# Between Ecology and Economy: From rigid to flexible water defense systems in the Netherlands

Jos C.N. Raadschelders
Department of Public Administration
University of Leiden, 1992

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## 1. Introduction

For centuries farmers and (later) policy makers in the Netherlands held a simple view with regard to water management. The abundance of water and the risk of substantial flooding made dikes inevitable. Water management may have been a private task in the beginning, but quite soon government became involved. Any policymaking in this field was dominated by the idea that land had to be protected against water. Lives and livelihood were at stake. At present, more than half of the Netherlands (total country size: 37.000 square kilometres) is at or below sea-level and is populated by almost three-quarters of the population. Farmers and government officials together emphasized the physical and economic importance of dikes. Where 'primitive' technology only allowed for flexible water defense systems, technological development since the late middle ages made more rigid systems possible in order to exploit the land more profitably. The Dutch have perfected a system of rigid water defense and policy makers are not easily convinced of the need to change.

This need for change is inspired by increased attention for the quality of the environment. Offical policy requires that dikes are strengthened through heightening, disregarding the damage done to the ecology and the specific culturo-historical landscape that developed over ages of dike-maintenance. Protection of ecology and the specific dike-environment, however, is finding more and more support. Government attempts to silence the ecological interests through piecemeal projects, while continuing to heighten the dikes. Hitherto, government is not prepared to consider the possibility to change from rigid to flexible water defense systems. What makes it so difficult to meet the heterogeneity of demands as represented in the economic versus the

ecological interests? The irony of the matter is that for two centuries it is technologically possible to change to and control more flexible systems of water defense. Is, and if so: to what extent, a 'public answer' to private conflicting demands possible? So far public policy is dominated by economical and agricultural interests, and ecological considerations are not adequately taken into account (De Groot c.s., 1990:36). Thus, we can speak of an unequal representation of interests at public decision making level. We are also dealing with an inequity problem. To what extent is it reasonable to demand that either economy or ecology ought to prevail? Farmers profit from the dike-heightening paid for out of public funds, but at the same time the damage done to the living environment is irrevocable. Their interest is visible. The public at large profits from environmental protection, but at the same time farmers will suffer damages. The 'public' interest is not so visible. It appears that certain changes in the institutional environment are necessary, before both economic and ecological interests can be served. The leading question for this paper is thus: *What changes in the institutional arrangements in the Netherlands are required to make a shift from a rigid to a flexible water defense system possible?*

In order to analyze this issue we will briefly outline our theoretical framework (section 2) and describe the institutional environment of Dutch water defense (section 3). In this section we will in broad outline describe the development of water defense systems. Some illustrations will indicate why flooding is such an important issue in teh Netherlands. We will then describe current Dutch policy and environmental critique (section 4). More than other sections, section 4 shows how passionate the different points of view are defended. Next we will present types of rigid and flexible systems together with their (dis)advantages (section 5). These too will be clarified by means of illustrations. Drawing upon the information from sections 3 to 5 we can analyze the institutional impediments against a change from a rigid to a more flexible system (section 6). In the final section we shall attempt to provide provide an answer as to how government can steer between economic and ecological interests.

## 2. Theoretical framework

For our purposes we like to keep the theoretical framework as lean as possible. Within human society several fundamental functions need attention: the production and distribution of goods and services, maintenance of public order and safety, education and integration of children, care for physical and mental well-being, and providing meaning to life and death. Such a function consists of activities that help face fundamental problems each society experiences. Organizing society around such fundamental issues can be understood as institutionalization. The term institution can refer to 'organization' (par example: the Department of Water Management) or to human relations in society (marriage, family). An institution can also be understood as a set of rules that is used by a set of individuals to organize repetitive activities producing outcomes affecting those individuals and potentially affecting others (Ostrom, 1992:19). Olson appears to combine both the notion of organization and rules when he indicates that institutions are structural arrangements and a configuration of rules which determine what is examplary behavior (Olson, 1992:7). He emphasizes that institutions are dependent upon, but cannot be reduced to individual intentions or broad societal forces. These individual intentions are important, though, since it is through the individuals' reasoning and understanding of how the world works that institutional performance is determined. Individual perception of and experience with reality is more important than preconceived, universal, abstract and logical absolutes.

An institutional arrangement then is a particular set of rules within a field of interest. An institution, however, does not function in a vacuum; it needs to come to terms with other interests. It needs to find a balance between its own objectives and those of the institutional environment. The institutional environment consists of more (formal organizations) or less organized groups (families, elites), culture, functions, and technology. Facing the need for collective decision making around a particular societal issue, organizations ideally need not only take other organizations into account, but also the interests of non-organized groups, and the prevailing culture (traditions, norms,

values). Furthermore, the function of a particular organization may pose limits to its structure and functioning and influences the choice of technology. We can illustrate this rather abstract exposée by describing the Dutch water management system.

## 3. **Institutional environment of Dutch water defense**

In Dutch history water has always played an important role in people's lives. It was fundamental to the Dutch to provide safety and physical well-being against the threat of major floods. Much of the societal activity regarding water control was aimed at water defense and profitable water use, especially in those areas that were below sea-level (id est: below NAP).

