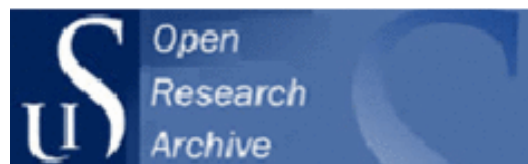




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Ditching from a water system perspective.

Draining the Swedish water landscape 1200–1900

Eva Jakobsson

Abstract: In this article drainage in landscapes with a surplus of water will be in focus. A water system perspective will be applied to ditching. Upstream–downstream relations—whether small, as in this article, or comprehensive—cannot be disregarded when studying water systems. A central task in this article is to describe and interpret the ways these dependences have been controlled. In the article, building drainage systems is regarded as the construction of water systems that extends over, encloses and binds together ever larger areas of the water landscape. Examples from slightly more than 500 years of Swedish drainage history are used in the article. As with other activities involving water, the Swedish state has built up social institutions to regulate these activities. These codes of rules coordinating the management and build-up of drainage systems are interpreted from a water system perspective. Reading the sources and results from Swedish agrarian research in light of this new perspective and using a long time perspective, establishes the legacy of the laws on ditch digging. In the article the physical and social dependence that are built in systems of ditches are demonstrated. Simultaneously the new water systems contributed to building a hybrid landscape, as well as they created new communities of which the Swedish farmer became a part.

Keywords Water system · Ditching · Drainage · Water laws · Swedish history

Introduction

“If the soil is wet, with rushes growing, then a ditch is dug so it can dry”, wrote the Swedish monk Peder Månsson in early sixteenth century.¹ Through the years, the process of healing the “vattensjuk” (Eng. water sick) land has had many different names. Ditching, land drainage, draining, reclamation, extraction of water, diversion of water are all terms

¹ Cited in Gustafsson (1955, pp. 75–76).

for the agricultural method of leading off water from land with the aid of gravity. The aim was either to arrive at a suitable moisture level for the soil or to bring wetter land under cultivation. Action may also be taken to get rid of frost pockets, or achieve full drainage of land not previously used for cultivation. The soil also became less acidic, so that weeds did not thrive so well.

Landscapes with a surplus of water also have their water history. In general, it could be said that there has been little consideration for drainage in historical literature (Pisani 1992, pp. XIV–XV), especially when compared to the great volume of literature on irrigation in areas of water shortage. There are in fact many similarities between preserving, extending, and maintaining a system, either to remove water or convey it into an area. The difference between controls of water in dry areas and in areas with abundant water is not qualitative.

In Sweden it is estimated that 70 % of the arable land is in need of ditching (Bonden 1977). The total area that had been gained by draining wetlands and lowering of lakes at the turn of the twentieth century was estimated at 600,000 hectares (ha = approx. 2.5 acres) (Håkansson 1997, p. 97; Morell 2011, p. 182)). Lowering and draining of lakes was first intended to dry out waterlogged land and later continued with the aim of producing new land for cultivation (Strömberg 1990; Lennqvist 2007; Morell 2011, p. 181). 2.5 % of all Swedish lakes (a total of 2,500 lakes) have been lowered, and 623 lakes have been drained completely.² These sweeping changes to the landscape were made in order to get rid of frost pockets and increase the cultivable area.

Concepts, perspectives and research questions

The way the water flows through the landscape is at the forefront in this study of ditching in a water system perspective (Jakobsson 1999; Fritzboeger 2009; Tvedt 2010).

Different ways of utilizing water have led to the rise of complex water systems. The complexity consists of the merging of those elements created by human agency and those created by nature. Field-ditching, ditching of wetlands, lake lowering, lake reclamation, forest drainage, log-floating, and hydroelectric power production are complex waterborne systems in the landscape. They form different claims to water and they have to coexist in the water system. They all have an intrinsic duality consisting of the fact that they are a part of the hydrological cycle and, at the same time, are under human control and has to receive maintenance in order to keep going. Their interlinking with the water cycle means that these water systems are both dependent on and in competition with each other. In an environmental history perspective, these landscapes with their duality can be labelled as hybrid landscapes (White 2004; Schneider 2011).

People who live near flowing water are linked to each other. This dependence, characteristic of water systems, has led to codes of rules co-ordinating the use of water ever since the ancient river cultures. As with other activities involving water, the state has built up social institutions to regulate activities concerning water (Jakobsson 1996b; Dellapenna and Gupta 2009). Water laws from later periods can be interpreted as the result of conflict between different types of water user, such as agrarian interests and power industries (Jakobsson 1996a). Therefore, a central question in this article is how this dependence in the water system has been controlled and managed.

² A report—“The Swedish Water Archive. Lowered and drained lakes”—by the Swedish Meteorological and Hydrological Institute lists all lakes lowered and drained after 1832 (Svenskt vattenarkiv. Sänkta och torrlagda sjöar 1995).

By legislation, the Swedish state—in the various forms it has taken, has regulated those who have interfered with water flows: for example by controlling the relationship between those living higher up the catchment area and those living further down. Vattenavledning (diversion of water) is the Swedish legal term that covers activities like ditching, land drainage, draining, reclamation and extraction of water. If diversion from watercourses for the purpose of generating power is involved, the operation is governed by lucrative water law. But if the aim is regulation for the purposes of reclamation or extraction of ground water or surface water, the operation comes under defensive water law. This text deals with diversion of water in the latter sense—what we normally call drainage, removing surface or ground water.

