

## Agricultural Geography and Regional Planning in a Marine Foreland

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### Abstract

*The characteristics of the Tønder salt-marsh are illustrated by fragments of history, and by the physical geography. This is followed by examples from the research work carried out concerning the land ownership, the land use pattern, the soil conditions and the topography, all factors influencing highly a regional planning.*

Tøndermarsken, the salt-marsh area along the river Vidå, is situated in the most southwestern corner of Denmark, just north of the Dano-German frontier. Nowadays it is a sparsely populated, an actually extensively utilized region that is technically underdeveloped, in that it is quite insufficiently supplied or totally devoid of such things as roads, fresh water, electricity, detail drainage and much else. Once upon a time it was a pioneer section. The fine old farm-houses, built upon mounds (Danish værfter = man-made elevations on which to build), suggest a certain measure of wealth in times gone by. The region comprises about 10.000 ha. in all, but the following remarks are confined to its western half. In several respects there is a marked difference between the early polders to the east, reclaimed in 1556, and the three outer, westernmost polders. The difference is manifested by the soils, the levels and the ages, but in addition the two regions are divided distinctly in an occupational- and a cultural-geographical sense. This holds good of their forms of settlement and land-use and of their ownership, as well as of their history of course in which the outermost polders form only part of the picture in more recent times (reclaimed 1692—1861). This does not include Trindsand, the ancient foreland to Vidding Herreds Gl. Kog (1436) — in the south-west border zone of Gl. Frederikskog.

Writing a summary of the more important features of this region, its position today and its prospects will necessitate a sporadic selection of certain phenomena. At this juncture I shall recount very briefly some historical facts before quoting examples from the most recent work of *De danske Vade- og Marskundersøgelse* (The Danish Tidal-Flat and Marsh Survey). The necessity of working out careful plans for developments in the future will also be stressed — plans which as far as possible should give proper consideration to natural factors (at any rate they should not be unknown) and also to the prevailing cultural and occupational structure which is greatly in need of modernization and change in step with the new possibilities. In Denmark today the marine foreland, of which this marsh region is but an insignificant trifle, is the only landscape complex embodying any future possibility of intensification and new cultivation. Reclamation in Denmark today is urgently necessary but the possibilities are limited. On this background the planning work of *De danske Vade- og Marskundersøgelse* is of particular interest as the approaches to the problems in fiord and meadow areas along every Danish stretch of coast can and should be analyzed along similar lines, so that we may be more or less ready when the thumb-screws of intensification receive another twist or two.

Tøndermarsken lies in the western part of the valley of the Vidå. Together with the tidal area and the range of dunes it forms the westernmost of the main geomorphological types that trisect South Jutland from north to south. Centrally in the region are extensive outwash plains with islands of older moraines. Rising near the east coast is the main Würm stationary line and the east coast itself is characterized by late-moraine deposits. The river Vidå with tributaries rises just west of the main stationary line. The total area drained through the sluice at Højer comprises 1225 km<sup>2</sup>. of which ab. 125 km<sup>2</sup>. are placed on the German side of the frontier.

The marsh is entirely of recent origin, created by the postglacial transgression which is still in process of development (1960, p. 58). Its situation on the south-east side of the North Sea signifies a tide of about 2 metres as well as passing of cyclones with wind changes from SW—NW as the predominating type of weather, in fact almost the sole type in gales (forces above 4 Beaufort). Such conditions cause the accumulation of water masses accompanied by disastrous floods, such as those which in 1362, 1634 and 1825 left permanent traces. Even present day technics are unable yet to give guarantees against recurrences, as was clearly demonstrated in Holland in 1953.

