

The German Wadden Sea coast: reclamation and environmental protection

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Abstract. Why did the reclamation of tidal marshes along the German Wadden Sea coast continue until the 1990s while the country is known for its awareness of the need for environmental protection? A study of the recently adopted reclamation policy in Schleswig-Holstein indicates that since the 1960s, the primary objective of embankments along the coast has been for coastal defence. While focusing their attention on this policy from the late 1970s, environmentalists have been objecting against any reclamation projects. Their main argument has been the ecological richness of the tidal marshes and the negative effects of embankments on the Wadden Sea. During the 1990s, objections from environmentalists, together with the fruition of the Coastal Defence Plan, recent economic factors, new legislation and sea level rise have led to a gradual decline of reclamation projects along the German Wadden Sea coast.

Keywords: Coastal defence; Ecosystem restoration; Environmental conflict; Environmentalist; Polder; Tidal marsh.

Introduction

A major question about German coastal management has been whether the reclamation of tidal marshes along the German Wadden Sea coast in the recent past was justified and whether this form of coastal management is still possible. Protection of the tidal ecosystems along the German coast has become increasingly common over the last two decades because of economic, ecological, social, legislative and even eustatic arguments. Nevertheless, from 1950 to 1991 ca. 33 400 ha were reclaimed against only 10000 and 1000 ha along the Dutch and Danish coasts, respectively. It also seems paradoxical that German authorities carried out such projects until the end of the 1980s, in spite of the tradition of environmental conservation which has characterized the German people since long. The following study examines the unique case of the completely reclaimed coast of the State (*Bundesland*) of Schleswig-Holstein where an unexpected landscape variation has recently arisen as a result of the restoration of tidal ecosystems.

The Schleswig-Holstein Wadden Sea coast

The shallow Wadden Sea, bordering the North Sea, covers 730 000 ha and skirts along 1 500 km of the Dutch, German and Danish coastline. The majority of it belongs to Germany, where it covers ca. 250000 ha off the coast of the northernmost state of Schleswig-Holstein. In this region the mean tidal range during spring tides varies from 2 m at Sylt to 3.40 m in the Elbe estuary. The coast is considered as micro-tidal in the north, between the continental shore and the islands and sandbanks of Nordfriesland, but rather as meso-tidal on the southern open coast of the Dithmarschen. Its continental boundary is determined by the artificial shoreline formed by the high sea embankments which range in height from 7.50 m to 8.80 m (Anon. 1992) and which are themselves bordered by salt marshes and large tidal flats (Fig. 1). As on other European shores, tidal flats have been formed since the Flandrian transgression. However, since the end of the 19th century their development has been accelerated, largely due to the construction of a network of wooden fences, which have encouraged the build-up of sedimentation and the growth of salt marshes, hence the term sedimentation fields.

Along the coast of Schleswig-Holstein salt marshes have been reclaimed since the middle of the 11th century (Meier 1993), and tidal flats since the 1950s. The drained and reclaimed area is called *Öthe marshes* (*Ödie Marschen*). Between 1954 and 1990 17 polders covering 18000 ha were reclaimed (Fig. 1). By contrast, over the same period reclamation projects over the whole Wadden Sea amounted to only 45000 ha, making up ca. 40 polders (Table 1). The authorities responsible for the reclamations and the coastal defence policy in Schleswig-Holstein are the Ministry of Agriculture of the State (MELFF: *Ministerium für Ernährung, Landwirtschaft, Forsten und Fischerei*) and its subdivisions, the Agriculture and Water management departments (ALW = *Ämter für Land und Wasserwirtschaft*). It is in fact through these authorities that the state of Schleswig-Holstein owns the sea dykes and is therefore responsible for their maintenance and safety and for the construction of new embankments (cf. Scherenberg 1978, 1988).

Table 1. Reclamation plans for the Wadden Sea from 1950 to 1997.

