrain offered a relatively safe, calm condition for human settlement [41].

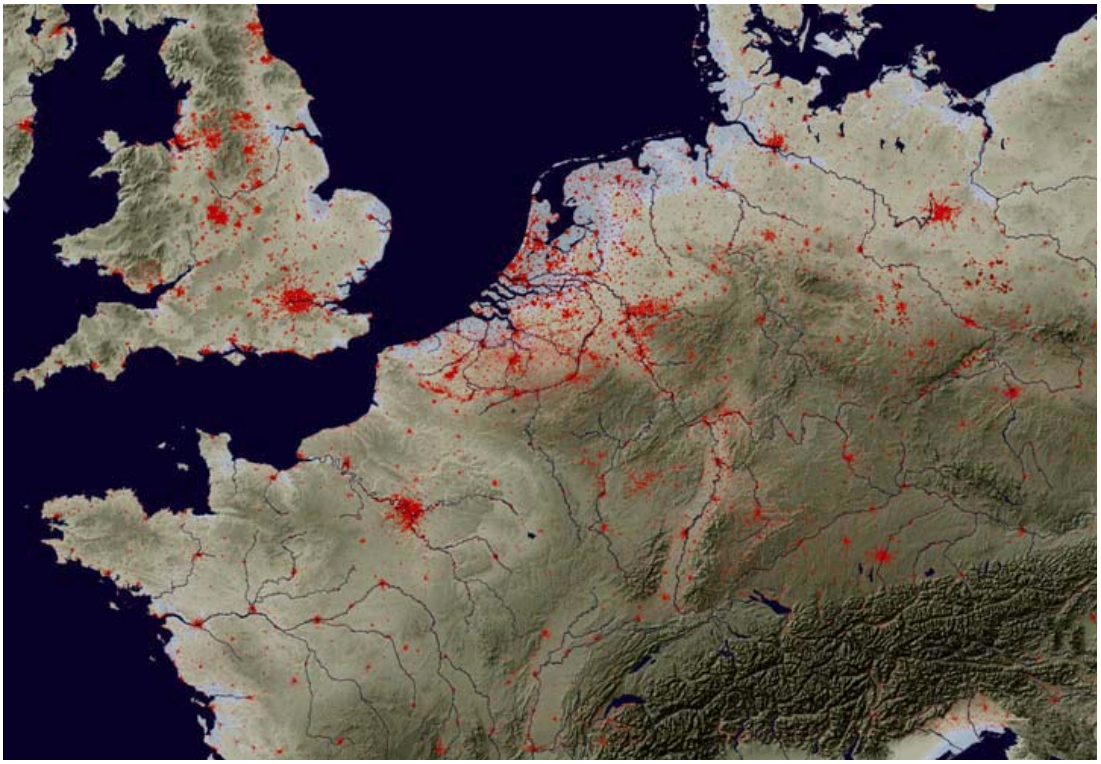


Figure 2 - urban patterns, rivers, coastlines and deltas in Northwest Europe

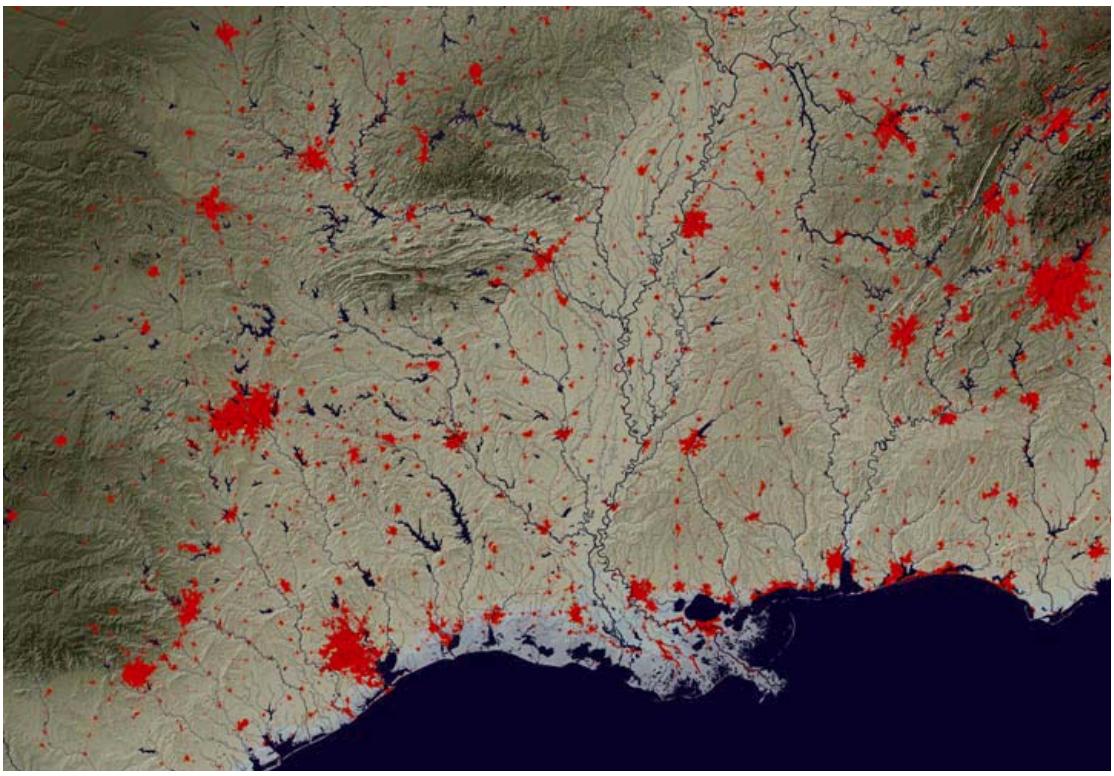


Figure 3 - urban patterns, rivers and coastline in the Mississippi delta-area (drawings by Nijhuis and Pouderoijen, U-Lab TU-Delft)

URBANIZATION: FIGHTING FOR THE CONTROL OF DIKES AND DAMS

Through history, in a watery region as the Dutch lowlands the question of water-management and flood-defence is related immediately with the question of the relation between the urban and rural communities. The coastal barrier of beach- and dune-ridges offered a *relative* safe but quite uncomfortable condition for human settlement. Agriculture and urbanization in the wet peat-lands was only possible after draining the land.