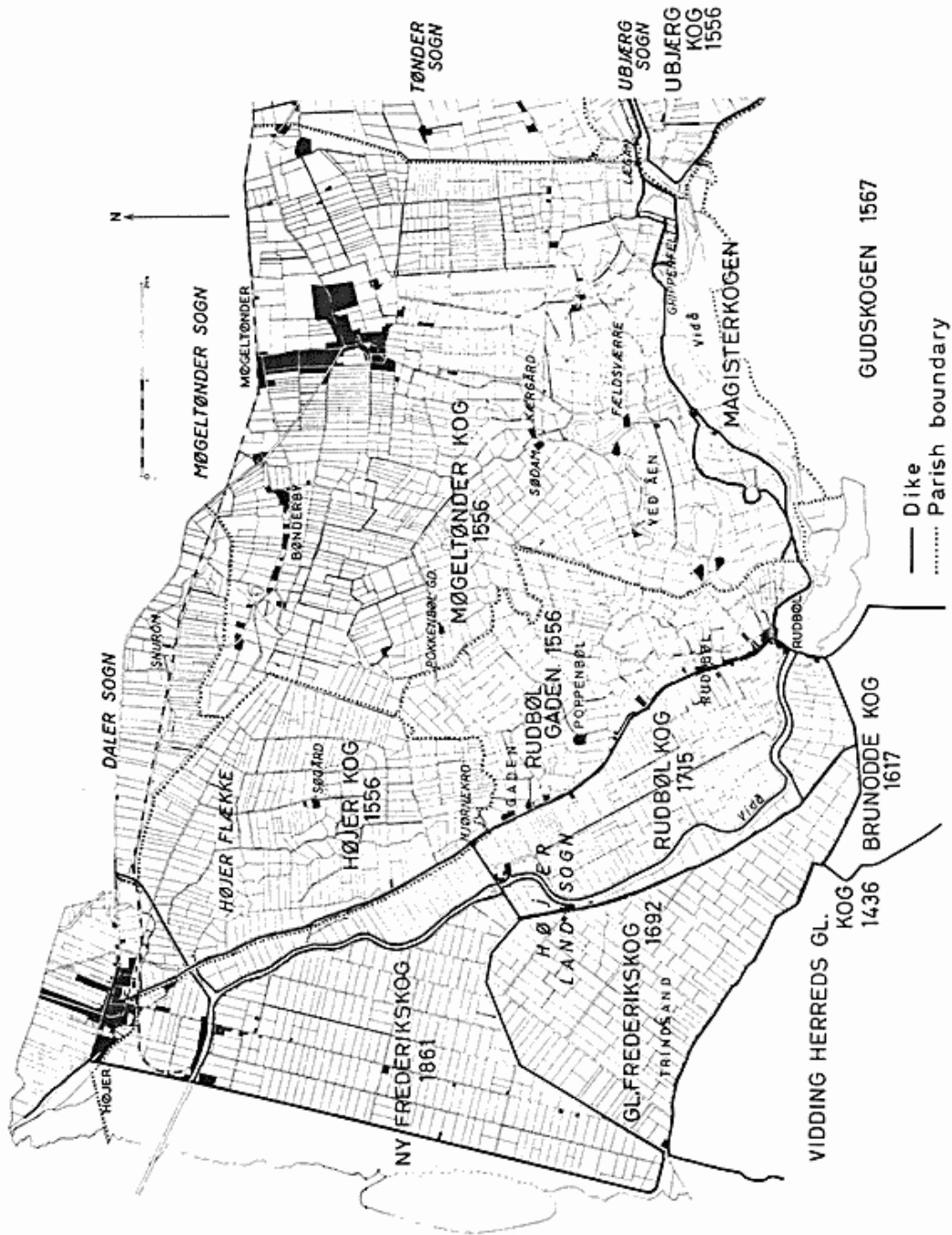


Fig. 1. Map of the western part of the salt-marsh area of Tønder (Tøndermarsken), indicating the position of the polders in relation to the parish boundaries. The pattern of ditches around the fields (Danish: fenner) differs with the age of the endikements. Further, the map elucidates old rivulets, dike-bursts and retirements of dikes.

As regards historical developments, Slesvig has lived a chequered sort of existence as the meeting place between Danish and German. Furthermore, westwards in the marshland and on the islands one encounters the Frisians, the earliest colonizers in this region. Slesvig is ancient Danish territory, segregated for the first time in 1115 as a duchy for Knud Lavard, the son of King Erik Ejegod. By this was set up the tradition of division among the king's sons which took place in 1241 after the death of Valdemar II, and in 1544 after the death of King Frederik I. In the course of time the Danish duchy of Slesvig was often coupled together with the German duchies of the Danish monarchs, especially Holstein. In periods, such as the first half of the 14th century, the entire region was owned by the dukes of Holstein. Contemporaneously with the changing political affiliations (the Danish king or the Gottorp dukes) Slesvig became more firmly associated with Holstein and Germanization spread, particularly via the Church, from south to north. In 1864 all Slesvig fell to Prussia and thus to the new Germany. In 1920 the northern half voted itself back to Denmark. One special problem of particular importance in the western districts was the monarchical enclaves, somewhat large areas of good strategical situation as regards trade routes on land and sea, which had belonged direct to the Danish crown in the period 1407—1864. Originally these areas belonged to the noble family of Limbek or to the see of Ribe. After 1683 the region was subject to Christian V's Danish Law, whereas the Duchy of Slesvig came under the Jutland Code given in 1241 by Valdemar II.

It was fairly late before man settled in Tøndermarsken. Nothing concrete is known about it, but to judge from the place-names there can have been no colonization before about 800—1000 A.D. (—mark, —bøl). There have been no archaeological excavations of the mounds, but borings have been made (the four types of mound shown in pl. II, sections A and B). Nothing definite has been found in the way of farms built on the flat ground such as those referred to by *van Giffen*, *W. Haarnagel* and *J. Bantelmann* for the Netherlands and German marshlands, but the mounds Ved Æen (section B) show three habitation strata, in the »hallig«\* islands Rudbøl-Gaden two strata and in Gl. Frederikskog one stratum, which corresponds to the assumption that settlement in this region was late in coming and that the earliest habitations were made on artificial earth mounds: »værfter« along the banks of the Vidå (cf. pl. II B), Møgeltønder parish in the region Ved Æen. It is scarcely to be doubted that this colonization

\* a "hallig" is an undiked salt-marsh island.

was made by Frisians. Between them and the Danish inhabitants of the geest lay miles of marshes in which a few geest blown-sand ridges rose like islands. The upper marsh sediments had not yet been deposited at that time. At about the same time or a little later came the colonization of the »hallig« area.

Rudbøl-Gaden. The first historical information about these settlements is contained in *Saxo Grammaticus'* description of the west coast of Slesvig, Frisia Minor (vol. 14), Bishop *Gunnerus'* account of a tithes dispute (1233) and in *Avia ripensis* (1340). The latter is a list of churches in the bishopric of Ribe and it contains the entry Anflod church (which must have stood at Rudbøl); subsequently it was deleted with the word; *submersa*, presumably in the flood of 1436 (*Cl. Rolfs*, p. 9).