Region in the Wadden Sea (continental side)	Wadden Sea coast of Schleswig-Holstein, Germany (Fig.1)	Wadden Sea coast of Niedersachsen, Germany	Wadden Sea coast of The Netherlands	Wadden Sea coast of Denmark	Total
Period	1954 - 1990	1950-1991	1969 - 1980	1981	1950-1991
Area (ha)	ca. 18000	ca. 15400	ca. 10400	ca. 1000	ca. 45000
Number of polders	17	16	5	1	39
Largest polder on each coast (ha)	Speicherkoog 4800 (N and S coast)	Nordkehdingen ca. 5.500	Lauwersmeer 9200	Margrethe Kog 1000	

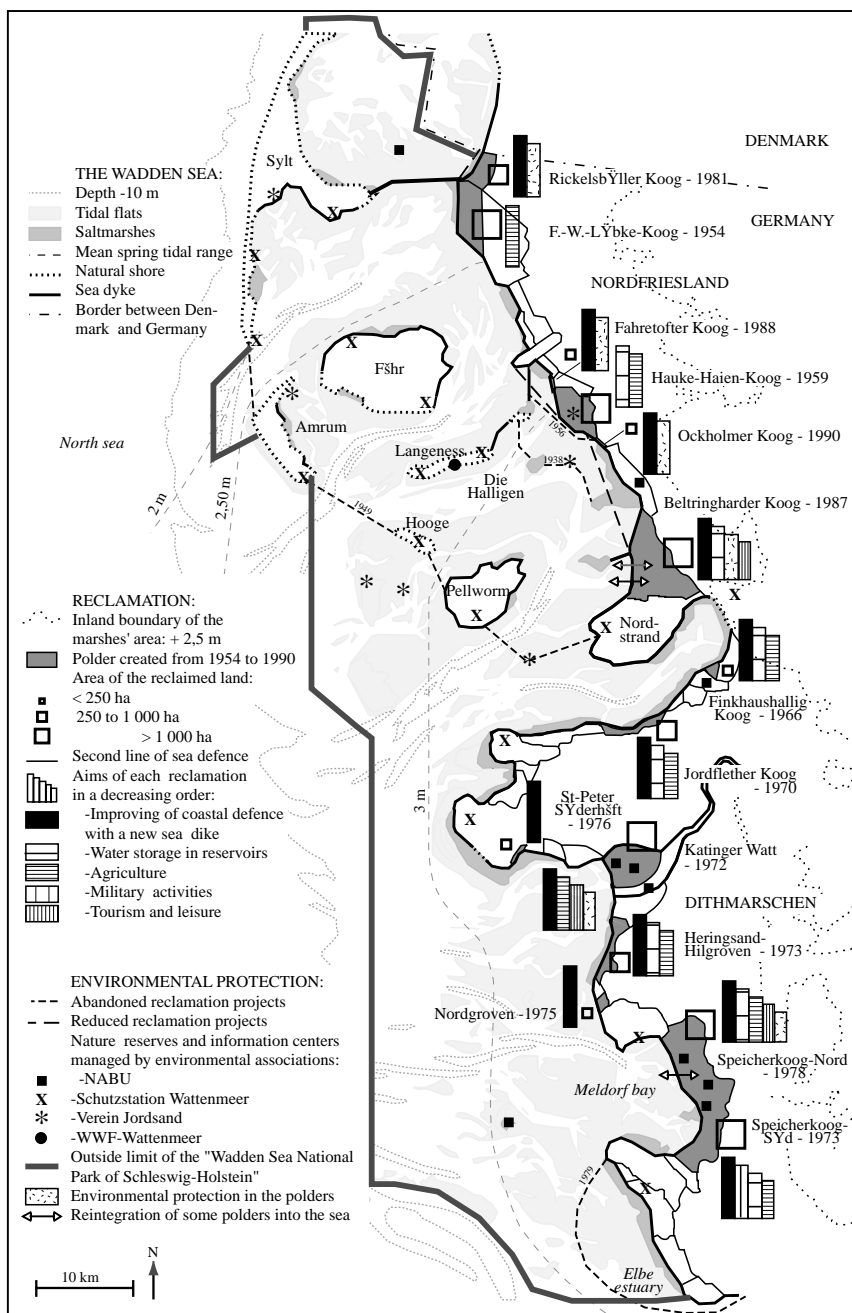


Fig. 1. The Wadden Sea and the marshes of the State of Schleswig-Holstein (Germany): reclamation and environmental protection.