A brief review of the progress of land reclamation in Sweden between the Middle Ages and the end of the nineteenth century shows that the diversion of surface water was the main concern for farmers until the mid-eighteenth century. Ideas of draining the soil to a certain depth arose during the 1800s. This lowering of the water table to obtain an aerated rhizosphere only became possible with the digging of deep ditches or covered drains (Gustafsson 1955, pp. 80–81; Håkansson 1997, pp. 93, 98). The state has built up systems of rules on bearing the cost of reclamation projects, as well as who has an obligation to dig ditches and who has a right to do so. Historically, the Swedish state had been enthusiastic about drainage and decided when ditches should be dug; it acted as the economic provider of grants or loans as well as the disseminator of knowledge through professionalizing and making available expertise in the construction of drainage systems.

When looking at drainage from a water system perspective, the water remains interesting even after it has been led out of the field. It broadens the spatial perspective to competing activities in the entire water landscape. The water that runs through the landscape on its way to the sea—through streams, tributaries and larger rivers, canals, dams and lakes are in this sense important. What had been the interplay between the increasing scope of water diversion techniques and the construction of institutional frameworks concerning the water in the landscape? The thesis is that social institutions, as water laws, encompassed more and more of the water system as the demand for greater control of this flowing water grew.

The catchment plays an important role in a water system analysis. In the Swedish Drainage Act of 1879, it is explained how a ‘joint natural property unit’ may have looked from the ditcher’s perspective.

Everywhere the land is divided by more or less perceptible elevations into valleys where as a result of precipitation or from springs underground the water burdens the soil, gradually running down into the bottom of the basin, whence it goes on to seek its outlet in the direction determined by the slope of the land and possible intervening obstacles. Each such basin represents a natural property unit, united by the common interest in arranging the outflow of the water in the most convenient manner, for to a greater or lesser degree every obstacle has an effect on the land above it and subjects it to the disadvantage of being damaged or burdened by the water remaining upon it (Lag om 1879, p. 6).

Within every catchment basin, sub-basins can be distinguished. From a drainage perspective we are interested in the smallest of these catchment basins. As ditching affected the water that flows through the landscape, it nearly always involved other landowners in the same sub-catchment. The quotation above makes clear that the catchment unit constitutes a whole and that those who lived in this natural property unit had to be united in their activity if they wanted to increase the outflow of the water. It also

illustrates the fact that this dependence was even found in the smallest catchments in a water system perspective.

The draining system had to be maintained in order to function. Ditches required continuous maintenance to prevent them from either collapsing or silting up (Myrdal 1999, p. 288). Swedish agrarian historian Janken Myrdal (1999, pp. 24, 50)³ mentions the ditches as a new feature of medieval agriculture “that required unexpected changes in the law” or were innovations “that needed control”. Without going more deeply into the matter, Myrdal mentions that the medieval laws gave the right to compel neighbours to dig and allow the passage of water, even if it did not benefit them. Without such provisions, the systems of ditches would not have been effective. In the Swedish medieval provincial law codes this water system dependence were described like this:

Whoever has land on which there is flowing water, may dig a ditch across his land up to that of another, and request him to dig across his land. If he wishes not to dig, than he may go to the church and plead against the landowner on a Sunday, on a second and on a third that he should dig through his land. If he will not, he shall be fined three öre.⁴

The ordinance governing cowshed land in the town of Arboga in 1659 also showed that this dependence must be embraced by everybody if the ditching system was to function: “that the water may have its free outflow into the main drain”. He who did not do so had to dig ditches and pay a fine.⁵

The time frame for this analysis is long—from the Mediaeval period up to 1900, when new prime movers (other than gravity) were put into the drainage system. We shall therefore follow the drainage of agricultural land from the low ditches of the Middle Ages that merely surrounded the fields, to the construction of more spatially extensive systems—both in range and in depth—among which the outlet drain had an important role.

The primary source materials for this article are thirteenth to twentieth century Swedish regional and national legislation and policy documents on water. Results from Swedish agrarian history research are also used.⁶

This study says little about actual practice and the extent to which there was compliance with all these different rules on drainage. It is also clear that we really know extremely little about the ditching itself; for example, how was it organized locally, who did the digging, and how. In other words, little research has taken us down into the ditch itself—right down to the mud at the bottom.⁷

The following text has three main parts: the Middle Ages, the sixteenth to eighteenth centuries, and finally the nineteenth century up to the Drainage Act of 1879. Each section begins with a description of the development of the digging of ditches, and is

³ Verena Winiwarter also discusses the same principles concerning other manmade structures in the medieval landscape (Winiwarter 1999).

⁴ Dalalagen, BB, XLII, p. 60. In: Svenska landskapslagar (1979b).

⁵ Cited in Lindegren (1988, p. 71).

⁶ For an overview in English on Swedish agrarian history, see: The Agrarian History of Sweden (2011).