It would thus seem that the Frisian colonization of the region comprised settlement on islands large and small along the shores of the Vidå. Apart from securing their dwellings the settlers built small dikes (summer dikes) to protect the cultivated fields around the mounds. It was much later that flood dikes (winter dikes) were put up in this region, and it was on the initiative of both king and duke who were eager to consolidate their access to, which also meant their control of Vidding Herreds Kog to the south, reclaimed in 1436. The inner polders on Tøndermarsken were diked in 1553--56 by a collaboration between the ducal parts and the monarchical enclave of Møgeltønderhus. This dike ran from Højer through Rudbøl eastwards to Grippenfelt, where the Vidå was crossed at Lægan, whereafter the dike continued southwards to Grelsbøl. This reclamation comprised in all nine polders, or about 7.000 ha. By this operation Tønder was cut off from the sea and acquired a port at Lægan. The diking of Gudskogen and Magisterkogen was completed in 1567, whereby Tønder's port was moved to Rudbøl. Till then the inhabitants had lived unprotected from tides and floods on the three hallig islands and in a row of mound dwellings along the banks of the Vidå as well as on small halligs where the marsh areas bordered upon the geest. The situation of these habitations is clear from the sections A and B on pl. II. The location of these settlements must have been determined by the somewhat higher levees and islands and the consequent possibilities of transport via rivers and tidal channels. After the areas were diked in, life was rather more secure, but more especially as regards agricultural utilization and transport by land, the subsequent centuries having records of many disastrous floods with breaches through the dikes, particularly in the area

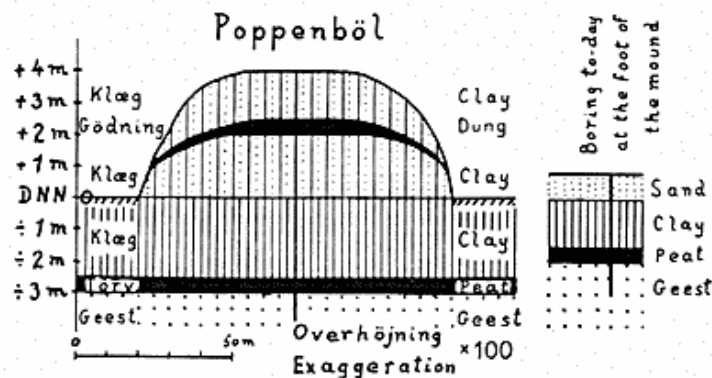


Fig. 2. Section through Poppenbøl "værft" (Cl. Rolf's description p. 234). The top of the mound is situated at ab. + 4 m. DNN, which is the flood-proof height. The previously inhabited stratum, at approximately + 2½ m. DNN, corresponds to a flood-proof height when the settlement was started. Borings at the foot of the mound show sand deposits of about 1 m. on top of the previous marsh surface (N. Kingo Jacobsen, 1956).

south of Højer and north of Rudbøl; at the latter locality when the dike was being restored in 1660 it had to be withdrawn several hundred metres over to the east side of the old hallig islands. This is visible in the course of the dike today and is also expressed through the reclamation rights west of this area, Rudbøl Kog. The following is a summary of the early settlements on the three hallig islands:

*Gaden* (northernmost hallig, cf. fig. 1)

1695 380 demat (= about 1 acre)

1769 5 bol on 4 mound, 5 houses with 52 inhabitants, 4<sup>1</sup>/<sub>16</sub> ploughs

1837 4 farms

1860 4 farms

*Poppenbøl* (middlemost hallig island, cf. fig. 1)

1695 216 demat

1769 2 bol and 2 houses with 22 inhabitants, 2<sup>1</sup>/<sub>5</sub> ploughs

1837 2 farms and 3 small holdings

1860 2 farms, 4 houses

*Rudbøl* (southernmost, largest hallig, cf. fig. 1)

1769 8 bol, 21 kaadnere and 12 inderster, in all 229 inhabitants, 4<sup>2</sup>/<sub>3</sub> ploughs

1837 5 farms, 27 kaadnere and 10 inderster, in all 51 houses

1860 6 farms, 51 houses.

Originally one »bol« was equal to one plough, i. e. one farm capable of being worked with one plough. About the year 1800 one plough was reckoned as equal to 100 demat.

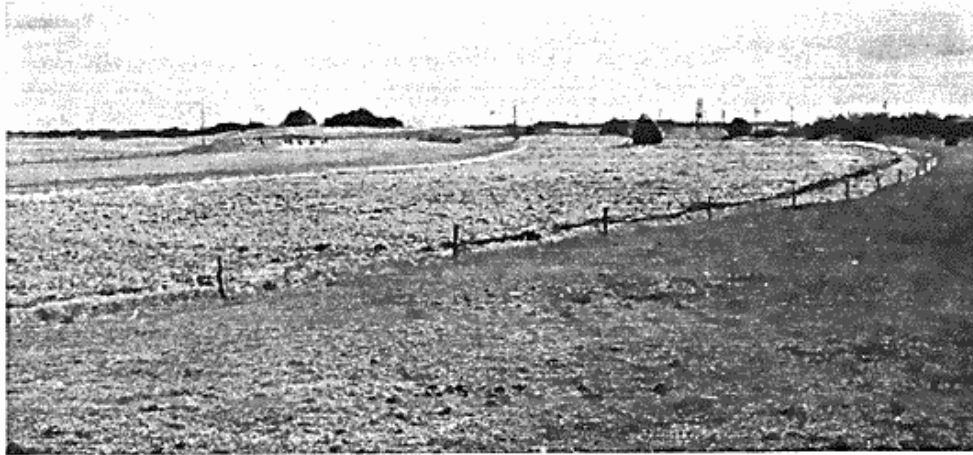


Fig. 3. A view of the Tøndermarsken in the region "Ved Aen". The old rivulet is seen on the curving fence-lines of the fields. In the background the dwelling-mound "Fældsværre", the south-easternmost mound in the profile B, plate II.