Where, in medieval times, these embankments were meant to protect the population from storms coming from the North Sea, they were later seen as a means of reclaiming tidal land in order to acquire new agricultural land. With their high levels of calcium carbonate and sandy and clay-like structure, the soils of the reclaimed salt marshes, and to a lesser degree, of the reclaimed tidal flats, were in fact particularly desirable. Today, the yields from several of the coastal polders of Schleswig-Holstein are comparatively high; according to the statistics released by the local farmers they averaged in 1995:

wheat 9 ton/ha	barley 8 ton/ha	oats 6,5 ton/ha
sugar beets 55 ton/ha	cabbage 75 ton/ha	

The recent reclamation policy of the state of Schleswig-Holstein

In the latter half of this century, however, the primary objective of reclamation has no longer been to acquire agricultural land. Since 1963 the Schleswig-Holstein government has given priority to its coastal defence policy which has, in turn, resulted in the improvement of the coastal defence system. The dangers engendered by storms have become a primary concern in the minds of coastal dwellers and of managers. In the North Sea, storms are frequent and are particularly dangerous during spring tides, as the February 1953 storm along the shores of The Netherlands proved. Between February 1962 and January 1995 about thirty severe storms battered the coast of Schleswig-Holstein (water levels were 1.5 m higher than the mean high-tide level). On 16 and 17 February 1962, 14 December 1973, 3 January 1976, 21 January 1976, 24 November 1981, 26 to 28 January 1990, 26 to 28 February 1990 and 28 January 1994, water levels rose more than 3 m and, at times, as much as 4 m above the mean high tide level in Husum (Anon. 1992; *Bundesamt für Seeschifffahrt und Hydrographie* pers. comm.). Hence, since the two life-claiming storms in The Netherlands (1953) and in Germany (1962), a new coastal policy has been developed in order to create a shorter, straighter and more uniform coastline through the construction of high sea walls on the tidal flats beyond the old ones. The shorter and straighter coastline has reduced maintenance and repair costs, has minimized the risks incurred during storms (Suhr 1964) and has brought about the creation of 12 polders.

Despite a decline in the importance of agriculture in these last polders, it still prevailed over the other economic uses (Fig. 1). This was due to the land regroupings carried out in the 1970s and to better drainage systems, both of which improved the local agricultural structure. For instance, the building in 1978 of the Speicherkoog-Nord dyke formed 1200 ha of arable land and enabled a large regrouping of lands in the 18 districts (*Gemeinde*)

located around the bay of Meldorf. This in turn led to an increase in the average area of agricultural holdings. Moreover, with the addition of large reservoirs, storage of the runoff of inland waters became possible during storms when the dyke gates were kept closed, thus avoiding flooding of the land. Since the reclamation of the Hauke-Haien polder in 1959, three reservoirs covering some 590 ha of the polder can, for a period of 36 hours, store the 7 million cubic m of water coming from the 720 km² of the marshes and the hinterland drainage basins. From 1959 to 1987, 60% of the coastal polders of Schleswig-Holstein were used in this way (Goeldner 1997). Other uses, current and past, which cover more limited areas and which are of lower economic value, include tourism and military activities. Nevertheless, in spite of this economic diversification (Fig. 1), the main polders built in Schleswig-Holstein over the last 50 yr have been created with the intention of coastal defence and agriculture, as in the past.