[figure 1 about here]

The physical and economical argument in favour of dikes prevailed throughout the first and second stages of water defense development. During the first stage protection against water was the main objective. For ages men built artificial mounds in the landscape where they could withdraw at high tide. From the late 10th century onward dikes were built in those parts of the country that were below sea-level. Gradually the 'endikement' resulted in a almost closed system of dikes along the large rivers at around 1400 A.D.

From the 12th century onward attention increased for drainage and irrigation. The need to control the in- and outflow of water resulted in technological development. Canals were dug. The improvement of windmills increased the opportunities for watermark control and land reclaim. Massive land-reclaim occurred between 1560-1640 and since the second half of the 19th century. Men's control over the environment increased. Often the dikes broke at times of excess-water supply. Sometimes they were intentionally broken as part of military strategy (the Dutch Water Fortification). In order to alleviate pressure on parts of the dikes, controled floods were allowed since the 18th century through the creation of a large number of *overlaten* (spillways). During the period of the French Occupation of the Netherlands (1795-1813),

Napoleonic legislation institutionalized the construction of spillways. Since then it is that 'public interest' overrides 'individual' interests (Havinga c.s., 1992:250), by now a tradition. There have been some 40 spillways in the Netherlands, in total affecting an area of several hundreds square miles (Havinga c.s., 1992:250-251).

In the late 19th century the Netherlands experienced a major transition from an agrarian to an industrial society with analagous technology. Farmers and house-owners in the spillway-areas were less and less inclined to accept the damages done to their crop and houses. social and political pressure encouraged the decision to close the spillways. That technology enabled the Dutch to battle high water marks through dike-heightening and river-corrections. By now the water defense system had become almost completely rigid.

In the shift from flexible to rigid water defense systems the typical Dutch polder landscape developed in the areas below sea-level.

[figure 2 about here]

Figure two presents a schematic picture of a polder. the polder can be seen just left of the center. It is ringed by a canal in which water is stored. Water in that canal is pumped up to the river (on the right: the 'bosom') and subsequently released into the sea through the dunes (left). The large rivers in the Netherlands are completely embanked (i.e. endiked) rivers (see figure 3). Immediately next to the river 'summer-dikes' are built. Paralel to these and a little further from the river one can find the higher 'winter-dikes'. The area between summer- and winterdikes, the *river-foreland*, can be flooded in case of excess water supply (see also figure 5.4).

The unprecendented population and industrial growth, resulted in a sharp increase of waste-production. The post World War II reconstruction of industry caused further pollution and thus a decline of water quality. Through several environmental acts since the 1970's Dutch government attempts to facilitate water quality management. So far water management policies did not seriously take other (related) policy

fields into account. Most recent is the attempt to coordinate policies in the fields of water, environment, and infrastructure (both transport as well as zoning policies). Through a policy of *integral water management* an appraisal is strived for between conflicting private and public interests (Glasbergen, 1991; Saeijs en Turkstra, 1992). That is to say, the growing public interest in environmental protection confronts a private interest in protecting arable land and a public policy in favour of dike-strengthening.

Institutional arrangements safeguarding economic and public interests developed accordingly. Farmers organized themselves in waterboards, or were organized in waterboards created by the province. For centuries water defense was a waterboard issue, monitored by the province from a distance. During the 1795-1813 era, when the Netherlands were more and more integrated into the French sphere of influence, a National Water Agency with field services (Rijkswaterstaat) was created for the maintenance and development of major waterworks (large river dikes, sea-defense walls). From the late 19th century onward various laws and other formal regulations have been enacted that standardize the organizational structure of watermanagement. The institutional arrangement was stable.

Recently, the existing institutional arrangements have come under fire. New organizations such as environmental associations advocate more attention for water quality and the environmental consequences of water management policy, more specifically of water defense policy. Since the 1970's government has tried to meet their demands through several environmental acts, aimed at improving water quality. Water quality management, however, is approached as a technical issue. It is improved technology (such as through Water Waste Treatment Authorities) that will result in a better environment. It is here that 'culture' comes into play. 'Culture' prescribes protection against flooding and is a public interest. 'Culture' also prescribes the protection of the livelihood of farmers and is a mixed public-private interest. The conciliation of traditional physical and economical interests with the new ecological interests constitutes a cultural shift. The current water management system and technology are not (yet) reared to fuse those interests.

## 4. Current Dutch policy: safety first and economy versus ecology

Flooding probably was part of life, and by building dikes the Dutch tried to deal with it to the best of their ability. In the twentieth century the danger of flooding has developed into what seems to be a national trauma. The 1953-flood in the south-western part of the country unsettled the nation as never before. Although casualties were not nearly as high as with earlier floods (nor as high as with road accidents for that matter), the flood initiated a government effort that had no precedent. Such a flood was never to happen again, and an ambitious programme was developed to ensure such. This programme consisted of the construction of major water defense systems in the south-west (the Deltaworks, since the late 1950's) and (since the 1960's) of the heightening of the riverdikes along the major rivers (Waal, Rhine, and IJssel). A norm was agreed upon that the height of the dikes ought to be such that only once in 3000 years the whole system would not be able to turn spring-tide. In the seventies this norm was adjusted to once in every 1250 years (Commission Riverdikes, 1977).