Although it has entire areas of good farm land Tøndermarsken is only thinly populated today, about 7 inhabitants per km<sup>2</sup>. There are several causes: the character of the land titles, faulty boundary drawing, bad roads, and so on. These phenomena could be clarified only by protracted studies in the field, for the reason that statistical material suffers from two grave defects: 1) where the material is most detailed the information is given parish-wise, whereas what is wanted is to segregate a geomorphological province which for many easily understood reasons lies transversally across the parish boundaries; 2) the actual subdivision and utilization of the lands of each farm cannot be elucidated statistically. In the following I shall give examples of how the details of utilization are charted as well as a single aspect of the very complicated ownership details. Equally important matters such as soils and levels will then be touched upon very briefly before the total picture is outlined in connection with the desiderata if a reasonable regional planning is to be carried through.

#### **Land ownership**

An account of the property rights is based upon information secured from the land registry as at 1st January 1954. The area investigated covers about 6.000 ha. in the possession of about 600 titleholders, a pattern which has been arranged in nine categories: five as to the domicile of the owners and four as to the properties held by institutions or the public. Here the marked difference between the earlier polders (1556) and the three outer ones becomes

clearly manifest. In the old polders it is plainly to be seen that originally there were only two categories of owners: a) the land owned by people living on the neighbouring geest, a category, comprising all Højer Kog, Daler Sogn and the half of Møgeltønder Kog nearest the geest (peat basins and the blown-sand terrace nearest the geest), b) the land owned by people living in the salt-marsh, this category is consisting of Rudbøl-Gaden and the area Ved Aen as well as isolated blown-sand ridges in Møgeltønder Kog which stood out as hallig islands relatively early in time. Whereas the latter group of owners is chiefly formed of farms with well-designed fields, there is a highly complicated system within the areas owned by people of the neighbouring geest, a system that is most disturbing to a modern form of utilization. Conditions are otherwise in the three outer polders, where there is a veritable labyrinthine distribution of all nine title categories. This will be realized from the following description of the endowment-owned land (fig. 4), which is an excellent type specimen of the cultural-geographical peculiarities prevailing in these parts, peculiarities that are rooted in natural factors and today represent the chief reason why this particular part of the Tøndermarsk must be described as an extensively utilized region.

»Gold may perish but marsh land persists« is a familiar saying round Tønder way, and one of deplorably apt significance when one recalls the contributions made by public benefactors (of which there have been many at Tønder, Møgeltønder and Højer in the course of time) but squandered in the State bankruptcy of 1813, the Great War of 1914—18 and the subsequent inflation. It is only in cases such as the P. Struck Foundation, established in 1713 and consisting of 91 demat of marsh land, that the capital has been maintained and indeed doubled by the reclamation of Ny Frederikskog in 1861, and furthermore by the interest being secured against market fluctuations. It is clearly evident from fig. 4 that the endowment lands are to be found almost solely in the three outer polders: Gl. Frederikskog, reclaimed in 1692, Rudbøl Kog in 1715 and Ny Frederikskog in 1861. On the whole these lands are distributed among 23 endowments comprising 125 »fens« (fields fenced by ditches) totalling 355.1 ha. In the inner polders the only endowment lands are two fens in Rudbøl-Gaden, 3.8 ha., and 8 fens in Højer Flækkekommune of in all 14.4 ha., and these lands are either athletic grounds or small, newly established endowments made since 1920. The rest of the land has the following distribution: Rudbøl Kog, 35 fens of in all