The first system of urban settlements, during the Roman period, was a series of fortified settlements along the rivers Meuse and Rhine, like Maastricht and Nijmegen. The river was important as defence-line (the Rhine was the border of the Roman Empire) and as transportation-infrastructure; the settlements were situated on natural heights and safe for floods. Also the first Dutch trade-cities, linked to the international 'Hanze-league' in the 12th until the 15th century, were mainly situated on high grounds along the banks of the rivers. These cities made use of the natural condition of 'safe havens' in the mostly swampy and vulnerable lowlands [31].

The start of the technology of drainage and dike-construction created new possibilities for urban expansion but was also a source of conflicts between rural and urban communities [41]. The two most important reasons of conflicts were the construction of the dike and the control of the water level. Water-boards (often dominated by landlords and farmers) regarded building upon the dike as a danger for the strength and maintenance of the dike. Urban communities regarded the dike as an attractive high and dry place for building and traffic. In areas dominated by powerful water-boards (especially in the south-western delta), a typology of 'front-street-towns' can be found, with the front-street perpendicular to the dike. In the more densely urbanized area of the county of Holland, urban communities were more powerful and could force the possibility of building on the dike.

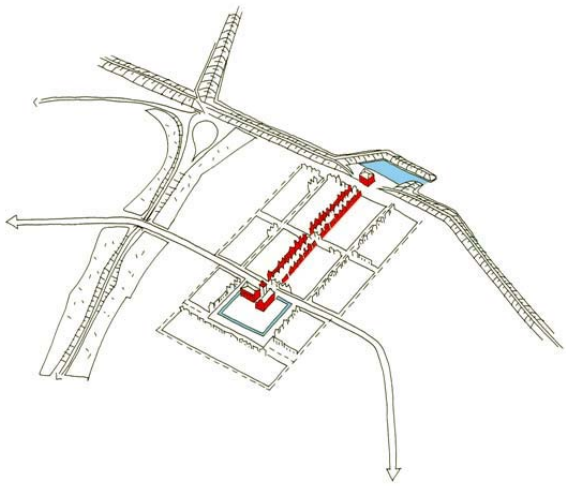


Figure 4 – Colijnsplaat, front-street town in the Province Zeeland: the Front-street perpendicular to the dike

Figure 5 – Dordrecht: the dike is the main-street

A second phenomenon, which was the source of many conflicts between cities and the rural environments, concerns the control of the water level in the hinterland. An essential key in this control was the *dam.* A dam is a closure in the mouth of a creek or small river and a central strategic element in a dike, which protects the hinterland against flooding. A lock in the dam made it possible to manipulate the water level of the hinterland and to inundate the hinterland. Manipulation of the water level was important to spout the mouth of the creek and to clean the urban water system; inundation of the hinterland was important in times of war.

However, changing water levels and inundations were very uncomfortable for the rural community and for the agricultural economy. As a result, the control of the dam was a source of many conflicts between urban and rural communities. To protect the dam against sabotage by farmers, city-authorities built their town halls (with police-department) upon or next to the dam [42, 47].

THE RISE OF CIVIL ENGINEERING: A FUSION BETWEEN URBAN DESIGN AND HYDRAULIC ENGINEERING

When a city succeeded to reach the victory in the struggle on the use and construction of dikes and dams, these artefacts became important expressions of civic pride and urban autonomy. During the 17th century, in many cities the local public works concerning hydraulic engineering were developed as the most monumental, representative public works of the city [8, 17]. Sea-front cities like Vlissingen, Hoorn, Enkhuizen combined their flood-defence-systems with military defence-systems and with a representative expression. Seen from the river or the sea the view on the city offered impressive panoramas, recorded by many painters for the benefit of the interiors of the patrician mansions [21]. But the most monumental and significant element of the city was the dam, combining the functions of central instrument of regulating water-levels and currents, transhipment of cargo and exposure of independence and self-governance of the city. The extreme example is the city of Amsterdam [37].

The 17th century showed the rise of a discipline, which was called *civil engineering,* to be distinguished from military engineering. This civil engineering was a combination of what we use to call hydraulic engineering and urban design in present time. The elements of hydraulic engineering - canals, quays, dikes, dams, sluices - were in the same time the main framework of the urban fabric. The quays and dikes were the most important urban streets; the dam was the main-square and the core of the Dutch water-city. City, port and water-management-infrastructure were interwoven completely. It is this special tradition

of constructing cities which resulted into the finest masterpieces of urban design, praised by authors as Rassmussen [28], Burke [8], Mumford [26], Bacon (1967), Castex et al. [10] etc. The 'civil engineer' played an important role in the construction of these cities. The most well known of them was Simon Stevin, advisor of the Prince of Orange and designer of many fortifications and hydraulic constructions and writer of several theoretical considerations on city building and on politics [36, 15].