The objection against reclamation by environmentalists

For many reasons the German part of the Wadden Sea remains a very rich ecosystem, with a high density of species (100 - 200 macrofauna species per m² of salt marsh (Heydemann 1981) and up to 2.5 million organisms per m² of tidal flat (Dankers et al. 1981). The total productivity of the tidal lands (tidal flats and salt marshes) is also very high, with primary and secondary productivities peaking at 2700 g m⁻² yr⁻¹ and 45 g m⁻² yr⁻¹ respectively (Heydemann 1980). Furthermore, some 500 salt marsh species are highly specialized (Heydemann 1981). The number of birds feeding on the flats and the salt marshes is also considerable: 10 to 12 million birds can be observed each year around the whole Wadden Sea (Ršsner et al. 1995). Moreover, many species and biotopes are considered threatened according to the criteria established by the International Union for Nature Conservation, for instance the bird *Calidris alpina*; the lapwing *Tringa totanus* is considered vulnerable (Nordheim & Merck 1995). Thus, the reclamation of the saline environments could contribute to the destruction of a rich and vulnerable ecosystem. 50-90% of the species living on tidal flats and in salt marshes may locally disappear after reclamation and the subsequent desalinization and drying up, causing a fast ecological succession into entirely different ecosystems (Heydemann 1981). For example, in the Kronenloch basin in the polder Speicherkoog-Nord, salinity levels fluctuated between 5 and 22 ‰ during the years following the building of an embankment in 1978, whereas the mean salinity in the Wadden Sea amounts to 18 ‰. The secondary biomass diminished to 5 g/m² while attaining levels of 46 g/m² on the neighbouring intact tidal flats (Brunckhorst & Claussen 1985).

A similar pattern was observed regarding birds, with a reduction in the number of benthos feeders such as *Tadorna tadorna*, *Larus ridibundus* and *Haematopus ostralegus* (Gloe 1984).

With large reclamation projects being proposed since the end of the 1960s in Germany, and particularly in the Nordfriesland region, this new knowledge has provoked a massive social protest led by ecologists and other scientists since the end of the 1970s. From that period to the beginning of the 1990s environmentalists and planners released numerous publications either contesting or supporting the reclamation policy on the Wadden Sea coast. A study of this large body of texts permits a deeper understanding of the opinions and values they all defend (Goeldner 1997). It appears that agriculture was no longer considered the major aim of reclamation. On the contrary, because of the growing importance of coastal defence, planners introduced new technical arguments, such as that of the 'double line of sea defence'. This notion of coastal defence, which originally came from The Netherlands, appeared in Germany at the beginning of the 1960s (Petersen 1966), at much the same time as the concept of the shortening of the coastline. It consisted of doubling the number of embankments facing the sea in order to better protect the population from storms. This doubling effect improved the storm-resistance capacity of the coastal defence system. Either a former dyke was rebuilt inland from the existing dyke or a new one was built beyond the old sea dyke creating an intermediate polder. If sea water would penetrate in such a polder through a breach in the sea dyke, this water would remain there and the area would remain uninhabited, while catastrophic flooding of the marshes is avoided (Kambeck 1981, 1982). Though this new idea of coastal defence appeared as early as 1963 in the General Coastal Defence Plan (*Generalplan Deichverstärkung, Deichverkürzung und Küstenschutz in Schleswig-Holstein*) it was not given priority at that time (Suhr 1964). However, planners turned to it more during the modification of the Plan in 1977: the second line of dykes effectively became the second argument in favour of the reclamation of the bay of Nordstrand (the future Beltringharder polder) and even the sole argument in defence of the reclamation of the Tünder region located on the border between Germany and Denmark (the future Rickelsbüller polder). However, at the beginning of the 1980s, while the reclamation project in the bay of Nordstrand was still in its infancy, this vision of the coastal defence was heavily criticized by environmentalists and scientists such as Professor B. Heydemann (Heydemann 1980, 1981). Environmentalists were in no way questioning the need to protect the coastal population and their lands against storms (Heydemann 1980, 1981; Anon. 1981a, b). However, they did criticize the