⁷ It appears in fact that we know more today about the lowering of our lakes than is known about the many miles of ditches that were dug all over the watery Swedish landscape (Fryksén 1973; Strömberg 1990; Lennqvist 2007).

followed by an account and survey of the institutional innovations of that particular period.

Ditches in medieval Sweden

A connection has been established between the agrarian expansion in Europe around the year 1000 and an increase in drainage (Myrdal 1985, p. 60, Myrdal 2011, p. 84). The earliest evidence of ditches in Sweden comes from a field in North Uppland (north from Stockholm) and was dated to the period 1000–1300 AD. Ditching is regarded as having become widespread by the early fourteenth century. Small boundary ditches were shallow, used for running off surface water, and generally surrounded all sides of the field. This distinguished them from farmland ditches that could remove water—those had to be levelled, deep enough out, and had an outfall, so the water would not become stagnant. Right up until the eighteenth century most ditches were in Eastern Central Sweden. The land here was more terraced and the soil was more permeable. The provisions of the various law codes regarding ditching were very similar in content and form; unlike, for example, the regulations governing fencing that varied from province to province. The agrarian historian Janken Myrdal takes this as an indication that these laws were introduced later but at the same time, and over quite a large region (Myrdal 1999, pp. 47?; Gadd 2000, pp. 149, 150).

The medieval laws were widely used in agrarian history, especially for the early period. These laws cannot only be regarded as a series of decrees from a powerful upper class—it may also be seen as the outcome of negotiation. The mediaeval laws can also be seen as describing people's everyday lives and the system of rules under which they lived. Here, the influence of a large free peasantry is not to be underestimated (Myrdal 1999, pp. 22?). Environmental historian Verena Winiwarter (1999) has discussed medieval normative sources as representing a collective perception of the environment and how they could be used for understanding environmental relations during that time period. She maintains that these laws inform us how “people saw, what they perceived as worthy of a regulation, and how they devised means of regulation to be enforced” (Winiwarter 1999, p. 24).

Ditching was thus a feature of East Central Sweden from the Early Middle Ages onwards. In other parts of the country, the plough was used to ridge the fields, and the water was drained off between the ridges. This was particularly so in the heavy clays of West Västmanland, Närke and to some extent in Västergötland, Bohuslän and Skåne. Ditches were therefore not needed for removing surface water. In Southern Sweden, the forests grew on easily drained sandy soils and there was little need for ditches (Myrdal 1999, p. 287).

Historian Jan Lindegren sees the mediaeval law codes as expressing a “pro-ditching” political climate when they made their mark (Lindegren 1988, pp. 62, 64, 82). This positive attitude to ditching could also be expressed as in the fourteenth century regional Hälsingland Law: “For he shall prevail that wishes to cultivate”.⁸

The fact that the laws are so similar in their formulation would seem to have its background in their simultaneous incorporation in the different law codes. They describe different types of ditches and regulate the division of the work of ditching and the penalties for neglecting this duty.

⁸ Hälsingelagen, Byalagsbarken IV: “About ditches between fields and damage through ditches”. In: Svenska landskapslagar (1979c).

The mediaeval law codes stated that the width of the ditch should be between 4 and 7 feet. Yngve Gustafsson explains that the provisions on the width of the ditch in earlier legislation come from the farmer's reluctance to relinquish more soil than necessary. To make the flow through the system, it was of course important for the size of the ditches to be roughly equal. The lack of stipulations regarding depth is taken as evidence by Gustafsson that it was only surface water that was to be run off. Each and every one was to dig in front of his arable, but it is important to stress that there was not yet a general instruction about digging (Gustafsson 1955, pp. 75, 80, 81; Myrdal 1985, pp. 60, 61; Lindegren 1988).⁹

A number of the law codes also state that if the ditch lay between the fields of two peasants, one half the ditch had to be on each one's arable. Each person had to dig in front of his field.¹⁰ Fines were imposed on anyone who allowed his ditches to become blocked up.

From a water system perspective, the essential point here is that there was a duty to lead the water off through the catchment area—to ‘let the water pass’ as it was expressed in the fourteenth century Magnus Eriksson's law code.¹¹ The Västmanland Law states:

Now someone lays the ditches through his field or his meadows and they reach the arables of another village or meadows or pasture or other village land. If those who own the village are not willing to let the water pass, they shall recompense the party that suffers loss.¹²

The Södermanland Law shows that villages could not impede the water from another village:

If a village's lands meet another village's ditches, which have been dug, and if those who have dug suffer loss of field or meadow because the others will not lead off the water from themselves, those who have caused the loss will be fined as provided by the statute.¹³

These examples highlight the need to formulate explicit rules to coordinate the dependence in those early drainage systems.

Drainage policy on the agenda—1500–1800

The first Swedish political pronouncements on the subject of ditches came in the prolific writings of King Gustav Vasa (1496–1560)—the first king with actual centralized power in Sweden. His advice and prescriptions to the Swedish people are well known, and one area that he believed that the population should be trained was in drainage (Myrdal 1999, pp. 216, 217). In the summer of 1555, the sovereign wrote in one of his many letters to his subjects about the obstacles encountered by farmers who wished to clear lands and dig ditches. The awareness that ditches form water systems, and of why they did not always function, becomes clear in this encouragement from the throne:

⁹ It should be noted that the preserved parts of the mediaeval regional Östgöta, Västgöta, Skåne and Guta Laws lack provisions for dealing with drainage.