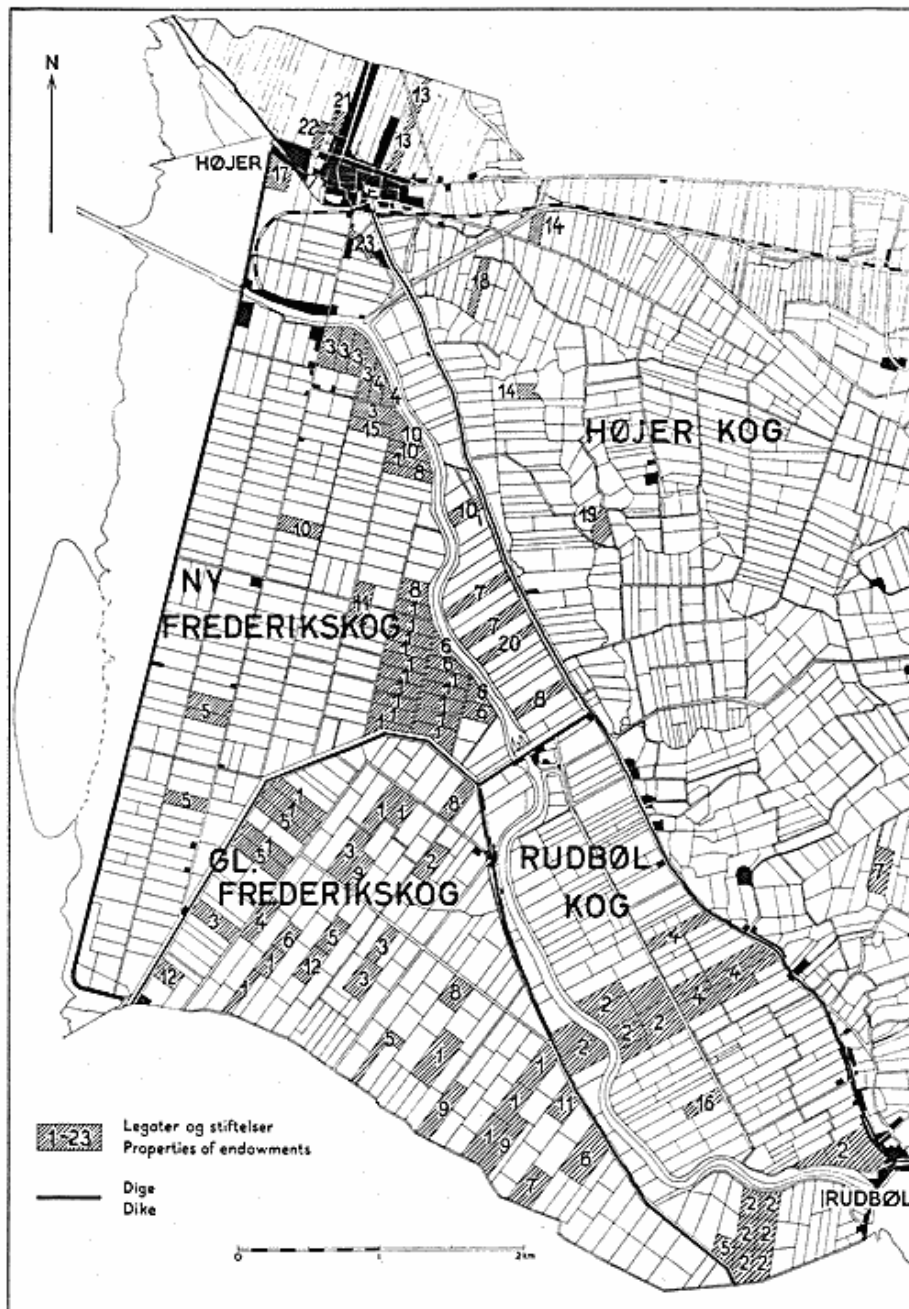


Fig. 4. Property rights as at 1st January 1954 in the Tøndermarsken, exemplified by endowment lands. Dikelines have been drawn to indicate the location of polders, of which most of the inner ones, diked in 1556, have been omitted, as no endowment lands are found here. The figures indicate the individual properties. The few small scattered units of different properties are seen in the inner polders. Further, Rudbøl Kog appears as a unit with other properties than those found in the Frederikskog's. Here, the properties in Gl. Frederikskog (1692) are similar to those in Ny Frederikskog (1861); however, in the old one the properties are scattered.

88.7 ha., Gl. Frederikskog, 34 fens totalling 125.9 ha., and Ny Frederikskog, 46 fens of 122.5 ha. in all.

The following brief enumeration of particulars (*Cl. Rolfs*, 1926) will illustrate the course of events which inter alia led to the appearance of the endowment lands and their special location:

*The inner polders* (Møgeltønder Kog, Højer Kog and Rudbøl-Gaden) were diked in 1556.

*Gammel Frederikskog*, in all 641 ha., was diked in 1692. The charter for Gl. Frederikskog was issued on 15th October 1690 by Duke Christian Albrecht, Gottorp, who afterwards transferred to the participants the property and reclaiming rights to the forelands north of Vidding Herreds Kog and the right to the diked lands free of charge for 17 years after the dike was finally completed. Thereafter the sum of a half rixdollar per demat was to become payable to the ducal treasury. Furthermore the participants and their heirs and descendants were granted complete occupational liberty. All participants with more than 60 demat of land, are principal participants with free hunting and fishing rights both within and without the dikes. Through an inspector they exercise the functions of police and administration in the polder and have the right to build their own church with advowson. Originally there were 5 principal participants, in 1859 there were 7 and in 1891 the number was increased to 10, among them being Tønder Orphanage and Tønder Hospital (see Ny Frederikskog).

*Rudbøl Kog*, 570 ha. in all, diked 1715. Charter issued by the ducal Bishop Christian August at Gottorp on 30th January 1712, giving the same rights as the charter for Gl. Frederikskog. The cost of diking was defrayed by Councillor Joh. Claussen (one third), Province Clerk Christian Bahr, County Clerk N. Hansen, Commissar Heinemann and Dike-Reeve Sibbers the second third, and the participants in the old Højer Kog the last third. The charter transfers to them Rudbøl foreland »vom Friedrichenkoog-Deichhörn westwärts und dann nach Hoyer Deich«. All the principal participants own more than 50 demat of land. They were nine originally: Councillor Clausen, County Inspector Bentzen, County Clerk Hansen, County Clerk von Sallern, Bailiff von Gunderoth, Commissar Heinemann or Dike-Reeve Sibbers, Estate Bailiff Muhl at Rodenæs, Andreas Todsén and Sønnich Nissen, Freemark. In 1859 there were three principal participants and in 1891 only two, one of which was the Gunderoth Foundation at Aabenraa.

*Ny Frederikskog*, in all 863 ha., diked in 1861. On 24th March

1859 it was announced that the Gl. Frederikskog charter issued in 1690, in so far as it was unchanged or had been amended by later common laws and decisions, was to be regarded as applying in the same measure as to Gl. Frederikskog, so that the foreland now lying beyond the polder was to become the property of the polder participants. The debt incurred by diking was repaid in the 17 years during which the polder was free of taxes under the charter. Thus the Gl. Frederikskog charter also applies to Ny Frederikskog and both polders are also joint owners of the foreland which, however, has now been transferred to the Danish State (by agreement in 1956). In 1891 there were the following principal participants of the Frederikskog's: 1. Crown fiscal, 2. H. R. Angel, Hohenwarte, 3. Julius Brodersen at Frederikskog, 4. Staatraat Thomas Todsen at Flensborg, 5. J. Hinrichsen at Østerterp, 6. N. A. Paysen at Vimmelsbøl, 7. J. A. Lund at Ballum, 8. Cl. Clausen at Svenstrup, 9. The Orphanage at Tønder, 10. The Hospital at Tønder.

These few particulars make it evident that land titles in these parts are extremely complicated. This is further exemplified by the fact that the chartered polders were subject to the Eiderstedt tribunal up to 1854, whereas the Jutland Code applied to the ducal parts of Højer rural parish and Højer urban commune and the law of Christian V to the monarchical enclaves including Møgeltønder parish. This played a part for instance in the settlement of the action regarding the Kannikhus entailed estate, when it was decided that the paragraphs to be applied were those of the Eiderstedt tribunal.