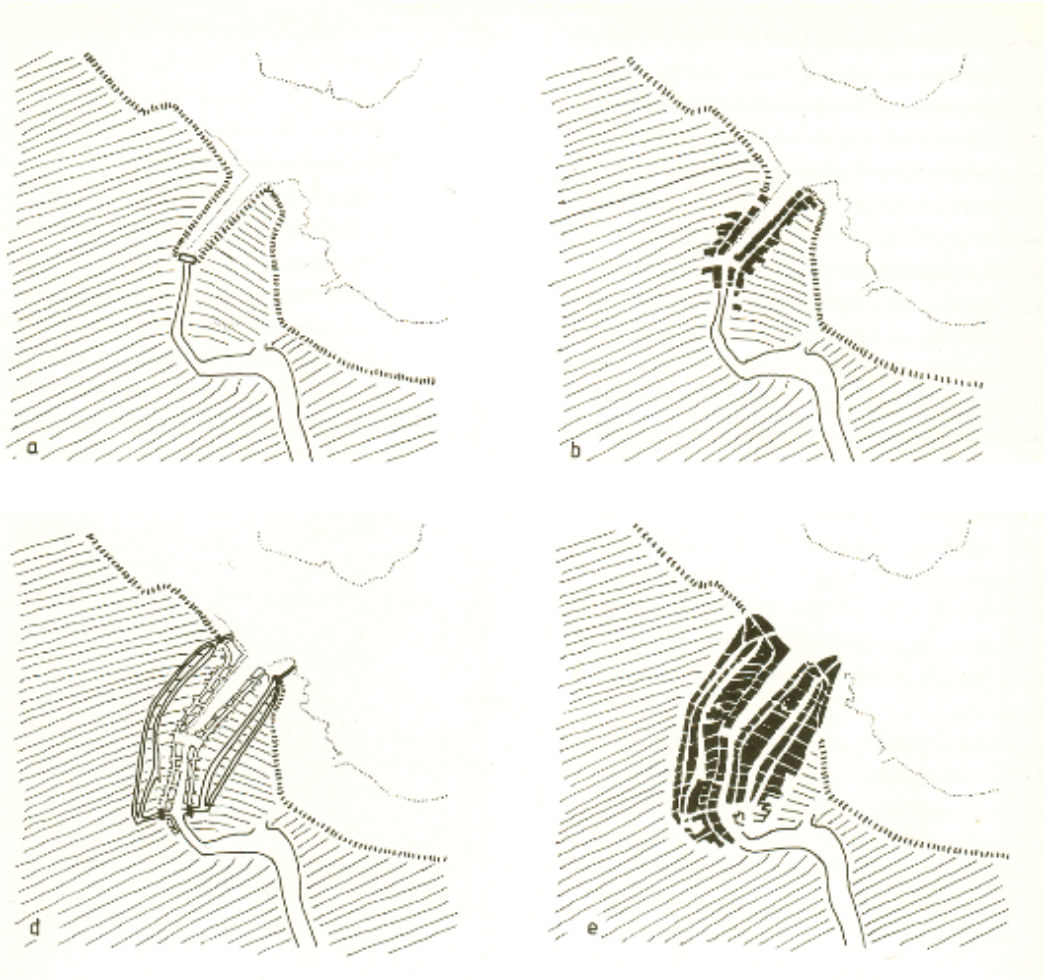


Figure 6 – Development of Amsterdam around the dam in the Amstel river: from 13th century (a) until 16th century (e)

A Land Of Cities: Four Urban Systems

The development of hydraulic technology created the condition for a change in the emphasis of the urbanization-patterns: from the banks along the rivers towards the areas surrounding the two big estuaries of the Dutch Lowlands - the Rhine-Scheldt-estuary and the Zuider Zee. Both estuaries where extremely difficult but also extremely attractive for

urbanization: difficult because of the swampy condition of the territory and the danger for flooding; attractive because the neighbourhood of rich fishing grounds and the propitious conditions for port-development, trade and commerce. Around both estuaries two urban systems developed, considering the estuary as the most favourable situation which offered an open connection to the sea and a relative protection against the direct influence of storms and high tides. Originally, the Rhine-Scheldt-estuary seemed to have the best credits for urbanization: In the 14th century Dordrecht and Antwerp were rich and powerful cities; during the 16th century Antwerp became the most important port-city of Europe, surpassing the Mediterranean port-cities [7]. The war between the Dutch Provinces and the Spanish (Hapsburg) King, with the occupation of Antwerp by the Spanish army late 16th century, created the condition for a downward economy of Antwerp and an increase of trade and commerce in the independent Northern provinces. The settlements at the northern part of the Rhine-Scheldt estuary and on the banks of the Zuider Zee increased very fast in size, economic activity and population: Middelburg, Vlissingen, Veere, Rotterdam, Goedereede, in and around the Rhine-Scheldt estuary, and Amsterdam, Hoorn, Enkhuizen, Harlingen and other cities around the Zuider Zee.

The propitious conditions of the estuaries for urbanization resulted not only in an explosion of urban expansions of existing towns and cities, but also in a boom of new towns, initiated by land-owners. From the 14th until the 19th century the Dutch lowlands were characterized by these two powerful urban systems in and around the estuaries, which overruled the previous system of urban settlements in the river-area. A fourth range of urban settlements could be found near the coast, just behind the dunes: cities like The Hague and Haarlem were considered as attractive residential places because of their dry and safe position. The area between these urban systems (during the 20th century discovered as a ‘Green Heart’) was mainly suitable for agriculture and shows a modest urbanization-process of villages and small towns.

All together, this process of urbanization with the four urban systems, resulted in the situation that the Dutch Republic was the most urbanized area in the world during the 17th century, with more than 60% of the population living in cities of more than 5000 inhabitants [42, 47].

Figure 7 – The Netherlands, four urban systems, ca. 1600: (1) River-cities; (2) cities around the Rhine-Scheldt estuary, (3) cities around the Zuider Zee estuary, (4) cities along the dune-coast.

THE RISE OF THE NATION-STATE: A FUSION BETWEEN NATIONAL SPATIAL PLANNING AND HYDRAULIC ENGINEERING

Towards A National Hydraulic Concept: Closing the Estuaries

From the mid-nineteenth century, new conditions created new possibilities for the approach of questions concerning economic and urban development and water-management. With the new technical conditions such as the introduction of steam-energy, and later electricity and gas, hydraulic works with an unprecedented scale became possible; with the forming of the nation-state, a coordinated and uniform policy at a national scale became possible. The foundation of the National Agency for Water-management (*Rijkswaterstaat)* in 1798 was a forerunner of this development [6]. The establishment of the national constitution in 1848 created conditions to extend the involvement of the national state in large scale infrastructure projects [47].

The rise of new industries in Europe essentially changed the economic position of the Dutch urbanized lowlands. The policy of the Dutch state became dominated by the

ambition to change the rather loose collection of more or less independent cities, into a strong and safe system which should be able to fulfil a central role in the transport of bulk and cargo among the new industrial centres of Europe and the world. Strengthening the economic position of the Netherlands and diminishing the risk of flooding of the most important economic areas went hand in hand: a large series of floods in the 19th century – as well in the two estuaries as in the river-area - was considered as a dangerous threat of the economic policy of the young nation-state. Constructing efficient shipping-routes and constructing flood-defences were the two main elements of this policy, which resulted into the construction of a nation-wide infrastructure of shipping-routes and flood-defences, together with railways, telecommunication-networks and roads [47]. New efficient navigation-routes were important because the entrances of the nation's largest ports, Amsterdam and Rotterdam, became critical. The navigation-routes through the swallow estuaries of Zuider Zee and Rhine-Scheldt-delta were not suitable anymore for the size of the modern steamships. The construction of two deep canals, which connected the ports of Amsterdam and Rotterdam immediately to the sea, created new perspectives.

At the same time, the quality of the rivers as main navigation arteries was improved by channelling, straightening, dredging and dike-construction. Heightening the dikes and narrowing the channel became a policy which provided deeper water for navigation as well as better protection against flooding of the polders.