¹⁰ Upplandslagen, Byalagsbarken IV ‘‘On ditches between fields’’. In: Svenska landskapslagar

¹¹ (1979a). Magnus Erikssons landslag, BB VI. In: Magnus Erikssons landslag (1962).

¹² Västmannalagen, BB IV ‘‘On ditches’’. In: Svenska landskapslagar (1979b).

¹³ Södermannalagen, BB XII ‘‘On ditches and peat pit’’. In: Svenska landskapslagar (1979c).

for when the one wishes to dig ditches or clear them, the other, who has the strip of land beside his, does not wish to do it, and so he who would gladly support himself and diligently use and drain his field and meadow, has all the water on his land himself.¹⁴

Jan Lindegren (1988) has identified Gustav Vasa as the first person in power to pay attention to inadequate ditch digging. He warned in no uncertain terms that the whole country was going to rack and ruin and would become bog and marsh, where “wild rosemary, bog myrtle, bilberry and cranberry” grew, all because “the fields have not been held by ditches as they should”. The exhortation was clear: “drain your fields”.¹⁵ As was his habit, the king put the lack of enthusiasm for ditching down to absence of industry and work ethic; on 15 May 1559 Gustav Vasa wrote to the people of Östergötland province to remind them that he had repeatedly urged them to “maintain and work your field and meadow with greater energy and intelligence by draining, clearing, and in other ways”, and it was because of their disobedience and sloth that the land was being “laid [to] waste and ruined”. He urged his bailiffs and foremen to be assiduous in their inspection of ditches and to try those who ought to be punished. The cost of negligence should be paid by the neglectful, and fines imposed for every inadequate ell of ditch found. Here, then, was the first steps towards an inspection system for the maintenance of the water system. In other letters to his subjects the king emphasized that this also applied to the tenants of the privileged classes and the church. But he also pointed out that this must be done without harm coming to anyone. He even described how ditches should be dug: The party living furthest down must start ditching, while the party “at the top of the slope” should start last. This was not in itself a new idea; the farmers already knew this.¹⁶ In the vocabulary of a modern sociotechnical system, King Gustav Vasa would have been considered a system- builder (Hughes 1987).

The sixteenth century brought a house inspection ordinance, which demanded that a certain amount of ditch be dug each year. Drainage in itself became more important, but in this case control became firmer (Myrdal 1985, p. 61). A distinct policy on drainage initiated by the authorities began to emerge—namely that a certain amount of ditch should be dug each year.

Also in the sixteenth century, specialist ditchers began to appear, probably with a background in mining. These “ditchers” became well known all over Eastern Sweden. They had knowledge of the actual planning and levelling of a drainage system. Here it was first and foremost the knowledge of correct alignment of the ditches that had primacy. At this time, special ditching spades also began to appear. But the ditch retained its medieval form for a long time. The width between the strips was 1–2 m and the depth somewhat less. Even if ditch digging appeared at the same time as the iron-tipped spade, the knowledge of the system’s construction was more important than the implements used (Myrdal 1999, p. 288).

The surveyors’ maps of the seventeenth century show a rather irregular network of smaller ditches connected with the drainage ditches. Yngve Gustafsson calls this ditching “as needed”, which means that ditches were dug as and when the fields needed draining. The ditches were straight, with right angles and almost in chessboard pattern, which may indicate

¹⁴ Cited from Gustafsson (1955, p. 89).

¹⁵ Cited from Lindegren (1988, pp. 74, 75, 80).

¹⁶ Cited from Gustafsson (1955, pp. 73, 74). There are several letters of similar content in the registry for 1550.

a medieval origin. The eighteenth century brought straighter, longer ditches that were closer together. The surveyors' instructions insisted that efforts be made to lay the ditches in straight lines. The provisions of the Great Land Redistribution stressed that the ditches had to form the boundaries between the parcels (Gustafsson 1955, pp. 76, 88; Lindegren 1988, p. 71). In these directives we now find the term "flood ditch", which is an important stage in the construction of a larger system of ditches. The flood ditch was one that collected water from smaller ditches that were laid in direct connection with the arable land.

One way of measuring the extent of ditching at this time is by looking at the number of metres of ditch per hectare. In the royal demesnes of the sixteenth century, the figure may have been 50–100 m per hectare. From the seventeenth century onwards, the ditches were shown on maps and an increase had been calculated for Östergötland to be from 150 m/ha in 1650 to 300 m/ha in 1690.¹⁷

The regional differences in Sweden persisted (Gadd 2011, pp. 128, 129, 156); at the end of the eighteenth century ditches were still unusual outside East Central Sweden, where the landscape was hilly and varying and it was easy to find solutions for run-off. There was a summer drought in this part of the country, but still there was abundant water during continuous autumn rains and the snow melt. In Western Sweden, Närke and Västmanland, the clay soils were deep and as a consequence difficult to dig. The field was ridged and furrowed with the plough, and the water was led away between the strips thus raised so that ditches were not needed in between. Agrarian historian Carl-Johan Gadd sees this ridging as a sort of risk minimization, in that in dry years conditions were good between the ridges and in wet years they were favourable on the tops of the ridges in the field. Gadd maintains that these flat lands made a ditch system driven by gravity hard to make efficient. The water stayed in the furrows (Gadd 2009).