A statistical investigation of the utilization of the lands in Tøndermarsken was made for the years of 1948, 1949, 1954 and 1957, by means of counts in each fenne (field). For the endowment lands it appeared that they were used solely for grazing, with the exception of 5—10 ha. (the fens in Rudbøl-Gaden and the easternmost ones in Rudbøl polder). The grazing is utilized by about 600 beef cattle and about 600 sheep as well as 25—30 horses and 25—30 dairy cows. In this connection it must be stated that Tønder Commune, which has the administration of large parts of the endowment lands, decided in February 1955 that in future the fens were to be let out for four-year periods.

Particulars of some of the foundations are:

1. *Peter Struck Foundation.* Peter Struck was a lace dealer and councillor at Tønder, he died in 1713. He was brought up as a semi-orphanage child in poor circumstances. The foundation comprises

- 27 fens totalling 91 ha., 11 of them being in Gl. Frederikskog (45.2 ha.) and 16 in Ny Frederikskog (45.8 ha.). Associated with the orphanage at Tønder which also possesses 7 fens of in all 17.6 ha., of which 3 are in Gl. Frederikskog (9.6 ha.) and 4 in Ny Frederikskog (8 ha.).
2. *The Günderoth's Dwelling-house Foundation and the Günderoth School Foundation, Aabenraa.* Set up in 1743 and 1747 by Captain H. von Günderoth, his wife Sophie née von Saldern, and his brother Master of the Stables E. C. von Günderoth. This land, in all 23 fens totalling 65.7 ha., is mostly situated in Rudbøl Kog: 22 fens aggregating 62.1 ha. and in Gl. Frederikskog: 1 fen of 3.6 ha. The land in Rudbøl Kog was conveyed to H. von Günderoth on 14th January 1752 from Councillor Joh. Claussen, who had defrayed one third of the cost of diking Rudbøl Kog.
  3. *Tønder Hospital.* Founded in 1527 by King Frederik I. Proprietor of in all 9 fens of 31.7 ha., of which 4 are in Gl. Frederikskog (15.9 ha.) and 5 in Ny Frederikskog (15.8 ha.).
  4. *The Leo Foundation.* H. F. Leo, dealer in spices at Tønder, died 1812, bequeathed 60 demat of land to the hospital. The foundation comprises in all 14 fens of 28.6 ha., mostly in Rudbøl Kog: 11 of in all 21.4 ha., one of 3.9 ha. in Gl. Frederikskog and two of 3.3 ha. in Ny Frederikskog.
  5. *The Kannikhus entailed estate.* Kannikhus Farm is situated in the west part of Bønderby (Møgeltønder parish). The trust was set up in 1787 by Peter Andersen and wife and comprised a number of areas in the marsh-land, and two-thirds of these were left to the direct heirs of the Andersen family, whereas the heirs of Hans Brodersen, Mrs. Andersen's brother, were to have one-third. The estate to be wound up when the third generation of the family is extinct. The last person of the third Andersen generation died in 1947. The courts have now decided that the will of 1787 also applies to the third generation of the Brodersen family, of which five persons are still living, all in Germany. It must be observed, however, that the total area of the estate within the Tøndermarsken has decreased from 81.9 ha. in 1876 to 25.7 ha. in 1954, comprising 8 fens, of which four are in Gl. Frederikskog (14.3 ha.), one in Rudbøl Kog (2.5 ha.) and three in Ny Frederikskog (8.8 ha.).