By constructing the new canals between the large ports and the sea, the estuaries lost their function as entrances to these ports. However, they did not lose their danger for flooding. Studies and proposals for closing the estuaries with dams and dikes had been made already in the 17th century, but with the new technology and the new shipping-routes of the 19th century realization of this idea became within reach. For the smaller ports and fishing communities around the estuaries the plans for closing the estuaries were disastrous [35]. They succeeded to postpone the implementation of the closing of the Zuider Zee for more than 50 years. In the south-west delta their opposition would result into a radical change of the storm-barrier concept of the East-Scheldt.

Figure 8 : Randstad Holland 2000; dammed estuaries and direct connections of the large ports of Rotterdam and Amsterdam to the sea

Delft as the Centre of Civil Engineering

Because of the new scale and dimensions of the engineering projects, the Netherlands needed a centre for education and research in this field. In 1842 the 'Royal Academy for Civil Engineering' was founded. The Academy developed into the first polytechnic university and the national centre for scientific education and research concerning hydraulic engineering, architecture and urbanism, as well concerning many other fields of technology.

The New Polders: Test-Case for Comprehensive Spatial Planning

Besides safety, also other arguments became important and resulted in the final decision to close the estuaries, such as the argument of the necessity of an independent agricultural economy. The strive for an independent production of sufficient food for the nation became an official policy after serious famine during the first world-war and created the necessity of an increase of the amount of fruitful and efficiently parcelled agricultural land. The existing agricultural land was considered as too fragmented, based upon

parcelling-systems from the 17th century, not suitable for efficient, modern agricultural production. Modernizing and rationalizing agriculture by re-parcelling all agricultural land in the country became a primary goal of the national government, represented by Sicco Mansholt, minister of agriculture in the 1950s [2]. Mansholt exported this idea of modernizing agriculture to the European community during his European commissioner-ship for agricultural affaires in the 1960s.

With this national ambition concerning agriculture, the Zuider Zee-works offered an enormous chance for modernization. By damming the Zuider Zee with the *Afsluitdijk* (Closing dike) and reclaiming a large part of this sea during the 20th century, the agricultural land of the Netherlands would extend with 1650 km2 (4 % of the land-surface of the country). Zuider Zee was renamed in *IJsselmeer* (IJssel Lake). The new IJsselmeer-polders became the prestigious and exemplary model of modern agriculture, showing a new type of efficiently parcelled agricultural land, provided with a carefully planned and designed system of new towns and villages [43]. Combined with a policy regarding selection of the population, the new polders became also a model of spatial planning as the central discipline which integrates agricultural and economic policy, town planning and urban design, hydraulic engineering, and demographic and social strategies. The polders became a testing-model for a comprehensive spatial planning approach, which would be, applied for the nation as a whole some years later [5, 2].

After a disastrous flood in the Southwest of the Netherlands in 1953, the government decided to close the Rhine-Scheldt estuary too. The prestigious project '*Delta-works*' supplied the closing of all sea-gates of the estuary with dikes - except the Scheldt river, providing the entrance to the port of Antwerp. In addition, these Delta-works produced not only an improvement of the safety, but also an improvement of agricultural conditions for the south-west of the Netherlands. By moving the primary flood-defence westbound, the fresh-salt-water-balance moved also to the west, resulting into a higher productivity of the surrounding agricultural land.

Moreover, Afsluitdijk and Delta-works provided also new highways on the top of the new dikes and dams, resulting into better connections and an integration of the north-east and the south-west parts of the Netherlands in a comprehensive road-network. Also the construction of a new navigation-canal between Rotterdam and Antwerp, independent from tidal influences, became possible because of the delta-works.

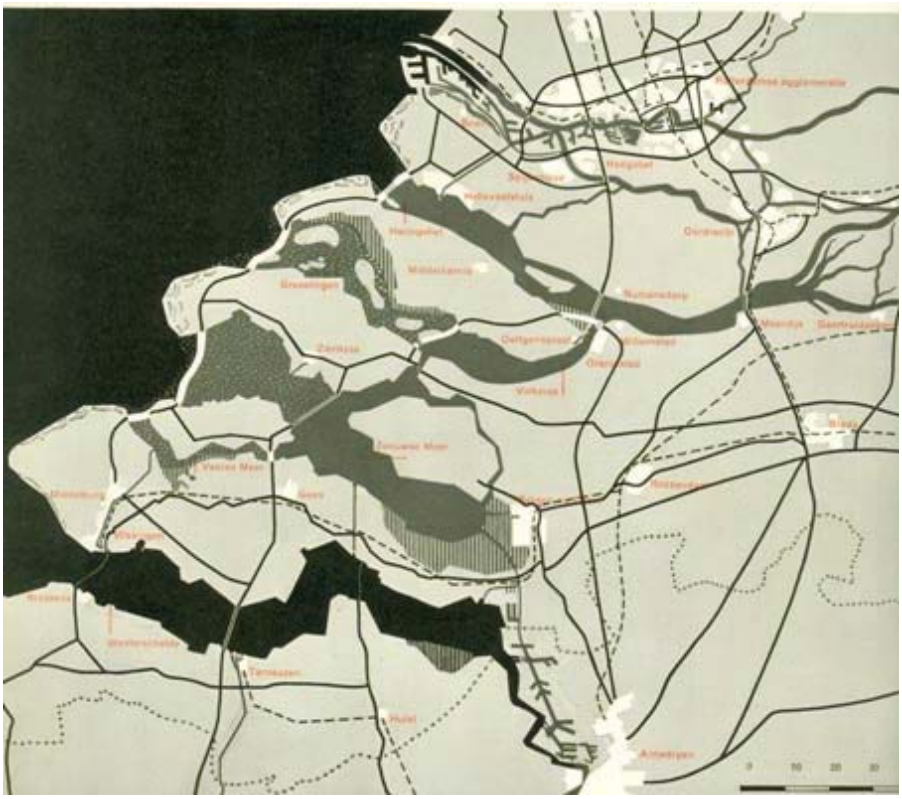


Figure 9 - Southwest delta with Delta-works. Plan 1962

It was especially this combination of goals which provided the arguments and political consensus concerning the need of construction of these large scale infrastructures: this combination of improvement of the flood-defence, enlarging agricultural land, a comprehensive national road-network and the aim to equalize industrial activities provided the arguments for the enormous expenses of public money. The construction of the Afsluitdijk combined with the reclamation of the new polders was calculated originally at 200 million Dutch guilders, which was the amount of the total governmental yearly budget in 1920. The expectations on the long term (no need for dike-heightening along the original Zuider Zee coastline, high agricultural productivity) were promising a final positive balance.