Among farmers there was ideas of that ditching depleted the soil. As of yet, the possibility of supplying nutrition had been limited. Gadd believes that modern research has shown that there may be something in such a view, but it could also be a case of making a virtue of necessity, because ditching was so difficult in and around the flat settlements on the plains (Gadd 1983, pp. 151, 236, 237; Gadd 2000, pp. 148, 312).

With the major farming reforms and the changeover to rotational cropping during the eighteenth century, with the same crops being sown on what had previously been arable land and meadow, there were less diversity in the agrarian landscape. Agriculture became more sensitive to changes in precipitation. Drainage became increasingly important (Gadd 1983, pp. 26, 237). Frequent, deep ditches were recommended so that the soil would "lose its chill, as happens when the water seeps out of the bottoms of the ditches and the sun can then warm up the field like a garden bed, freshened and caressed by the air".¹⁸

During the eighteenth century, agricultural reformers asserted that the country's ditches were in a poor state. The inadequate drainage was repeatedly put down to the innate indolence of the peasantry. Some farmers contended, as was mentioned, that drainage drew the essence out of the soil or the fat out of the land. The agricultural innovations of the eighteenth century were the redistribution of land and rotational cropping. The old designations of the soil disappeared and the meadow became a field.¹⁹ The new ditch digging applied not only to new cultivation but also to new drainage on old lands.

¹⁷ It has been difficult to distinguish ditches from edges of fields and roads through fields on the maps. Other areas have shown a constant quantity of ditches (Myrdal 1999, p. 288).

¹⁸ Cited from Gustafsson (1955, p. 83).

¹⁹ The committee of 1865 had already drawn attention to how with the general introduction of rotation farming the distinct difference between meadow and arable had disappeared (Lag om dikning och annan aflädnad af vatten, utg. af G. B. A. Holm och Wilh. Huss. Stockholm 1879, p. 18). It has also been asserted in the literature that this change was essential for efficient ditching, (Weibull 1923, pp. 117, 118).

New cultivation involved the old meadowland, which was often wet, making drainage more important. “With this, farming became more sensitive to extreme quantities of precipitation” (Gadd 2000, p. 312). A description from Skåne in the 1770s described this change: “(Formerly) the peasantry were thoughtful in their farming, not turning any land to arable unless it was elevated and did not become waterlogged [...] but now [...] waterlogged meadows are being ploughed and sown without first being drained [...]”²⁰

The great structural transformation of agriculture required the construction of an entirely new system of ditches. This was a sizable task. At a change of tenancy inspection in 1774, a quartermaster’s home was reported to be:

in quite good use because the person leaving has without sparing the substantial cost thereof repaired with much diligence and skill and refilled the old ditches left useless after the great land redistribution and instead dug new ones.²¹

During the agrarian reforms of the eighteenth century, publications on matters of agricultural technology intended to stimulate land reclamation and the transformation of bog and fen into meadowland were published. Agricultural questions were also much discussed by the Swedish Academy of Sciences. In 1690 Åke Rålamb wrote a text that has been designated “a modern view for our time” (Gustafsson 1955, p. 82).

Ditch the arable well, indeed as much as is possible, it enriches the tilled land and gives it air; for just as man has pores in his skin for sweat, so the soil has countless numbers through which the fire burning in the earth finds so much better air to work; but when all the ploughed fields lie flat and without ditches it must get choked so that the soil becomes totally barren, full of acid and toxic matter, which attacks and ruins the pure grain of corn. And a hard-working husbandman can test the difference between a healthy and a sick field by taking soil from both and placing each in a glass of pure water overnight, then tasting both; he will then find a noisome taste from the sickly one while soil from the well-ditched and ploughed field will give off a healthy clean-smelling, saltpetre flavour, which does not arise from any carrion odour or other stench.

In addition to this basic draining, Rålamb continued, surface water must be led off

especially in winter and spring in the field and always when there is a thaw, lead off all pools of water and take care never to allow ice to remain on the fields, because it does more harm than anyone thinks; and even less should a pool of water be allowed to stand, not even for an hour.

But these ideas were far from universal at this time.²²

What were the legal frameworks that regulated drainage during this period of energetic digging? As early as 1681 the house inspection ordinance prescribed that a farmer should dig 40 fathoms of new ditch every year or, where there was no call for more ditches, clear double the length of existing ditches. This was an obligation that could be imposed on the farmers during the golden age of autocracy. Also the house inspection ordinance introduced a differentiation between types of ditches in terms of function and appearance, making the system more complex. A specific depth of ditch was now introduced. The main

²⁰ Cited from Gadd (1983, no. 183, p. 237).

²¹ Cited from Ehn (1991, no. 30 p. 75).

²² Cited from Gustafsson (1955, pp. 82, 83).

outlet drain should be “2 ells wide at the top, one ell deep and one ell at the bottom” unless local conditions required otherwise. The smaller cross-ditches at the ends of the field, “which draw water off the fields” were to be 6 quarters wide at the top and three at the bottom “as was customary”, which indicates that this established the practice (Gustafsson 1955, pp. 76, 78?).