[figure 3 about here]

One is either in favour or against dike-heightening: there appears to be no middle way. Politicians do not want to be held responsible for flooding and so, backed by Parliamentary consent, the National Water Agency, the Waterboards, and the Provinces have taken up the job. Engineers and politicians strengthen each others beliefs. Due to the rise of sea-level and global warming, as well as changes in the riverbeds, the outflow of water is slowed down. We may be in time if we heighten the dikes now. Politicians adopt the calculations of engineers, and those engineers do what politics prescribes.

A total of 600 kilometers of major river-dikes need to be strengthened at a cost of approximately 4 billion guilders (Chavannes, 1992). Indeed, the Dutch General Accounting Office calculated that the cost-estimates for the dike-strengthening had risen in one year with more

than 350 million guilders (Brenk & Mul, 1991:274). About one-third of the dikes is thus now strengthened/heightened. According to EC-regulations major interventions in the environment require a socalled 'Environmetal Impact Assessment' (EIA, EC-directive 335, 1985). For minor waterworks this rule does not apply. Some say that through strenthening the dikes in portions of less than 5 kilometers at a time, Dutch government evades the necessity of an EIA. However, maybe the manpower and technology involved are so large that it is necessary to work in relatively small segments.

What then are the consequences? (Chavannes, 1992; Hellmann, 1992). First there are ecological effects. Around the dikes more than 250 varieties of plantlife are found, of which at least a 100 are unique to the 'dike ecological system'. This flora is destructed. Second, a centuries old landscape is destructed. Cottages built next to the dike, and sometimes built on the dike-slopes have to be demolished. A characteristic Dutch landscape with dike-cottages, pollard willows, vegetable gardens, and meandering dikes (following the natural flow of the river) is about to disappear. There still are areas where the atmosphere of 17th century paintings is very much alive. Figure 4 provides a cross-cutting of the increase in size when a dike is strengthened.

[figure 4 about here]

The dike-population, environmentalists and artists have found each other in the resistance against the 'blind pursuit of safety' and, indeed, are invited to participate in the decision making. The National Water Agency organizes hearings when a particular dike-segment is about to be strengthened. Those hearings, though, are meant to convert people to the official government policy, and are certainly not used to find other ways of water defense. Under pressure of a recent law-suit the National Water Agency may reconsider its policy of dike-strengthening (Van der Velden, 1992).

As it is, thinking about water defense has not grown out of the ideological stage. It is passion and not reason upon which the debate

rides. For 'reason' to dominate we need to know more about the options and their (dis)advantages.

## 5. **Rigid and flexible water defense systems**

A *rigid water defense system* is one in which the way of controlling the in- and outflow of water is determined by the functions of the surrounding territory. Building and strengthening a dike to protect the land from flooding and thus facilitate agriculture is an example of such a system. In a *flexible water defense system* the functions of the surrounding territory are determined by the natural in- and outflow of water. Allowing part of the land to be flooded at times of high watermarks is an example.

There are several methods to deal with water defense that can be categorized according to their degree of flexibility:
- flood plains,
- artificial mounds,
- spillways (or: waste weirs) and basins,
- river forelands, and
- river embankments.

The most flexible method is *flood plains* (De Groot c.s., 1990). These are areas along rivers subject to frequent flooding in moments of excess water supply as is the case, for example, with the rivers Loire in France and Nile in Egypt. The only limits to the movement of water are the natural heights in the landscape. In early days people lived on natural heights. From the late middle ages onward, they moved toward the river and embanked the lower grounds.

The earliest human attempt to protect against high tide is represented in the construction of *artificial mounds*. Initially these mounds (in Dutch: terpen, woerden, vliedbergen) offered temporary refuge from floods. In later days these mounds were enlarged and continuously inhabited. Towns and cities grew on and around them as is illustrated by various names of towns in the Netherlands (Leeuwarden, Woerden).

The oldest dikes were not always able to hold an increased inflow of water (smeltwater from the Alps, or spring-tide at sea) within the river beds. An answer was found in *spill-ways* (later also: waste-weirs,

Canters. 1988.) and *basins*. A spill-over system is basically a means to divert excess-water at high tide and prevent a dike-breach. At the construction of a dike, part of it is intentionally lowered so that excess-water can 'cross' and can be led to a point downstream, where the river is wider. Such a system is also known as a 'green river' when it regards an area of several kilometers. Lately, basins are being built surrounded by quays where water can be held and drained-off downstream as soon as the watermark has decreased there.

More rigid is a system of *river-forelands*, where the land between the low summerdikes and the higher winterdikes can be flooded. During the summer these forelands are used as pasture, while in winter times they are meant to provide room for excess-water. Scarcity of land and pressure on land-use in the twentieth century have resulted in declining acceptance of such floods and thus in increased efforts to prevent flooding.

Through *complete regulation and embankment* a stable riverbed is realized. This has happened in the Thames area and the Rhine Delta. Measures to achieve that are *inter alia* cutting through natural windings of the river, dredging the river bed, widening the river, and decreasing the number of water-bifurcations. Most recently, large-scale dikestrengthening is taking place.

[figure 5 about here]

For both rigid and flexible systems there are advantages and objections.