The Delta-works were estimated originally (1956) at 1.5 – 2 billion Dutch guilders (680 – 900 million Euro), but the final expenses were more than 10 billion guilders (4.5 billion Euro). All these costs were paid with public money. Altogether, the flood-defence-policy resulted in a chance of flooding of the western part of the Netherlands (roughly the area of the Randstad) once in 10.000 years. As most important area of the Netherlands in

terms of population and economic dynamics, the consequences of a flood would be disastrous: the damage would amount to 300 billion euro, and 4, 5 million people would be in serious danger [16]. This results in what has been called the flood-paradox: never before the chance was so low, but in the same time never before the risk[i] was so high.

A National Urban Concept: The Randstad

The physical change of the Netherlands, with the damming of both estuaries, the construction of new canals between the main-ports and the sea, and the construction of railroad- and (later) highway-systems, resulted in a dramatic change of the reality of the urban systems of the Netherlands. The importance of the urban systems around and in the estuaries decreased drastically; only the largest cities Amsterdam and Rotterdam succeeded to maintain and extend their position – thanks to the new canals. The railroad- and highway-networks created stronger connections with the cities at the dune-coast (The Hague, Haarlem) and at the east (Utrecht). Thus, a new reality was arising, the reality of a system which obtained the name '*Randstad*'. Finally, the two airports near Amsterdam and Rotterdam emphasized the central position of the Randstad.

During the second half of the 20th century, the national government developed a spatial planning policy which included a policy concerning urban growth, demographic development, industrialization, port- and shipping-economy, agricultural economy, and water-management. The Randstad was considered as the economic engine of the nation, but the growing together of the cities of the Randstad into one large metropolis was considered as a danger for social harmony. Controlling the size and development of the cities of the Randstad, and creating a balance in demographic and economic development between the Randstad and other parts of the country, were important goals of national policy during the 1950s and 1960s [9]. The new infrastructure of dams and dikes combined with roads created the condition for the development of new industrial centres in the previously marginalized regions, and resulted in a new balance between centre and periphery.

Celebrating the Nation

Emphasizing the struggle against the sea as a *national* struggle should be considered in the framework of a series of disastrous happenings for the Dutch state: not only the economic crisis of the 1930s and the occupation by the Germans in 1940-1945, but also and especially the loss of the large colonial archipelago Dutch-India (Indonesia, 1949), which meant the end of the Netherlands as a colonial empire. The big flood of 1953

delivered the main stimulus to start a new national project. Thus, the construction of a national hydraulic infrastructure had not only a meaning concerning safety, port- and shipping-economy, agriculture, but especially contributed to the creation of an idea of national coherence, expressed in a holistic spatial planning policy. The physical character of the delta, as an archipelago of islands, peninsulas, wetlands, cut by rivers and estuaries, originally created a condition for emphasizing the autonomy of the cities and regions and not for a broadly supported national identity. With the transformation of this fragmented territory into one interlinked system, the physical structures of this system became the symbols of a new national identity.

This symbolic function of the Afsluitdijk and Delta-works, as the monuments of the Dutch nation, was emphasized and cultivated with large sculptural buildings, designed by famous Dutch architects as Dudok (monument Afsluitdijk) and Quist (Haringvlietdam).

Figure 10: Afsluitdijk with monument

Figure 11 2nd Memorandum on Spatial Planning, 1966

Two publications can be considered as the monuments of the melting of spatial planning and hydraulic engineering at the national scale: the book Dredge, *Drain, Reclaim- the Art of a Nation* by Joh. van Veen[40], Chief Engineer of Rijkswaterstaat and the genius behind the 20th century national hydraulic works, and the government's *Second Memorandum on Spatial Planning*. Van Veen's book shows the optimistic approach of the transformation of the Netherlands from fragmented hotchpotch into one coherent territory, by giant damming- and reclaiming-projects. He claimed also the necessity of reclaiming all the water-areas of the Rhine-Scheldt estuary and the Waddenzee, north of the Afsluitdijk. These proposals were not realized finally, but the sum of realized projects was more than enough to underline the ideas of Van Veen.

The Second Memorandum on Spatial Planning shows the optimistic ambition to combine urban, demographic, economic, industrial, agricultural, traffic and hydraulic plans in one comprehensive plan. The goals of rationalizing and modernizing the economy, agriculture, transport, and flood-defence were combined with goals of rationalizing the

society and creating ideal urban communities. The Memorandum was the spatial expression of the idea of the *welfare state*. The Memorandum shows the planned situation for the Netherlands in the year 2000, with an expected population of 20 million inhabitants in a territory of about 40.000 km2. This was considered as the definitive shape and content of the nation.

Disappearance of Water from the Cityscape; Separation of Urban Design and Hydraulic Engineering

The rise of the emphasis on hydraulic engineering at the national scale was accompanied by the disappearance of the 'old' civil engineering, characterized by a fusion between hydraulic engineering and urban design at the scale of the city. Water and water-management was not anymore a central matter in the cities, at least it was not treated that way by hydraulic engineers or by urbanists. From the end of the 19th century, it was not necessary anymore to interweave the water systems in the urban network, because of the vanishing function of water as traffic and transport system. The introduction of steam, electricity and oil meant also that railroad and road networks overtook the role of water-networks. Drainage could be arranged with underground networks of pipes. In Dutch water-oriented cities, a big part of the urban water-networks has been filled up from the end of the 19th century.

Flood-defences were not regarded anymore as a matter of concern of individual cities. The national agency Rijkswaterstaat had taken over the main responsibility for this infrastructure. A possible contribution of the new dikes to an urban civic space was not a matter of concern anymore. Two examples, the reconstruction of the city-centre of Rotterdam after the Second World War, and the building of the new town Lelystad in the IJsselmeerpolders, show the attempts of local urban planners to integrate the new dikes in the urban pattern of the city. However, the increased autonomy of the Rijkswaterstaat-agency frustrated these goals by maintaining its own standards of dike-construction [14, 24]. In the public debate the new dikes along the waterfronts of these cities were not considered as welcome contributions to the safety of the city, but mainly as a fence, which robbed the city of the view on the open water [20].