necessity for a second line of defence along the coast for they felt that a single dyke would suffice. Consequently, in order to retain as many tidal lands as possible, they proposed to reinforce and heighten the existing dykes as is the case along several parts of the shoreline in Niedersachsen and The Netherlands (Anon. 1980). However, some of them did take into consideration the possible fear in the coastal populations provoked by the simple heightening of the existing dyke and went as far as to tolerate a second dyke, but at a distance of only 100 to 200 m from the old sea dyke (Heydemann 1981; Anon. 1981a). Obviously the idea of improved coastal defence had been well understood by the population. A poll carried out in 1994 concerning the dyke of the Fahretofter polder, which was to be built later on, confirmed this. It showed not only that the argument was widespread, but also that it had been assimilated by the coastal citizens (Goeldner 1995). Without creating any doubt about the obvious efficacy of this double defence system, one may therefore assume that this argument allowed the planners to counteract the arguments of the environmentalists and, at the same time, indirectly convince the local people of the need to continue with the reclamation policy (Goeldner 1997). This is particularly true of the period spanning the great protest years of the early 1980s.

As work on the dykes in Nordfriesland progressed, the debate progressively diminished, but nevertheless continued until the completion of the General Coastal Defence Plan, which was finished with the last reclamations carried out in 1989 in Fahretoft and in 1990 in Ockholm. Though the protests by environmentalists were unable to put a complete stop to this policy concerning the Wadden Sea, they still led to the renunciation of numerous post-1965 reclamation projects amounting to ca. 76000 ha and to the reduction by more than 5000 ha of the remaining areas reclaimed in the 1980s and 1990s, especially on the coast of Schleswig-Holstein (Table 2; Fig. 1).

Apart from the Social Democrats (SPD) who have governed the state from 1988 onwards, the other political parties and even the Green Party of Schleswig-Holstein apparently showed little interest in protecting the Wadden Sea ecosystems (Goeldner 1997). Rather the main proponents were national, regional and local associations which concentrated much of their efforts on the issue. Some, such as 'NABU' or 'Verein Jordsand', were formed at the beginning of the German environmental protection movement at the end of the nineteenth century. Others appeared in the 1960s and 1970s when the movement enjoyed new-found success and when opposition to the reclamation policy began ('Schutzstation Wattenmeer', 'BUND'). More recently there have been associations such as 'WWF-Wattenmeer' which was founded in 1985. Their strong influence on reclamation

Table 2. Recent abandoned and reduced reclamation projects in the Wadden Sea.

Abandoned reclamation projects since 1965	Unreclaimed area (ha)	Reduction in reclaimed area from 1981 to 1991 (ha)
Wadden Sea coast of Schleswig-Holstein (Germany): -small area located in front of the Marienkoog (creation of a harbour at Medemsand in the Elbe estuary. project of a local association (Verband zur Förderung der Elbe-Weser Küstenregion, 1979)	(> 20 000)	Nordfriesland: -Rickelsbüll Koog: 200 -Beltringharder Koog: >2200 -Fahretofter Koog: >500 -Ockholmer Koog: 65
Wadden Sea coast of The Netherlands: -Tidal flats of Den Helder harbour (Friesland) -Summer-polders of Groningen -Tidal flats of the Island of Ameland (Friesland) -Salt marshes in the Dollart -Summer-polders of Friesland -Tidal flats of Eems harbour (Groningen)	> 40000	
Wadden Sea coast of Denmark: tidal flats between Romø, Fanø and Esbjerg	30000	
Wadden Sea coast of Niedersachsen (Germany): -Tidal flats of Emden harbour -Creation of an industrial harbour at Scharhörn -Summer-polders of Spieka-Neufeld (Butjadingen)	ca. 6000	Ostfriesland: -Leyhörn: >2300 -Jheringsgroden: < 10

policies is due to their social and financial impact. For instance, their membership numbers or the circulation of their newsletters concerning the Wadden Sea (*Wattenmeer International*, *Wattreport*) often are in the thousands. In the mid-1990s, these associations together employed some 25 people and carry a budget of ca. 5 million DEM (Goeldner 1997). In The Netherlands, where the movement for the protection of the Wadden Sea is more concentrated, one particular association (*Vereniging tot Behoud van de Waddenzee*), with its 30 employees and a budget of nearly 7 million NLG, reached 60000 members in 1991. These associations share common interests and action plans to save the Wadden Sea and manage many nature reserves and information centres around the sea and in the marshes (Fig. 1).