A *rigid water defense system* makes intensive land use possible. At the same time the citizenry at large enjoys a sense of protection. Dikes provide a certain degree of security. Yet in view of global warming and rising sea-level, it is argued that dike-strengthening does not provide a permanent solution. Furthermore it is expensive. Not only does the dike-strengthening require huge amounts of money, but it also involves the relocation of people living at or near the dikes. The ecological and historical loss is not compensated.

A *flexible water defense system* provides for a more sustainable solution. Not only the natural landscape is preserved, but both economic and ecological demands can be met. It is disadvantegeous that an

assessment of the financial and safety consequences of such a system have not been made. Flooding might damage intensive agriculture, and may enhance a sense of unsafety among the citizens.

The impediments in the change from a rigid to a flexible defense system are complex and various.

## 6. **Impediments to change**

At present, the vested interests of farmers and water management organizations are firmly entrenched. They point to the economic importance of maintaining a rigid system and have no difficulty in pointing out the disadvantages of flexible systems. The case for those in favour of a more flexible system is weaker, since it has been based on considerations of a more ideological almost passionate nature. The legitimacy of the existing rules (*id est*: current policy, emphasis on agricultural interest) is under siege.

What are the problems that together constitute an impediment to change? We discussed the traditional and novel ideologies about water defense in section 4, and therefore we will now concentrate on the more practical problems.

A major problem concerns the *heterogeneity of interests*. Farmers are clearly in favour of dike-strengthening and find strong support with the National Water Agency, with the exception of course of those farmers who will be directly affected by dike-strengthening. As with the spill-ways in the early 19th century, their interests are not considered and in the worst scenario their property is appropriated by the government. Waterboards have by tradition supported the farmers, but are more and more inclined to take ecological interests into consideration. They are supported by the Ministry of Traffic and Watermanagement who favours integral watermanagement. Environmental interest groups together form a strong lobby in favour of ecological interests. Formally the number of decision-makers is fairly small: waterboards, provinces, and state. But the legitimacy of their decisions will be larger when citizens, environmental associations and municipalities are invited to

participate in the policy process. Thus the *complexity of the interaction* constitutes a problem in itself. So far it has not been very satisfying to any of the actors. The new Waterboards Act (1992) makes it possible to allocate seats to new interest groups, but it is the Province that decides whether or not these interest groups will be given voting-rights. Furthermore, integral policymaking is hindered by *compartmentalization of policymaking*. At present only those 'institutions' are involved that have direct responsibility for water management. Horizontal coordination between them and government officials in the fields of spatial planning and environmental management is limited.

Heterogeneity and complexity are complicated further because of *lack of information*. Neither the costs of maintaining adequate dike-height in the future nor the costs of changing to a more flexible system have been calculated. A realistic *assessment of transformation costs* is needed. What will it take to change existing planning procedures for zoning, watermanagement, and environmental management? What will it take to change existing permit-procedures? Without proper permits one cannot change or deliberately hinder the watercourse nor can one allow discharge of water in spillways. At present a permit that locally makes a flexible system possible can be refused on grounds of flood-risk. In case policy making decides in favour of spillways and green rivers, the question arises to what extent government appropriation of land is necessary. The costs of this have not been assessed. Also an *assessment of ex post costs* is necessary. Allowing land to flood now and then will increase production costs of agriculture. What damage-claims can government expect from farmers? Not the least of problems is the waterquality of the large rivers (Rhine, Meuse, Schelde). Sedimentation of polluted silt can have disastrous effects on agriculture and are direct ex post costs. An assessment also needs to be made about the indirect costs. Flooding might lead to accumulation of toxic substances in the food-chain and that is an externality not to be overlooked.

In view of these problems it appears that they are caused by polycentricity and lack of information. For ages waterboards were only concernced with quantity management at micro-level. The inclusion of

quality management has changed the organizational culture of the waterboards enormously. Furthermore, the interdependence between their contemporary set of tasks with tasks in other policy areas (zoning, traffic, environment) and thus other actors creates a situation of uncertainty. It appears as if there is no 'single' coordinative structure that can help steering toward a solution that serves both economical and ecological interests.

These problems are of a short-term nature. There is, however, a more long-term problem. The benefits of changes toward a more flexible system will not immediate
ly be apparant. So the question arises who is willing to pay for generations to come?

## 7. **Future Dutch policy: economy and ecology**

Changing existing institutions is always difficult because not all actors involved recognize the need for adaptation at the same time. Moreover, institutional change now will only succeed if there are economic incentives to conserve (Kupchella & Hyland, 1986:220, 546). Governments are the principal institutions that can develop policies to protect the environment.

On the short term various changes in the institutional arrangements can be pursued:
a) creation of a *clear coordinative structure*: this is not synonimous with a centralized structure. We advocate a projectorganization in which all relevant governmental and 'private' actors are involved. As we write the minister for Traffic and Watermanagement has decided (july 21st 1992) to have an advisory committee installed in order to review the necessity of dike-strengthening.
b) *changes in the legal framework* (permit procedures, appropriation of land) so that a change to a flexible system is facilitated and controled flooding is possible.

These changes will be more effective and make more sense once a clear *cost-benefit analysis* has been made.