AFTER THE WELFARE STATE: CONFUSION AND RECONSIDERATIONS

Bursts In the Trust in Modernity

While in the previous decades national independency was based upon a strong belief in a rationalized and holistic organization of agriculture and industry, efficient production-land, efficient road-systems, modern town-planning and hydraulic engineering were interwoven, all these elements became subject of doubt, resistance and reconsidering. The last three decades of the 20th century show a transition to another reality, a farewell to industrialization, agricultural independency, rationalized town-planning, national hydraulic engineering, and a reform of the welfare state.

Several new trends undermined the existing consensus and paradigms of urban planning and hydraulic engineering as a nucleus of societal and spatial coherence. These trends are based upon (1) economic motives, (2) ecological motives and cultural motives, (3) political and financial motives, and (4) spatial development motives. Finally yet importantly, the climate-change has become a fifth motive since the late 1990s, forcing drastic changes in the policies concerning spatial planning and hydraulic engineering.

Economic Motives

While the 20th century often has been described as the century of industrialization and agricultural rationalization, the emphasis of governmental policy on these items did not take longer than two decades: from 1950 to 1970. The 1970s show the start of the end of the industrial era with the closure of many ship-yards, textile-industries, followed by the closure of the national car- and aircraft-industries. Also the policy of agricultural autonomy disappeared from the national political agenda during the 1970s. It was the Dutch state itself which was one of the main initiators of a new European agricultural policy, which aimed to create a more efficient agricultural production at the European scale and to stop the protective policies of the individual states [2, 27].

The powerful and solid coalition of industrial economy, agriculture, hydraulic engineering and spatial planning of the previous decades melted into air. Since the 1970s, economic governmental policy has been meandering between emphasis on services, transport and distribution, and finally on knowledge and creativity. This political meandering did not produce a new clear idea and a national consensus about a new relationship between economy, spatial planning and hydraulic engineering. Meanwhile, it becomes more and more clear that economic life has become a cross-national reality. Considering the southwest delta, a comprehensive cross-national policy concerning seaport-development is increasingly regarded as necessary. Officially the ports of Rotterdam and Antwerp are two competing port-clusters. But the economic reality is that

these ports, together with a number of smaller ports in the delta-area (Vlissingen, Terneuzen, Gent, Dordrecht), are operating as one large port-cluster. Port-companies settled in Rotterdam have also terminals in Antwerp, and vice versa. Both ports and the smaller ports are connected which each other by navigation canals, pipelines, roads and railroads. Together they are the largest and most important port-cluster of Europe [45]. Considering the common economic interest, and considering the common interest of the Netherlands and Belgium regarding flood-defence and improving environmental qualities, a common, cross-national approach for the South-west delta is inevitable.

Ecological and Cultural Motives

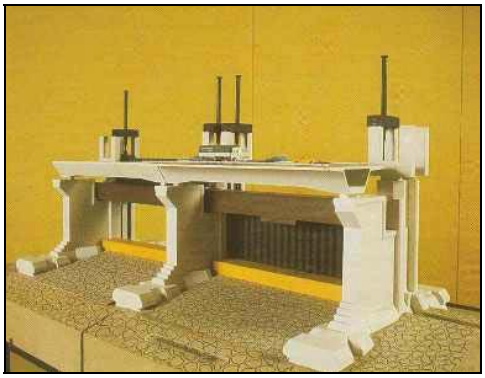
From the 1980s, an increasing concern with the ecological and cultural consequences of the modern approach in hydraulic engineering (canalizing the rivers, sharpening the edge between sea and land, etc) resulted in new experiments regarding the defence against sea-floods and the treatment of the river-area. Also cultural motives played a role in an increasing resistance against modernizing flood-defence-systems. Ecological and cultural motives often were interwoven and supported each other.

In 1970, the National Agency for Water-management (Rijkswaterstaat) employed the first ecological and bioenvironmental experts [33]. They were commissioned to look after the ecological quality of the Rhine-Scheldt-estuary after the construction of the Delta-works. Their first observations were alarming. They found a dramatic change of the water-quality in the estuary. The essence of the estuary is its character as a transition-zone between fresh (river-) water and salt (sea) water. Before the construction of the Delta-works, the daily tidal change produced wetland-zones alongside the borders of the islands, which were a condition for complex ecological systems. Also the Rhine-Scheldt estuary functioned as an incubator of many fishes, shellfish and seaweed, etc., and was one of the important incubators of North-sea and Atlantic Ocean. The transformation of these bays into dead fresh water lakes had disastrous effects on this ecological complexity. Repair of the estuary is considered as important not only for the delta itself, but also for the survival of many fishes and plants in the seas [33]. The East Scheldt was also a main incubator for shellfish and lobsters and an important condition for local fishing-industries. Damming the East Scheldt in the traditional way would kill all flora and fauna as well as the linked industries.

The argument for maintaining the open Oosterschelde was advocated especially by the increasing environmental movement, which found the fishers, dependent from the production of oysters, mussels and lobster, at its side. The debates, actions, negotiations

and quarrels between Rijkswaterstaat and the coalition of environmental movement and fishers took more than ten years [34]. The final result was the invention of a new type of construction of the final element of the Delta-works. The flood-barrier in the East Scheldt, opened in 1984, showed a new type of flexible barrier between sea and estuary, with the aim to maintain the special ecological balance of this part of the estuary. Besides a revolutionary innovative concept, the East Scheldt dam was also an extremely expensive construction. The final costs of the dam, 3.6 billion euro, were a multiple of the originally calculated budget and amounted to 80% of the total costs of the Delta-works.

Figure 12: East-Scheldt Dam



Model showing the principle of doors which can be closed during storm surges.

However, the most drastic example of the new domination of ecological and environmental motives was the cancelling of the final large project of the IJsselmeer-reclamations, the *Markerwaard*. Although the construction of the surrounding dike of the Markerwaard was completed in 1975, the draining of the Markerwaard was blocked by strong resistance of environmental action groups, emphasising the ecological value of this part of the IJsselmeer. The Markerwaard-story is the clearest example of the turn in the approach concerning spatial planning and hydraulic engineering: the process of extending the territory with hydraulic works stopped abruptly, and changed into a process of returning to a situation of more water and less land.