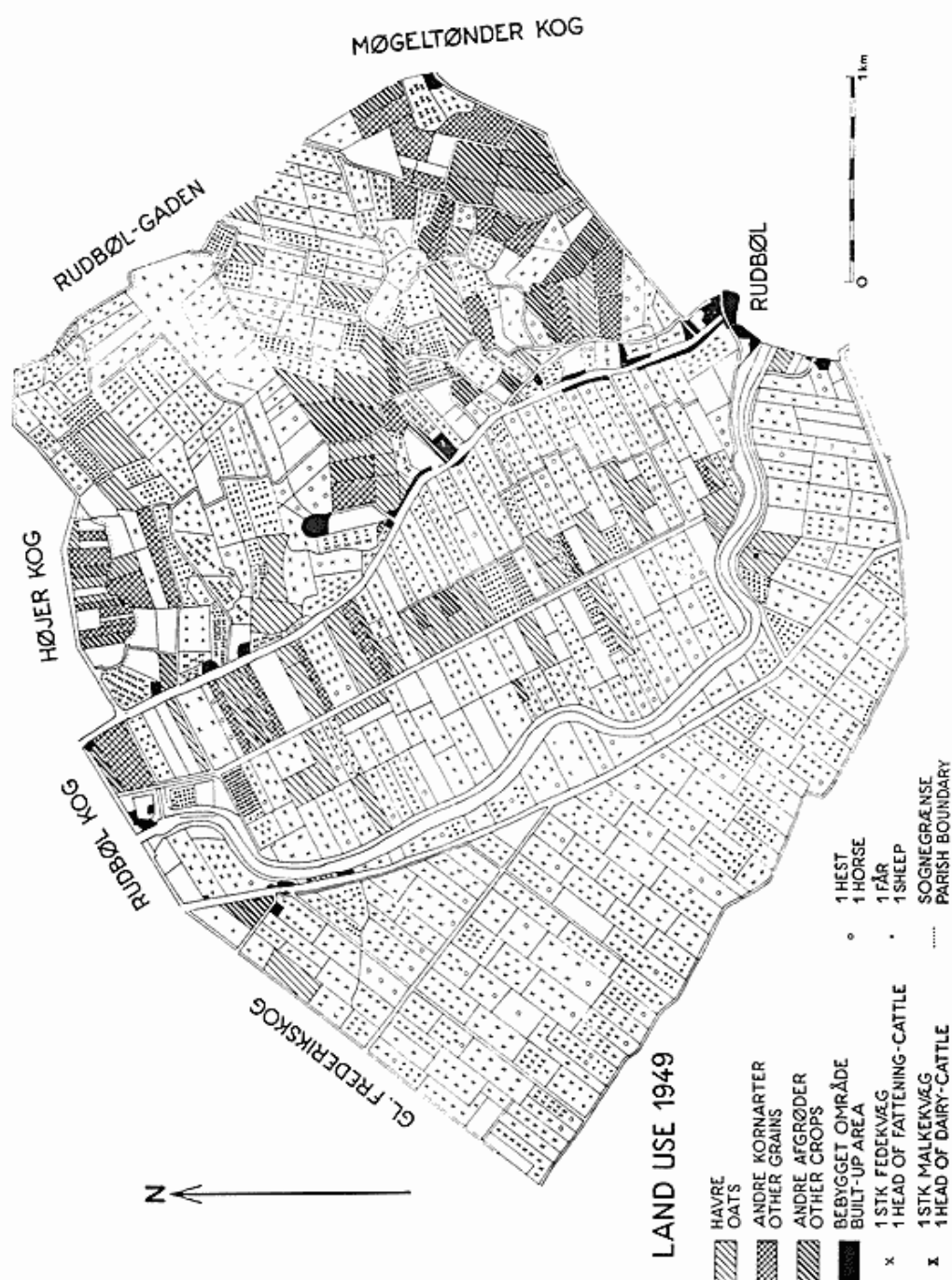


Fig. 5. Section of the land-use map 1949 of Tøndermarsken. The area comprises parts of Gl. Frederikskog (1692), Ruddbøl Kog (1715), and the old polders Ruddbøl-Gaden—Møgeltønder Kog (1556), west and north of the village Ruddbøl. The quite different types of land-use are clearly seen.

These five examples illustrate the character of the endowments and their purpose. It should be added that some of these endowments own extensive areas in the marsh-lands south of the present frontier. Some of this land is occasionally exchanged for German-owned land in Tøndermarsken; for instance, the Popsen Foundation in 1954 acquired a further 10 ha. in exchange, 4½ ha. in 1955 and 3 ha. in 1956, and that the Richtsen Foundation also received 10 ha. in exchange in 1955.

#### Utilization of the land

The area investigated covers about 5000 ha., of which 2500 ha. were diked in 1556 and about 2000 ha. in the new polders. Outside the 1861 dike is a marine foreland of about 500 ha. How the land is utilized was mapped on the spot in July 1949 and included the following crops: oats, barley, wheat, rye, mixed grains (oats and barley) or (oats, barley and rye), root crops, flax and a little potatoes and other crops. The grass fields are used as pasture land, hay fields or grass in crop rotation. On the day when the registration was made every head of cattle in the fields was included.

In *the old polders*, diked in 1556, about half the area is ploughed land. About 75% of this is occupied by oats, followed by barley, wheat and root crops (7% each), the rest having flax and horsebeans. The pasture land occupies the other half with 1800 head of beef cattle, 100 horses, 1500 sheep and about 500 dairy cows. *Gl. Frederikskog* (1692), about 641 ha., has only 5 ha. of ploughed land (oats and flax). The rest is pasture: 1100 head of beef cattle, 60 horses, 300 sheep and a few dairy cows. *Rudbøl Kog* (1715), about 570 ha., ploughed land about 50 ha. (oats 35 ha., barley 5 ha., wheat 5 ha. and root crops 5 ha.). The rest, about 520 ha., is pasture land with 600 head of beef cattle, 50 horses, 500 sheep and a few dairy cows. *Ny Frederikskog* (1861), about 863 ha., with about 25 ha. ploughed land (oats). Most of the area is used for pasture: 1400 head of beef cattle, 100 horses, 550 sheep and 25 dairy cows. *The foreland* is utilized partly as hay fields and partly as pasture. It covers about 500 ha. with 1650 sheep and 22 head of beef cattle.

The general impression is of extensive agriculture, especially in the new polders; a more intensive system is employed in the area close to the geest (the older moraine), as may be seen from the choice of crops (reflecting a rotation system) and the keeping of dairy cattle. The isolated farms in the middle of the old polders have a rotation system of crops mixed with grass land for sheep. Fig. 5

illustrates this distribution of the crops by means of a section north of Rudbøl, comprising parts of Gl. Frederikskog, Rudbøl Kog and some parts of the inner polders. It will be seen from this and the figures given above that the marsh-land is utilized mainly for grazing, especially in the outer polders and other areas with badly marked-out boundaries and owners living at a distance. Here the utilization must be described as extensive with a low hectare yield: 20—30 crop units per annum compared with 60—100 crop units per hectare in rational pasturing (*S. Tovborg Jensen, 1956*). Moreover, areas under field culture have too small a yield on account of the poor drainage while simultaneously the system of open ditches takes up a disproportionately large area. A drive along the Højer-Rudbøl dike (1556) gives a very clear impression of the difference in the land use in the old and the new polders, and of the intermediate position of Rudbøl Kog, due especially to the soil conditions. One will also notice the entire different designs of the ditch and canal system in the two regions. East of the Højer-Rudbøl dike the whole picture is characterized by old channels and creeks (loer), whereas in the outer polders the system is regularly rectangular. This touches upon one of the most delicate of the marsh-land problems: drainage. Since the very first diking this problem has been in the forefront, solved only partially by the construction of sluices. Contributory factors have been and still are the rising sea level with the consequent sedimentation at ever increasing levels. This is clearly evidenced by the relatively high location of the new polders compared with the earlier diking. The problem was only solved effectively by the artificial drainage of 1929; but the four pumping stations: Lægan, Hjørnekro, Snurom and Højer, only provide for the main drainage, making use of the river Vidå and the lake Rudbøl Sø as reservoirs when the sluice at Højer is closed owing to bad weather. This sluice is regulated automatically. Smaller areas along the Vidå, for instance west of the stream in Rudbøl Kog and east of the stream in Ny Frederikskog, are protected by lower river dikes in order to act as emergency reservoirs during protracted gales in periods of heavy rain. The basin of the Vidå extends right over to Aabenraa on the east coast and it takes only two to four days for the run-off to appear in the lower course of the Vidå. What is more, the German pumping station Verlath (Rudbøl Sø) also uses the Vidå as an outlet for the Gudskog area south of the frontier. The detail draining still proceeds chiefly through open ditches, supplemented in the western, high part of the inner polders and in the outer