Jan Lindegren maintains that the productive force of the ditch was hamstrung by the middle of the eighteenth century at the latest. This was a part of the stalemate that arose from the redistribution of common lands and mixing of ownership and the fact that ditches were assumed to lie around the fields. The mediaeval legislation protected the small square fields, or rather the ditches along the sides of the fields. Lindegren considers that in this way, the legislation preserved the status quo and hindered ditching. When the fields were widened, the ditches were filled up, with poorer drainage as a result (Lindegren 1988, pp. 67?, 82). The structure of medieval agriculture was an obstacle to efficient drainage.

Finally, The Act of 1734 (Sveriges 1984) a law that applied all over the kingdom replaced the medieval provincial codes. The mentioned house inspection ordinance was incorporated without amendment in The Act of 1734. The ditch was dealt with specifically in Chapter IV of the Building Ordinance—“How roads and ditches in villages should be laid, and what benefit he shall enjoy who gets his field that way”—and in Chapter VI—“How arable and meadow should be cultivated and added to, fences be closed and ditches be dug”.²³ The outlet ditch, the key component of the ditching system, which would carry away all the water, was given a set width of 2–2.5 ells, a depth of one ell and a width of one ell at the bottom. The cross-ditches were to be 6 quarters wide, 3 quarters at the bottom and one ell deep. Where ditches separated fields with different owners, an equal width of ditch belonged to each side (“Now neighbours’ fields lie side by side, each having half the ditch”). The law stated that everybody should maintain outlet drains by his fields and dig at least 40 fathoms (approx. 70 m) or clear 80 fathoms of old ditch every year. These rules on amounts to be dug would increase the size of the system and systematize its maintenance.

The Mönsterby (literally “model village”) Ordinance of 1742 gave concrete expression for much of the eighteenth century enthusiasm for ditching. The background to the village ordinances was the royal letter on the improvement of agriculture. The village ordinances may be seen as an innovation accompanying the great redistribution of landholdings (Ehn 1991, pp. 9, 22). On the importance of maintenance to provide an efficient water infra system The Mönsterby Ordinance said: Ditches should be inspected in spring and autumn, outlet drain and flood ditches must be maintained, a neighbour must be made to dig a ditch if he blocks flow for a neighbour, a certain area should be designated annually for common

²³

In Chapter 4 § 2: “Outlet drains ought to be laid on undistributed land, two and a half, or two ells wide, one ell deep and one ell at the bottom, as is necessary and if this is possible. And he whose field is beside it may use one ell as a verge, except for common land. The same rule applies where road or fence meet the fields. If a road or ditch runs by the meadow bank no increase is granted. A ditch is laid as needed between neighbours’ fields, two and a half ditch is laid between neighbours’ fields, two and a half on the field of each. At the end of the field each digs his own.” In chapter VI § 2 “All in the village shall maintain outlet drain and flood ditches along their lands. New ditches shall be dug by him who needs it for his field at least forty fathoms per year or he shall clear eighty fathoms of old ditch; outlet drain as deep and wide as said before, and cross-ditches six quarters wide above, three quarters at the bottom, two and one half deep. Also dig outlet through the verge down to a ditch [...] If he does not do that, fines as in 27 Chap” In chapter VI § 3, “Now neighbours fields lie side by side; have two half ditches each. If the village’s ditch meets the ditch of another village, each digs up for himself through his lands, or fine two dalers and repair the damage. If a man lays a ditch through his yard or meadow and meets the meadow of another village, or bank or other village land, there may this village may not hinder the water’s outflow. If it cannot be led off without a ditch, and they cannot agree who is to dig it, let a judge hear them and try the matter.” (Byggningsbalken in Sveriges rikets lag: gillad och antagen på riksdagen år 1734. Stockholm: Inst. För rätthistorisk forskning: 1984).

ditching, those ditches should be cleared where inspection shows this necessary, and high edges should be dug up. Ditches on one's own fields were private, whereas larger ditches were to be maintained communally. Minutes of village meetings showed that ditching and the requirement to prevent damming of water were one of the most prominent items on the agenda. This still applied after the great land redistribution was completed (Ehn 1991, p. 64).

From the end of the eighteenth century an increasingly complex framework was constructed around the pro-ditching policy, which from this time onwards also involved the flow of water outside the field. When the system of ditches became more extensive, the natural waterways had to be opened up for more efficient drainage. If the non-built water system could not take in the new quantities of water, there was a risk of flooding and the purpose of the ditches would not be fulfilled.

One can claim that the water system comprised more and more of the landscape. For this reason His Royal Majesty's Gracious Ordinance on how Lakes, Streams and Rivers all over the Realm should be annually Maintained, to prevent harmful damming of water, dated 1764, (Kongl. Maj:ts 1764) is from a water system perspective an additional step towards controlling and prioritizing drainage. The ordinance also represented an instrumental view of nature: that it could be shaped. Flooding harmed both "waterworks" and farmers who "with the grounds of their home border thereon". Here it was not humans who were the obstacle to the functioning of the drainage system, it was nature herself. In the ordinance, we find

Howsoever streams, rivers and lakes—the greater the body of water, the greater the problem—become choked up, whether by their natural situation, or by accretion of flotsam, fallen trees and earthen banks, thereby the water being divested of its proper depth, causing unwanted damming and great floods, especially during those years in which significant rainfall or snow also contributed, this not seldom causing the water, subject to this great force, to carve out new courses for itself that are less desirable.