In addition, the river-area was subject of debates. Plans of Rijkswaterstaat to heighten the river-dikes in the 1980s met serious resistance because of an increasing concern of the public with the cultural and historic values of the river-landscape. These pleas for maintaining the cultural-historic character of the landscape were mixed with pleas to maintain and repair the former environmental quality of the rivers [4]. In 1986 a design-competition concerning a new lay-out for the river-area near the city of Arnhem resulted in the first price winning design '*Plan Ooievaar*' ('Plan Stork'), which aimed a repair of

retention-areas and wetlands, resulting into a come-back of the ecological balance of the river area before the canalizing. It was the start for a series of 'de-polder'-projects in the river- and delta-area in the next decades, with the aim to create new wetlands, which provide more space for river-water as well as a repair of environmental qualities.

In addition, ecological policy has increasingly international dimensions. The future of the Dutch delta has become strongly dependent from international agreements and collaborations. In order to improve the quality of the seriously polluted rivers, the Dutch government started negotiations in the 1970s with Germany, France and Belgium to stop the voiding of effluents by industries in the rivers. The national governments agreed to strive for a restoration of the natural character of the rivers, including the reopening of the estuary of the Dutch southwest delta.

These negotiations resulted into serious improvements of the quality of the water in the Dutch rivers. Nevertheless, the reopening of the estuary of the southwest delta is still on the agenda of the Dutch [33, 1].

The Rise of Landscape Architecture and Bioenvironmental Sciences

The increasing attention for environmental qualities of estuaries and rivers, and for the qualities of the landscapes, was adopted especially by Wageningen University. This university was founded as an Agricultural University after the World War II, as a scientific support of the agricultural policy of the Netherlands. When the attention of the state on agriculture disappeared to the background, the university developed a new 'raison d'être' in a smart way, by focusing on 'life sciences' and incorporating the large research institution Alterra, specialized in environmental and bio-environmental research. Stimulated by the societal pressure to develop new concepts for water-management and flood-defence-management, Wageningen University succeeded to play a main-role in the debate on these issues. Landscape architecture and landscape architects from Wageningen University succeeded to get important positions and influence 'between politics and science' [19].

Changing Spatial Development Motives

During the last two decades the policy concerning spatial planning has changed substantially, because of several reasons:

First, the main-streams in politics tend to a radical reform of the welfare state, like in many other western countries. The embracement of neo-liberal concepts resulted into an abolishment of the central position of the national government in spatial policy. Prepared

during the nineties, and formalized during the first years of the 21st century with the 'Nota Ruimte' ('Memorandum on Space'), the national government has moved many responsibilities to the municipal and provincial authorities, and stimulates the role of the market in spatial development.

Second, a general awareness of importance of the scale of the *region* has increased. To be able to develop a coherent policy concerning economic development, demographic development, culture, infrastructure, and urban planning, it has become clear that the scale of the region is more appropriate than just the local or the national scale. Especially the metropolitan regions of Amsterdam - Haarlem - Almere and Rotterdam – The Hague are recognized as spatial entities, which need a coherent planning. However, the big problem is that there is not a self-evident authority and 'owner' of this regional scale. While the national government has thrown its responsibilities in spatial planning over the fence, there are no clear institutions to pick up these responsibilities [24].

The most essential exponent of the disappearance of a consensus regarding spatial planning is the eroding of the Randstad concept. Since the 1990s the individual cities are more involved in a new competition with each other (in which Amsterdam is more and more a winner) than tending to become a coherent metropolis [30]. The big cities started to define their own interpretation concerning the question which regional context is relevant and which position the city should develop in this regional context.

In 2008 the national government published the report 'Randstad 2040', which is a new attempt to integrate the local and regional initiatives in a comprehensive strategy for the Randstad as a whole, in order to regain a top-position in the ranking of European metropolitan regions. The building of 500.000 residential units, of which 40% in the existing cities, and the upgrading of the landscapes between the cities to 'metropolitan parks' are the two fundaments of this new policy. In this context, the rediscovery of the potential meaning of urban water-landscapes is discovered as an important issue.

The new attention to urban waterscapes originally was based upon cultural motives, starting with the recovery of obsolete docklands in the port-cities in the 1980s. In the period when city-administrations started to reject modernist urban design schemes, regarded as anonymous and boring, docklands and urban river-landscapes were discovered as potential carriers of improvement of the image and identity of the city [24]. Also cities where the structures of canals and harbour-basins had disappeared because of filling up in the 1950s and 1960s, decided to repair these canals and harbours in the 1980s and 1990s [17].

Regarding the ambition of the big cities to play a central role in the development of regional entities, large-scale water systems and water-landscapes are discovered as important potential carriers of regional spatial structures. Especially the cities of Amsterdam and Rotterdam are developing strategies based upon the spatial development of regional water-structures: in Amsterdam along the IJ and IJ-lake, in Rotterdam along the river Nieuwe Maas [24].

These developments have resulted into a surprising renaissance of the marriage between urban design and civil engineering, which was interrupted from the 19th century. The transformation of former docklands ('Eastern Harbours in Amsterdam, 'Kop van Zuid' in Rotterdam) and the construction of a large scale new reclamation at the east-side of Amsterdam for a new urban district 'IJburg', show a new integration of civil engineering works in the design of the urban framework, with the new Erasmus-bridge in Rotterdam as one of the most striking examples.

Climate-Change: 'Working with Nature', Adaptation or Traditional Civil Engineering

In 1993 and 1995, the Netherlands were confronted with two serious floods in the river-area, and with the danger of breaking dikes which would cause even more serious problems. It was the start of a series of new initiatives of the government and national agencies such as Rijkswaterstaat. Climate-change was regarded as a serious condition, which made it necessary to reconsider flood-defence-policy seriously.

In this process of reconsideration, we see a remarkable change of approaches and the rise of a new type of coalitions. Building upon proposals like 'Plan Ooievaar', a new approach with an emphasis on 'building with nature', 'more space for the rivers', and 'Living with water' aims to integrate the environmental motives in new flood-defence strategies. Making use of natural processes of winds, currents, sedimentation-transport and alluvium is the key in this approach. Manipulation of these processes is regarded as more effective and as more sustainable than the 'traditional' approach of shortening and strengthening the coastline and riverbanks with mere artificial infrastructures such as dikes and dams. Important representatives of this new policy are the 'Planologische Kernbeslissing' (Fundamental Spatial Planning Decision) 'Ruimte voor de Rivier' (Room for the Rivers) and the recent advice of the 'Delta-committee' to the national government concerning future flood-defence strategies [11].