Towards the end of reclamation in the Wadden Sea

In Schleswig-Holstein coastal embankment was finally stopped at the beginning of the 1990s. This cessation of embanking, which was most certainly due to the General Coastal Defence Plan of 1963 coming to its fruition, nevertheless respects contemporary views. Agricultural circumstances, increased environmental protection, restoration projects concerning the already reclaimed ecosystems and a rise in sea level -all of which are current issues- support the termination of reclamation.

The end of agricultural reclamations, and even of the agricultural use of the most recent polders, coincided with the awareness of the European agricultural overproduction which dates back to the beginning of the 1980s. The last polder used for agricultural purposes was that of Speicherkoog-Nord in 1978 whilst the first decision to reduce the number of reclaimed areas was made in 1980 (Rickelsbüll Koog). The increase in the

number of set-aside areas is more proof of the lack of interest of the farmers in new land. In 1995 these set-aside areas covered more than 5400 ha, a figure which is equivalent to ca. 17% of the arable land used in the coastal districts (*Gemeinde*) of Dithmarschen and Nordfriesland (Anon. 1996). This is a considerable area, certainly when compared with the figure of 14% in the state of Schleswig-Holstein and in light of the high quality of the polders' soils. In fact, in half of the coastal holdings located in the coastal districts, on the islands and on the *Halligen*, agriculture is no longer a viable activity (Anon. 1994). A survey of 220 inhabitants living in the coastal district of Dagebüll in Nordfriesland confirmed that, due to overproduction, farmers have changed their minds about reclamation (Goeldner 1997). It also showed that, on a local scale, this new way of thinking is more the product of the current economic situation rather than the need of protecting the environment. The ecological impact of reclamations continues to be largely unrecognized by the local inhabitants.

Legislation concerning the protection of tidal marshes has progressed considerably since 1973, facilitated not only by the aforementioned economic context, but also by intense social pressure. The protected areas have continually grown in number and size, thanks to the regional and federal environmental protection laws of 1973 and 1976 (*Gesetz für Naturschutz und Landschaftspflege, Schleswig-Holstein*, 16.04.1973; *Bundesnaturschutzgesetz*, 20.12.1976) and to the creation in 1974 and 1985 of both the conservation area of the Nordfriesland Wadden Sea (*Landesverordnung über das Naturschutzgebiet Nordfriesisches Wattenmeer, Schleswig-Holstein*, 22.01.1974) and the Wadden Sea National Park of Schleswig-Holstein (*Gesetz zum Schutze des schleswig-holsteinisches Wattenmeeres*, 22.07.1985).

The protection itself has become increasingly specific. In 1982, for instance, the revised regional law on environmental protection concerned wetlands in general (*Gesetz für Naturschutz und Landschaftspflege Schleswig-Holsteins*, 19.11.1982) whereas in 1985 the more specific flora and fauna of the Wadden Sea was targeted (*Gesetz zum Schutze des schleswig-holsteinisches Wattenmeres*, 22.07.1985). In 1987 and 1993 both the tidal flats and salt marshes were included as biotopes in the revised federal and regional laws on environmental protection (*Bundesnaturschutzgesetz*, 12.03.1987; *Gesetz zum Schutz der Natur, Schleswig-Holstein*, 16.06.1993). On an international level, the Wadden Sea has, since 1990, benefited from its inclusion in the group of biosphere reserves (UNESCO MAB programme) and, since 1991, from its inclusion on the international wetland list adopted by the Ramsar Convention. Today, thanks to this legislation, the Wadden Sea ecosystems can no longer be destroyed or damaged by embankments. However, despite this assortment of protective measures, 'coastal defence' policy still prevails over 'environment' policy in that the construction of embankments for coastal defence is still permitted in the aforementioned regional and federal environmental legislation and in the regional water law (*Wassergesetz des Landes Schleswig-Holstein*, 07.12.1992). The reason for this is their importance for the protection of the coastal population. Nevertheless, since the enactment in 1982 of the regional law on environmental protection, the damage caused by an embankment is systematically 'compensated' for by ecological or financial means. Moreover, in accordance with this legislative evolution, the laws concerning coastal defence have increasingly respected the requirements put forward in the environmental protection acts. Proof of this (Goeldner 1997) may be found in the different amendments to the General Coastal Defence Plan in 1977 and 1986 or in the technical plans for new embanking in Fahretoft (Landesregierung Schleswig-Holstein: Anon. 1987). In the case of the latest reclamations, the reduction in the quantity of area to be reclaimed can be explained by a desire to come to an indirect compromise to appease the environmentalists and public opinion (Table 2 and Fig. 1).