During "the summers when most of the water has already come down," the local population was encouraged to "clear and maintain all streams, becks, and rivers, large and small, in their natural courses." To let the water through the landscaper the natural watercourses had to be kept opened and in good order.

The nineteenth century—the drainage century

The digging of ditches accelerated in the 1820s, and the 1830s were years of heavy rainfall that further speeded up the process. Much land was waterlogged and frost damage was a scourge in other parts of the country. With governmental economic support, now drainage of the plains of Western Sweden began. A system of open field ditches 18–20 metres apart grew up across the landscape. Between 1840 and 1859 the government redefined its role as ditching promoter, and beside its role as lawmaker also became an economic supporter by starting to grant loans for around 240 different drainage projects. The areas that were drained out have been estimated to total 90,000 hectares, equivalent to 4 % of the arable land of 1840 (Betänkande 1937, pp. 9?; Gadd 2000, pp. 312, 313; Gadd 2011, p. 162). The state loans for cultivation are described by Gadd as the embodiment of a new principle; "This was a break with the order that had previously prevailed, where the individual farms or villages themselves had been responsible for necessary agricultural investment and maintenance". He interprets this as agriculture having reached a stage "where the

investments and the organizational efforts that were necessary for further development were too great for either farms or village collectives.” (Gadd 1983, p. 238).

During the second half of the nineteenth century the area of arable land grew from 2.3 million to 3.5 million hectares. A large proportion of this increase came from water meadows and wetlands (Håkansson 1997, p. 94).

The eighteenth century brought the idea of deep-covered ditches with a filling of pebbles in the bottom. In Sweden there are notes about covered ditches from a little way into the eighteenth century. Covered drains with tiling occurred in Sweden from the 1830s. Thereafter, the production of brick pipes developed and the spread of covered drains accelerated. Pipe drainage soon became widespread. There was also a lively debate on the depth of the ditches, with the deep ditchers prevailing with their assertion that a depth of at least 2.5 feet was suitable for Swedish conditions. Towards the mid-1850s there appeared to have been a change to a depth of between 3.5 and 4 feet. (Gustafsson 1955, pp. 83, 84, 89?, 97, 98).

During the nineteenth century, the county agricultural societies stepped up as the leading advocates of ditching. Inviting foreign drainage experts to Sweden made it possible to introduce covered ditches by the middle of the century. The Swedish Peat Cultivation Society played a similar part in the drainage of bog (Runefelt 2008). Finally, after 1865, the agricultural engineers were the professional group entrusted with projects involving the lowering of water levels of lakes. The total number of drainage projects has been estimated at 30,000. The scope of the transformation of the landscape was great. One of the effects of the drainage was the disappearance of frozen winter roads, a side effect of the break-up of the old agrarian landscape (Gadd 1983, p. 238). Quite simply, there was less water lying around.

The ordinance of 1822 on streambed cleaning and keeping waterways open was actually a repeat of the intentions expressed in 1764 (Kongl. Maj:ts 1823). It was promulgated in order to prevent destructive flooding and water standing “on adjoining lands” and to prepare the soil for cultivation. It was important for streams and rivers to be cleared “and every obstacle to the outflow of the water, that may be there, to be removed”. But the ordinance reinforced control and organization of the task of clearing the watercourses, in that government officials were to direct it and ensure “that it is undertaken and carried out” and thereby “keep a firm hand” on the clearing of waterways.

The ordinances of 1764 and 1822 had been about removing natural obstacles in the watercourses. This kind of provision would ensure that waterways were kept open for the water to run off—to protect a draining system. But along with the changes in agriculture another activity had developed along Sweden’s waterways. Flourmills, sawmills, or any other machinery was now powered by the flowing water. The primary interest here was to regulate the flow of water or what we might call an interest in damming the flow, as opposed to the ditchers who represented an interest in releasing it. In 1815 the Riksdag (parliament) decided that there was no right to erect new or modify old water-powered plants over and above those for which consent had already been given. Work could only begin when new consent by the county governor had been issued (in other words the state) (Kongl. Maj:ts 1815).²⁴ The same ordinance also laid down that the first day of autumn on which water could be dammed was 1 November—“when most grazing had stopped and

²⁴ In English: His Royal Majesty’s Gracious proclamation concerning both his Royal Majesty’s Commanding right to hear complaints against the unlawful establishing of new Waterworks or the unauthorized modification of old Waterworks and also the time for damming water in the autumn. Published at Stockholm Palace in the Hall of State on 6 August. Stockholm 1815.

the farmer's work on the cultivation of arable and meadow has been completed". Those water mills that had special privileges and licences were exempted. But, the lawmakers pointed out, the law was "necessitated out of concern to help farming", so it was possible to get consent for the postponement of damming until later in the autumn.