‘Ruimte voor de Rivier’ focuses on the river-landscapes in the centre and the east of the Netherlands, where a series of medium-size towns are regarded as bottlenecks in periods of extreme river-discharges. All these areas are subjects of design-studies to create more space for the flow and temporary storage of the river-water. The policy itself and the projects along the rivers are dominated strongly by the new ‘working with nature’ approach.

This holds well also with regard to the report of the Delta-committee, which is subtitled ‘Working together with water’. To be able to resist a possible rise of the sea-level of 130 cm in the year 2100, the committee proposes a yearly supplementary addition of 40 million m3 sand to the complete coastline of the Netherlands, which will result into an extension of the coastline of one kilometre in the sea after hundred years. Concerning the south-west delta, the committee proposes to repair the estuary-qualities by re-opening the closing dams. In addition, the East-Scheldt dam should be dismantled after 50 years, according to the report.

Figure 13 - Interventions proposed by the Delta-committee 2008

In the same time, a second approach has been advocated, with the title ‘adaptation’. One of the forerunners of this approach is the City of Dordrecht, which started a research on adaptation of built structures in urbanized flood-plain areas, together with the Cities of London and Hamburg [39]. The researchers developed several typological principles for building which should be able to deal with high water in flood-plain areas: heightened buildings, buildings with ‘waterproof’ ground levels and basements, buildings as floating structures. Both Hamburg and Dordrecht are implementing a mixture of these typological principles in their flood-plain areas. Meanwhile, ‘traditional’ civil engineering did not stop to exist. Therefore, we can distinguish three different approaches concerning flood-defence: ‘working with nature’, adaptation and ‘traditional’ civil engineering.

The report of the Delta-committee seems to choose for ‘working with nature’, but is in doubt when it addresses the most complex area of the delta, the densely urbanized and industrialized area of the Rotterdam region. This region is a white spot in the Ruimte voor de Rivier policy as well in the report of the Delta-committee. The region is appointed by the Delta-committee as ‘study-area’. An illustration regarding a possible system of dams and locks surrounding this region (a ‘traditional’ civil engineering solution) is inserted in the report, but the committee does not make any recommendation on it.

The Challenge for New Metropolitan Water-Landscapes

All together the present-day situation in the Netherlands is rather remarkable. At the level of national policy-making, the approaches considering water-management and flood-defence have been changed substantially. ‘Traditional engineering’ approaches are competing with new ‘working with nature’ and ‘adaptation’ approaches. The ‘working with nature’ approaches have been developed especially in the mainly rural areas. But in the large cities, in the densely urbanized parts of the delta, these new approaches meet their limits. Introducing ‘more room for the river’ and ‘working together with water’ seems to be much more difficult in the complex built-up areas of these cities.

After the disappearance of the former fusion between civil engineering and spatial planning which dominated during the 20th century, a new consensus concerning the approach of complex urban areas like the Rotterdam-region is lacking. Such a consensus will be necessary, regarding the ambitions of the national government as expressed in the ‘Randstad 2040’ report. Moreover, such a consensus can be reached only when new strategies include aims considering urban planning as well as considering nature, environment, and new economic developments and, finally yet importantly, effective and

sustainable strategies concerning flooding. Such a comprehensive approach is only possible as a cross-disciplinary approach.

Important for the development of a cross-disciplinary approach is the stimulating role of NGOs such as the 'Eo Wijers Foundation', which organizes competitions for regional design. Their initiative to organize competitions concerning the future of the IJmeer (IJ-lake) between Amsterdam and Almere (2006) and the future of the Rotterdam-Dordrecht region resulted into a series of new proposals for future developments of these regions. The price-winning proposals regard the restructuring of the hydraulic system as the most strategic intervention: it creates the possibility to improve water-management, flood-defence and biodiversity, as well as the possibility of strengthening water-structures as the main elements of the spatial structure of the metropolitan region [12, 13].

Figure 14 - 'Blauw Bloed' (Blue Blood): water and flood-defence systems as main spatial structure in Rotterdam metropolitan area. Entry Eo Wijers design competition 2008, by Kuiper Compagnons Spatial Planners & Urbanists.

CONCLUSION: THE NECESSITY OF CROSS-DISCIPLINARY, CROSS-INSTITUTIONAL AND CROSS-NATIONAL APPROACHES

The urbanization of the Dutch delta is a result of two factors: first, the typical form of this delta, and second, the coincidence of the delta-area with the nation-state. Especially during the 19th and 20th century the national policy was able to pay extreme attention to the safety of living in the delta, by combining national flood-defence strategies with national economic and infrastructure strategies.

These two conditions made the Dutch delta a particular case, which is difficult to compare with other urbanized deltas. Nevertheless, the Dutch example was regarded as a

benchmark of a paradigm that was dominating during the 20th century. This paradigm can be described as the idea that it is possible and desirable to control nature and to subject a territory to national and rational goals concerning economic development, urbanization and society-building. The transformation of Dutch delta was a ‘modern project’ par excellence.

The recent developments and reconsiderations concerning the Dutch delta are an expression of the end of this paradigm. The climate-change, the increasing concern with the natural environment and the processes of globalisation and internationalisation force politicians, planners and engineers to look for other approaches.

At this moment, the Dutch delta looks like a laboratory, where many different approaches are proposed. The Dutch delta has to be reinvented, searching for new balances between hydraulic engineering, urban planning and environmental qualities, new balances between local, regional and international scales and new relations between different authorities and institutions. This search is something, which is important in every delta-area these days.

The need for a comprehensive approach concerning water management, port development and urban development can be regarded as the start of a new paradigm concerning urbanized coastlines and delta-landscapes, with a new coherence between landscape, urbanization and port development, and between landscape design, bioenvironmental science, urban design and hydraulic engineering.

This approach in planning and designing urbanized delta- and coastal areas creates the necessity of reconsidering the existing assignment of duties of planning-institutions and authorities. Existing separations of port authorities, city planning departments, water-boards and landscape-organizations should be changed into strong collaborations. Moreover, the existing separations of urbanism, hydraulic engineering, landscape architecture and environmental design should be changed into a close collaboration and interweaving of these disciplines. This can be considered as an important challenge for the schools and universities.

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