For the longer term it will be necessary that government educates the population about the necessity of a change toward a flexible system. *Education* will facilitate the internalization of externalities (Kupchella & Hyland, 1986:565). It used to be good business and good house-management when costs of production respectively house-keeping were externalized as much as possible. This is no longer acceptable. Environmental protection may only be succesful when everyone shares in the costs and understands why the expenditure is necessary. From an economic point of view it does not really matter whether a choice in favour of dike-strengthening is confirmed, or a change is made toward more flexible systems. Either way each individual citizen will share in the costs. Indeed, this may prove to be the largest impediment in the choice between rigid and flexible systems.

*** Acknowledgement**

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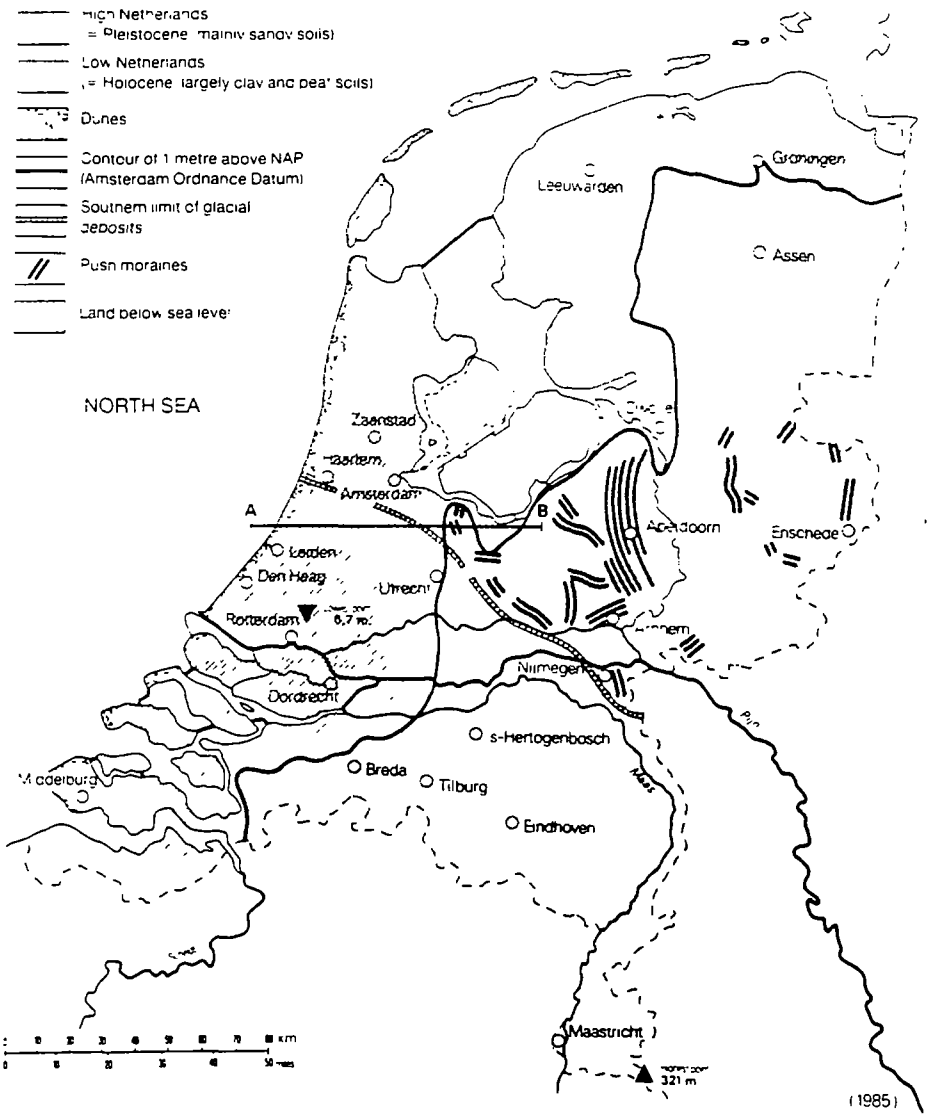
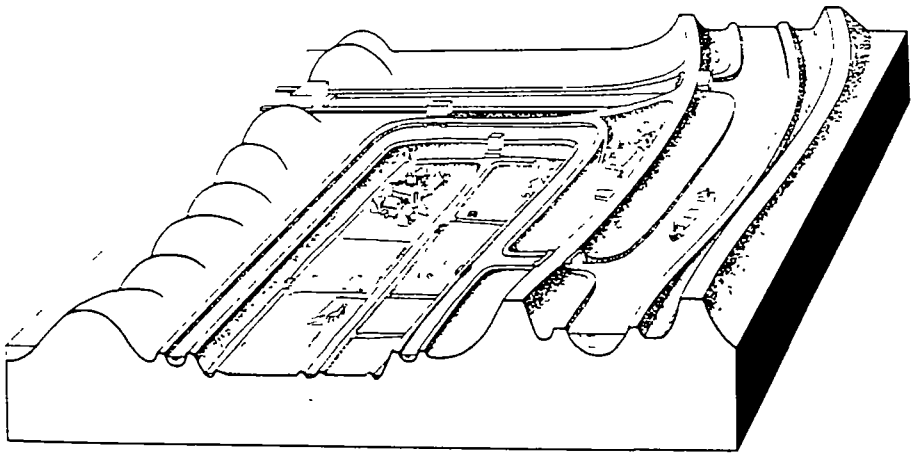
Figure 1 *Land above and below sea-level in the Netherlands*