What may be of more interest is the change in outlook of the coastal defence managers themselves. Over the last 15 yr their vision of coastal defence has evolved with the increased environmental protection pressure and the changes in legislation. In order to materialize this compensation clause, they introduced an unexpected landscape innovation on the coast of Schleswig-Holstein. It involved the reintegration of certain polders into the sea. These recent changes have allowed some polders to experience once again the rising and ebbing tidal process. The water of the Wadden

Sea have been allowed to flow over the reclaimed area entering via certain pipes or sea gates which were built into the dykes. At the same time, the polders have been conserved since they continue to be protected by the dyke which separates them from the sea. To describe this experiment, the term 'reintegration' seems perfectly justified since the process involves the return to the sea of some 2000 ha which had been reclaimed from it. This return of the sea, which is totally controlled by planners, allows for the recolonization by different species of plants and animals which are adapted to this new environment. Consequently, the engineers working on coastal defence artificially recreate the ecosystems which were previously destroyed by the embankments. Nevertheless, the first two ecological restoration attempts (Table 3) should be seen as the search for a means to appease the environmentalists who were increasingly opposed to embanking: this solution allows the embanking to continue, but at the same time leaves the polder under the influence of the tides in order to appease those who want to protect nature. However, restoration of these environments was intentionally undertaken by the planners themselves during the first half of the 1980s¹. The reintegration project of 1988 in the Beltringharder polder was more the result of the application of the law on environmental protection, which compels the planners to compensate for any damage to the environment through the restoration, for example, of biotopes which have disappeared after construction of an embankment.

Although these ecological restoration experiments are still too recent to determine whether they have succeeded in leading to ecological succession, they are nonetheless doing well. In these polders (Speicherkoog-Nord and Beltringharder Koog), tidal flats and small areas of salt marshes have reappeared since their reintegration into the sea. Moreover, the mean biomass of these artificial ecosystems is comparable to the mean biomass of the neighbouring Wadden Sea, although the biodiversity and the species densities still remain inferior to the values prior to the construction of the embankment (Hagge 1994). According to ornithologists, the birds which use the Beltringharder polder as a resting ground - especially the waders - need the neighbouring flats of the Wadden Sea in order to feed, because the artificial environments proved too small and poor to support wildlife (Hstker & Klsch 1993). This only supports theories that the experiments remain unsatisfactory: ecological succession has not been achieved

¹In 1998, the Schleswig-Holstein coastal defence department (ALW) was restructured. The reintegration of polders into the sea and the monitoring of the restored ecosystems is now governed by the Ministry of the Environment and its subdivisions (Staatliche Umweltämter).

Table 3. Reintegration of polders into the sea on the Wadden Sea coast of Schleswig-Holstein (after Hage 1994).