polders by surface channels corresponding to the ditches (grøble-render) of the foreland. The cattle are also watered through the ditches, which prevents the drying of the soil in the winter months with the result that spring sowing is delayed three or four weeks. Soil improvement work, taking due regard to local levels and the character and spread of the sedimentary deposits, is therefore necessary. Cultivation experiments in connection with it is already being carried on by the State Marsh Experimental Station at Hohenwarte (Højer).

### Soil types and area morphology

#### *Soil types.*

It was stated above that soil types and surface topography have been mapped. About 30.000 borings have been made for the purpose of investigating problems relating to the structure, stratification and genesis of these soils (*N. Kingo Jacobsen, 1956, 1960*). As a result it has been ascertained that the salt-marsh consists of basins to varying depths containing deposits of a variety of types, for instance fat clays are encountered, as well as sand of different characters, mud and peat. This all combines to make the area a mosaic of different landscapes, even if to the student in the field it looks almost the same. It is of practical importance to know about this, because it has a bearing upon the use of the land, the construction of roads, the foundations of farm houses etc. Another important thing is that drainage and cultivation of the salt-marshes result in the immediate shrinking of the soil. Other problems include sodium soils of bad structure and acid soils due to oxidation of FeS which gives ochre and sulphuric acid. In this connection it is important to realize that the salt-marshes are young soils composed of sedimentary strata of varying age, depths and origin, i. e. different facies types. The physico-chemical characteristics of these soils are determined partly by the content of organic matter, partly by the content of CaCO<sub>3</sub>, chloride, salt cations, pH values and partly by the particle sizes and the packing of the sediments (*Kjeld Rasmussen, 1956*). These characteristics are further influenced by climate and drainage conditions as are the biological factors working too.

#### *Surface topography.*

Levellings have been carried out to an accuracy of about 1 cm. Surface spot heights have been determined at each 25 m. in a net, and contour lines have been drawn. In the topography the high-lying geest stands out very distinctly, as do the dikes and the mounds.



The river Vidå is also a clear feature, as well as the old rivulets along which are the mounds with the old farms. Other very low areas are to be seen in the south-east section, caused by breaches in the old dike of 1556. In Rudbøl Kog the old course of the Vidå is also low-lying, as are the small former lakes at Søgård and north of Nørregård farm.

Most of the old polders and Rudbøl Kog lie between 0 and + 1 m. DNN. Very clear is a low basin north of Pokkenbøl farm, which is one of the peat basins where shrinkage has started after the pumping of the Tønder salt-marsh in 1929. Pokkenbøl stands high on a prominent islet in the sub-surface, easily to be seen in the contours to the south-east of the farm. The old 1556 dike running from Højer to Rudbøl has been breached several times north and south, as may be observed on the contour lines west of the dike and also from the turns in connection with the retirement of the dike. The northernmost part south-east of Højer is high-lying according to intruding sand masses during storm floods. Gl. Frederikskog has a high part close to the German frontier. This is a very old foreland from the polder just south of the frontier. The rest of Gl. Frederikskog lies rather low as a result of the influence of the river. Ny Frederikskog lies very high, + 1½ m. — + 2 m. DNN. Along the high parts running N-S through the middle of the polder an old coastline comes into view. The foreland lies high too, + 1.2 m. — + 1.5 m. DNN.

It is a common experience that new polders lie higher than old ones as a consequence of the relative subsidence of the land. In this area the range of the tide is about 2 m., normally from — 1 m. to + 1 m. DNN. In bad weather water masses may be stored in the wadden sea and high water may reach about + 4 m. DNN. The height of the sea dike is + 6.5 m. DNN. With a topography such as this the drainage of the area is as mentioned rather difficult.

### **Regional planning**

In the foregoing I have indicated by example and implication some of the problems which will need searching investigation if the salt-marsh areas along the estuary of the Vidå are to become the colonization territory with intensive cultivation and dense habitation to which its natural potentialities entitle it, by application of present-day science and technics. The realization of such an aim will necessitate long-term planning based upon a thorough-going analysis of conditions today in every respect. As also appears from the examples figs. 4 and 5, the legislature must be empowered to cause a re-

organization of the prevailing systems of ownership and use. Such an organization should proceed gradually, as indeed is already being done; but the drawing up of a general plan provides possibilities of taking convenient advantage of any change, great or small, in the existing conditions, whereby the aim will be attained with the least possible delay. In actual fact plans are already in existence for the safety of the houses, the elaboration of the road system, the parceling-out of areas owned by the State and for further reclamation. The next step should be plans for detail drainage, cultivation and rounding off of property borders — of course in conjunction with general financial plans. Geographical researches of the kind outlined above can enable several of the above detail plans to be realized. The material from Tøndermarsken has not been fully worked up as yet and certain problems need further elucidation; but all in all it should be possible before long to assemble satisfactory long-term plans for the development of the region.

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