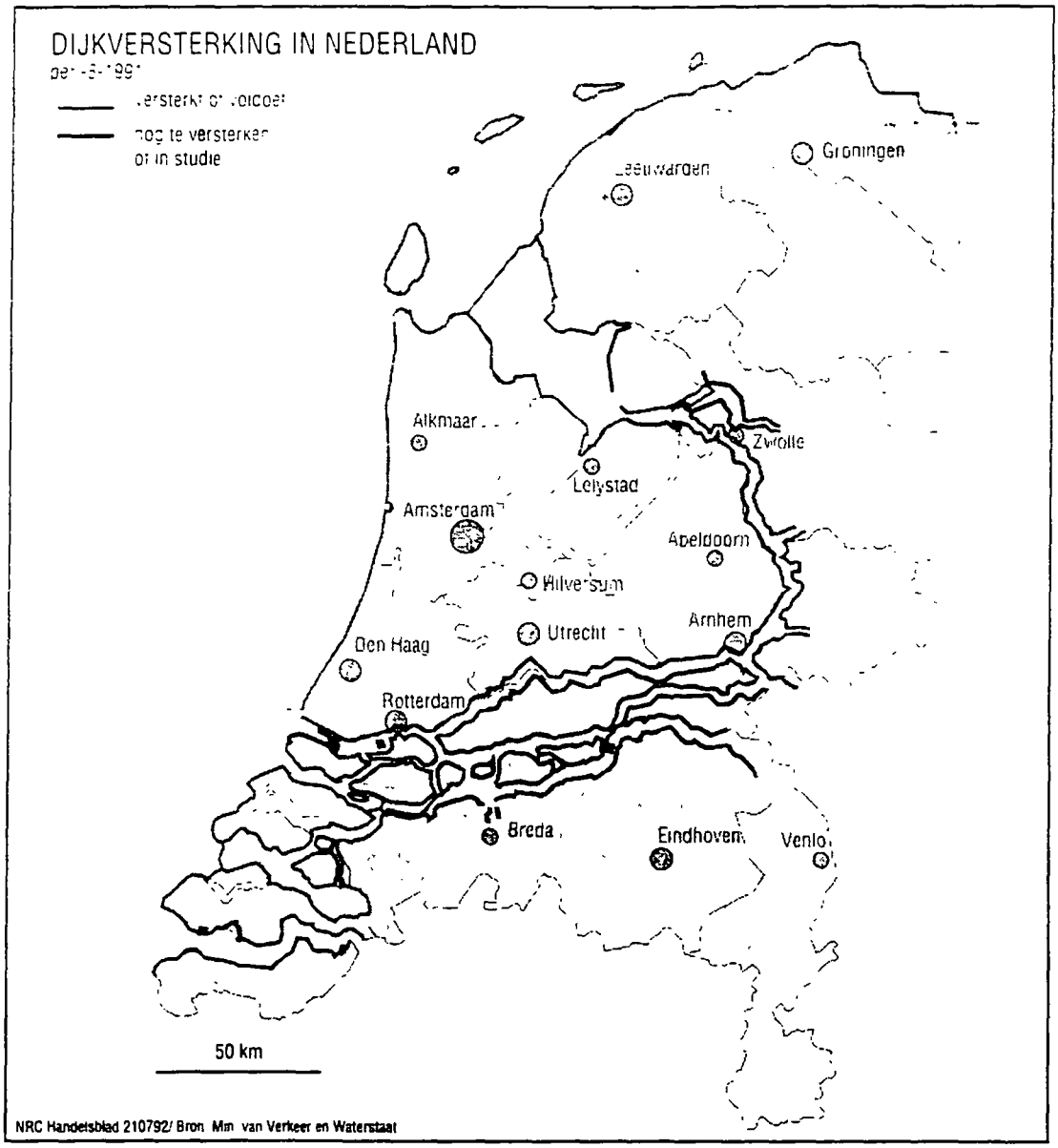

Source: William Z. Shetter, *The Netherlands in Perspective* (1987) 23.

Figure 2 *Dutch polder landscape in the lower regions*



source: William Z. Shetter, *The Netherlands in Perspective* (1987) 33.