Polder	Rantumbecken (Sylt)	Speicherkoog-Nord (Dithmarschen)	Beltringharder Koog (Nordfriesland)
Date of reclamation	1938	1978	1987
Area reclaimed	570 ha	3200 ha	3345 ha
First entrance of the sea	1982	1984	1988-1989
Area of the sea biotope	570 ha	532 ha: < 16.5% of the polder	853 ha: 16% of the polder
Inflow and outflow of sea water	Through two sea gates	through 2 pipes, working since 1986	through 2 sea gates, working simultaneously since 1994
Artificial tidal range in the polder	- Tidal range of 20 cm - Four tides for inflow and three tides for outflow	- Tidal range of 20 cm - Six tides for inflow and two tides for outflow	- Tidal range of 40 cm - Natural tidal rhythm - In effect since 1991 and annually since 1994
Water in movement	-	340000 m ³	1800000 m ³
-Sublittoral zone	238 ha	215 ha	544 ha
-Intertidal zone	47 ha	89 ha	166 ha

after a decade, and no specialized species have yet proven adapted to the new biotopes. But, more positively, this new method of environmental management has emanated directly from the managers themselves and has shown a high degree of respect for the environment and a real desire to come to a compromise which lies within the boundaries of the coastal defence policies. One cannot overlook the fact that this outlook has been, and still is, rather rare on the other tidal coasts of Europe. In fact, only along the Danish (Margrethe polder) and French (Aber de Crozon and Baie des Veys) coasts has the restoration of some tidal marshes been experimented with for purely ecological reasons.

Furthermore, the present rise in sea level paradoxically plays an important role in the decline in the reclamation movement. On the German coast, tectonic subsidence and eustatic variations have engendered higher water levels. The mean high tide level rose by 2.5 mm/yr between 1881 and 1989 and it has risen by 6.7 mm/yr since 1971 (Hofstede 1994). According to recent estimates, a total rise of 75 cm will occur along the coast within the next century (Stengel & Zielke 1994). The consequences of this rise in sea level may well be further erosion of the tidal flats and salt marshes, which, in turn, could lead to the weakening of the resistance of the dykes in place, with the possibility of breaching. In Dithmarschen and Nordfriesland, 70 to 80% of the population and 70 to 90% of the property may be threatened (Sterr 1996). In such conditions the revival of a defensive reclamation policy would not be surprising. However the managers of Schleswig-Holstein have decided to reconcile coastal defence with the protection of the environment. They would heighten the existing sea dykes rather than build new ones along the Schleswig-Holstein coast of the Wadden Sea (Probst 1994). The future coastal defence policy also seems more innovative in that planners would agree to remove, partly or totally, the first line of defence should its strengthening prove insufficient or in the case of an excessive eustatic rise (Probst 1994). This surprising

proposal would be possible because of the existing second line of sea defence, which itself would be reinforced eventually, and thanks to the presence of numerous small agricultural polders. Other reasons would be geological, spatial, legal and financial. The removal of the first dyke would permit the expansion of the potentially eroded salt marshes and would allow for the conservation of this rare and vulnerable ecosystem. Nonetheless, German planners do not intend to remove the recently strengthened dykes even if some environmentalists have already drawn up precise proposals (Reise 1993) and will only do so if the eustatic situation should obviously deteriorate (Probst 1994).

Conclusion

The reclamation of land in the Wadden Sea of Schleswig-Holstein for economic reasons or for coastal defence is now a part of the past. Despite the rise in sea level, there will be no resumption of coastal embankment. In fact, a complete change in strategies has recently appeared in reclamation policy. That is, the reintegration of polders into the sea for legislative or ecological reasons is now possible. This reversal is the result of the will of planners to adapt to recent scientific knowledge and social changes by recognizing the ecological value of tidal marshes, even in relation to coastal defence. This study of German reclamation policy was made at the turning point between the end of a thousand-year-old tradition and the beginning of a new way of coastal management. Henceforth, the opposing values of coastal defence and ecology are now on the way to reconciliation. Thanks to this reversal, a new area of research has appeared in the field of geography: the reintegration of polders into the sea (Verger & Goeldner 1995). In the decades to come, this area is not likely to be limited to the Wadden Sea coasts, but will certainly extend to other western European coasts bordered by tidal marshes.

Acknowledgements. The author thanks Dr. A.W. Pringle (Lancaster University), whose comments and suggestions contributed to the improvement of this paper. The author also thanks W. Iwamoto, who corrected the manuscript.

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Received 5 February 1998;

Revision received 8 October 1998;

Accepted 29 November 1998.