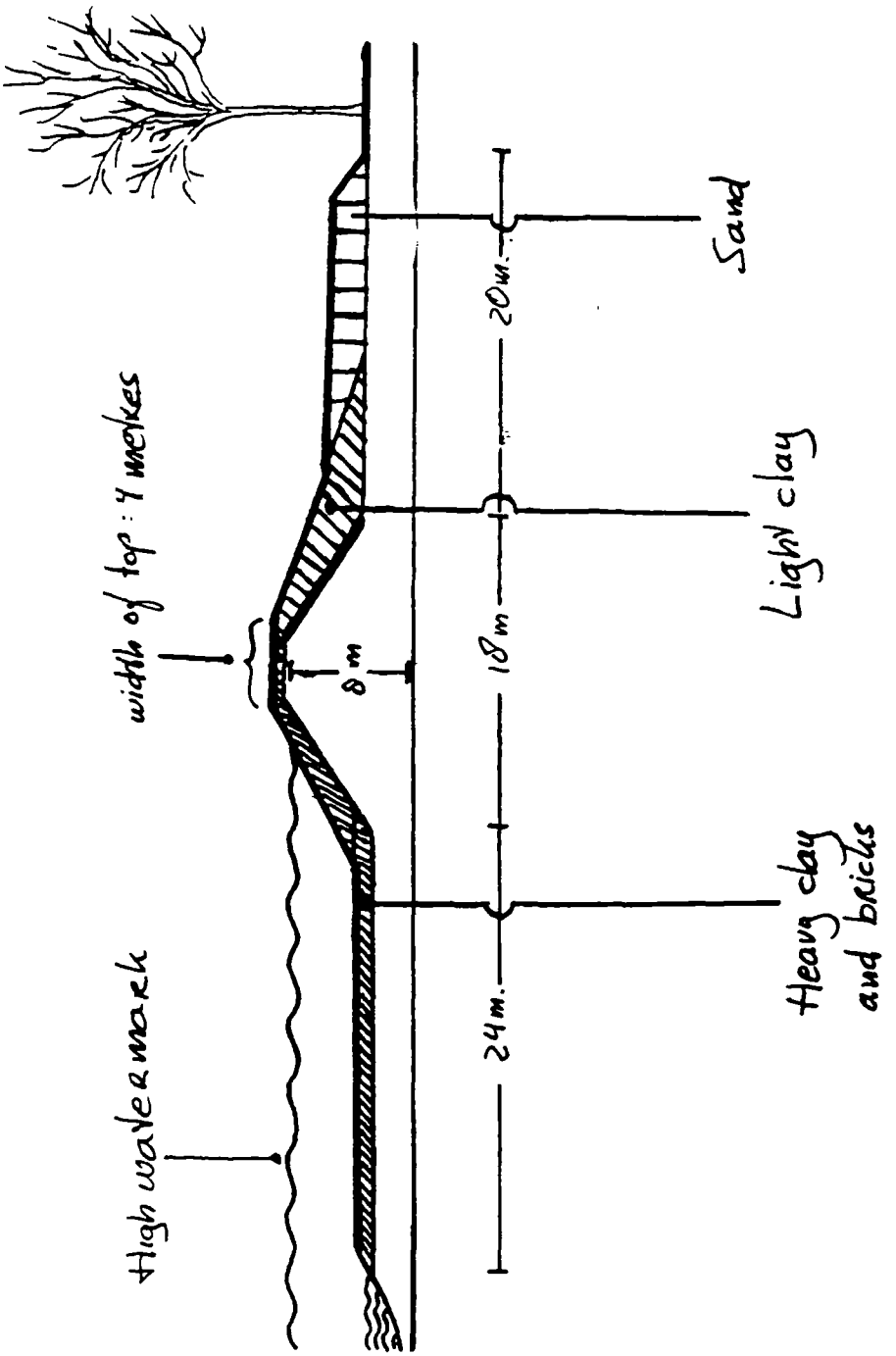
Figure 3 *Dike-strengthening and heightening in the Netherlands*




Situation in august 1991: grey bold lines indicate completed dike-strengthening. black bold lines indicate those dikes that are to be strengthened or whose strengthening is under consideration.

Source: Ministry of Traffic and Water Management, as depicted in Ben van der Velden *NRC-Handelsblad* 21 july 1992.

Figure 4 *Cross-cutting of a dike-strengthening*




Adapted by author from Feddes & Halenbeek 1988:25.

Figure 5.1 *Natural flood plain*

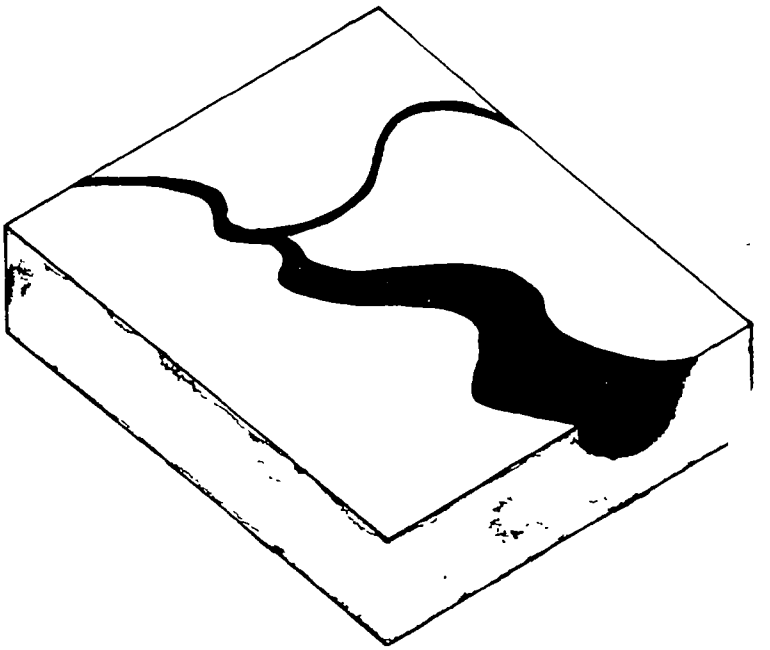


Figure 5.2 *Flood plain with artificial mounds*

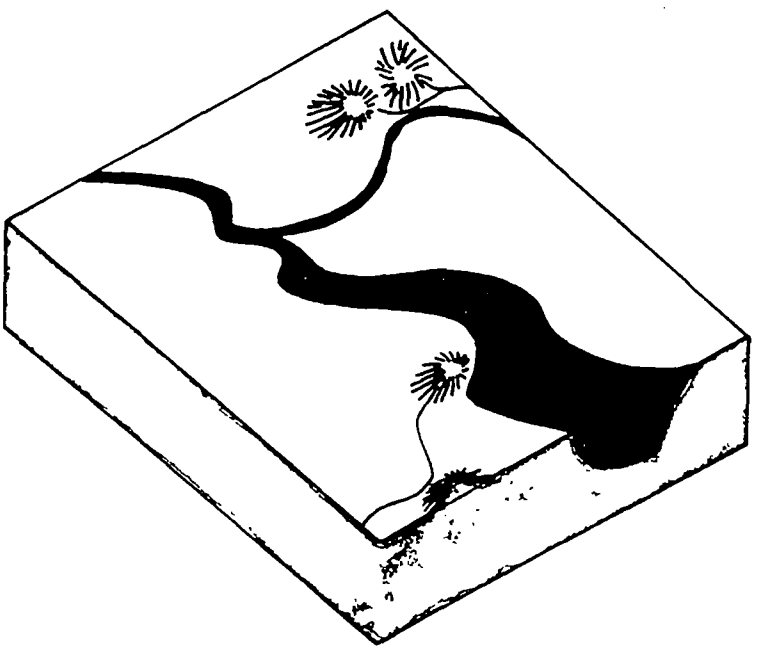


Figure 5.3 *Spillway-system*

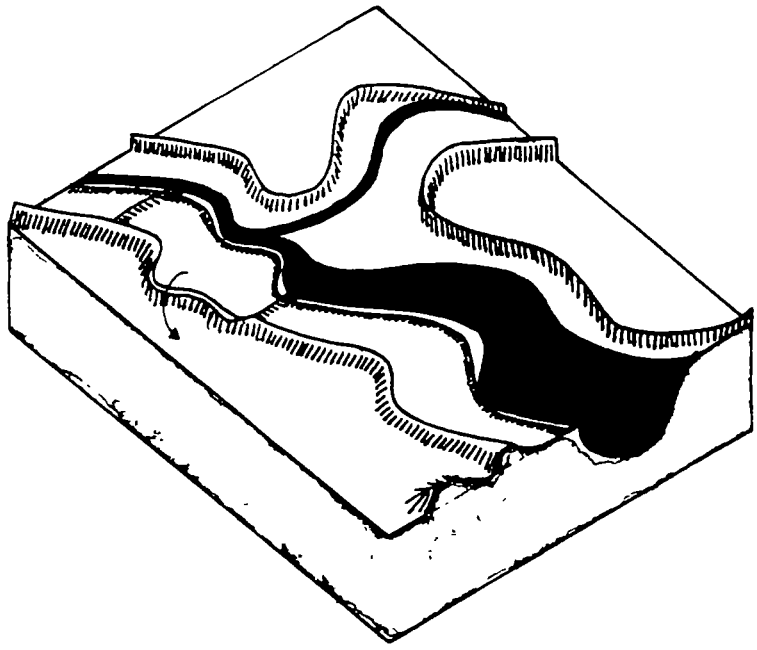
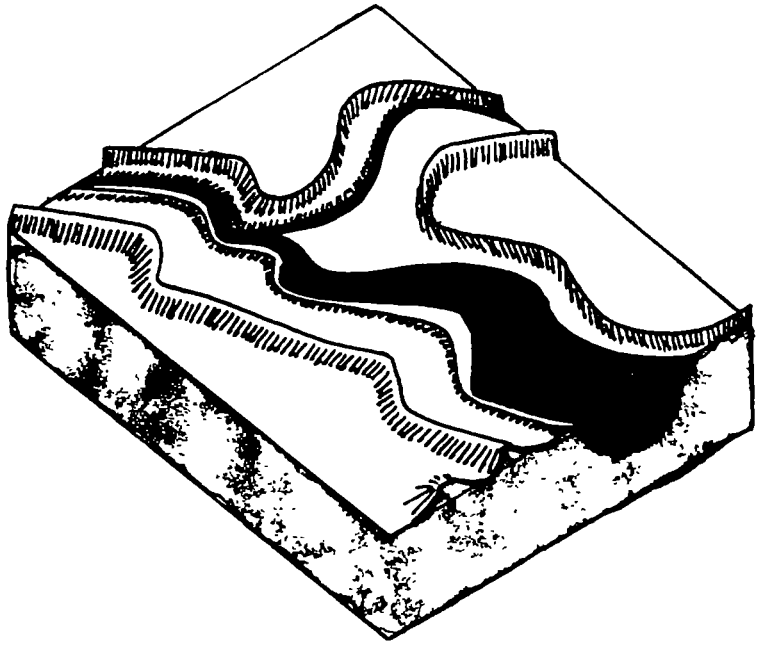


Figure 5.4 *River-foreland system with complete embankment*



Adapted by author from Havinga c.s., 1992:249.