During the nineteenth century the agrarian interests—the interest in letting the water go—became stronger in the riksdag, and agrarian reforms were defined as a public interest (Jakobsson 2010). His Royal Majesty's Gracious Ordinance concerning amendment or demolition of Water Works that by stopping the water damage the Soil or prevent cultivation of it (Kongl. Maj:ts 1824) published in 1824, reflects such currents of opinion and went a stage further in making it actually possible to demolish water mills. The ordinance was adopted with the support of the landowning estates of the farmers and the nobility. Opposition was expressed by the middle class and in region Bergslagen with its many waterworks (Fryksee 1973, pp. 42?, 104?, 138). It was decided that if the water of the dams infringed the rights of the landowner, the victim had the right to have the waterworks modified or moved. The agricultural interest weighed so heavily that the possibility "of demolishing the Works completely" was allowed. However this right did not affect "larger Mills or Mines and major factory installations." "If landowners had agreed on a right to dam across, the waterworks could be pulled down. It was only necessary for the value of damaged land, or the land that could be gained by soil improvement, to be twice that of the waterworks. Over time, this kind of provision could, of course, have undergone a drastic change—and especially during a time as dynamic as the nineteenth century—as the value of the land changed and the value of manufacturing and industrial activity in the water-courses fluctuated. The principles governing how such interests were weighed against each other were also of significance to the outcome (Jakobsson 1996a).

Only after more than a century—in 1841—was there a new ordinance issued on drainage. His Royal Majesty's Gracious Ordinance on certain conditions for water diversion for the preparation of cultivation on communal land regulated drainage projects rights, benefits, and costs that concerned two or more landowners (Kongl. Maj:ts 1841). This laconic ordinance shows the power that rested with those who wanted to extend the system of ditches. It had been passed particularly for major projects, such as drainage of mires, but also to clarify how costs were to be shared and how those not wishing to take part in ditching projects were to be treated. But it was worded in such general terms that it could be used both for drainage or ditching. The purpose was to regulate and thereby promote drainage between those affected by drainage projects. It determined how division of the cost was to be decided and considered the problem of the party that, although benefiting from ditching, did not want to share the expense. It stated that the cost of implementation of "water diversion" for cultivation or improvement of land that affected two or more landowners should be divided based on the land that was improved by the ditching. Those who did not wish to share in meeting this cost was entitled and obliged to accept compensation from other partners "which ought to be given in other land", equivalent to the land surrendered. If other land could not be found, the party that had declined to participate could receive newly drained soil equivalent to the value in "its waterlogged condition" (Lagberedningens 1878, pp. 47, 48).

The efficiency of the ditches and their ability to drain deeper increased. Only in 1858, at the initiative of the Academy of Agriculture and Forestry and showing signs of British influence with regard to trenches, was a change made to the 1734 regulation in the depth of the outlet drains. The depth was doubled from one ell to two (Gustafsson 1955, p. 98).

The Drainage Act of 1879—at the height of drainage policy

The road to uniform legislation on ditching had been a long one. Two commissions had sought to draft a law for both lucrative and defensive water rights. The debate in the Riksdag in 1878 lasted several days. The 1879 proposal aroused a strong reaction from the Supreme Court. There was criticism of the principle that all those who benefitted from a drainage project were compelled to participate. However the drafts legislation committee took the view that the provisions of 1841 had not set a limit on compulsion. Thus the dispute was not about drainage as such but about the priority of the public interest or the right of individual ownership. Finally the Drainage Act was passed (Nilsson 1994, pp. 178?). What, then, did the 1879 Act on Drainage and Other Removal of Water (Lag om 1879) contain? The most important passages were the definition of the obligation and the right to dig ditches, how conflicting interests were to be reconciled, and priority for those who took the initiative in ditching or diverting water and the design of the ditch; in other words, in many respects the subjects that reoccur in all previous provisions on drainage. But the content was much altered.

The initial paragraph read: ‘‘If it is wished for the cultivation or improvement of one’s land to make a ditch and land is encountered that belongs to another party, the latter may not obstruct the outflow of the water; should also a ditch for the purpose need to be on his land, he has a duty to surrender what is needed for the ditch.’’ This paragraph closely followed the earlier ditch-friendly rules that we have been seeing since the provincial law codes of the Middle Ages, which were about releasing the water—that is to say, securing the system. But the new law no longer distinguished between cultivated and uncultivated land. In the rationale behind the act could be read:

As the purpose of the ditching must now be to give the possibility of a higher level of cultivation; to the degree that the natural conditions permit, to transform the fen into meadow or meadow into arable or the poor arable into good, it is evident that the temporary degree of cultivation of the soil at the particular time when the question of drainage arises, cannot in itself constitute an appropriate basis for assessing the utility of the undertaking but in addition the future improvement must largely be taken into account. (Lag om 1879, p. 9)

The fact that the party taking an initiative in digging ditches had precedence—‘‘then he has preference who seeks to make a ditch’’—means that it was possible to require the assistance of the others in building up a drainage system. The system idea was also maintained by the fact that one could not deny anyone consent to divert water into another party’s ditch, although the party leading water in was to pay the additional cost this entailed.

The previous voluminous provisions concerning the size of the ditch had now been changed to read that the size of the ditch should be such that one could demand ‘‘that his land be drained to a depth of four feet’’. This meant that they could become involved in removing water even if, for topographical reasons, they did not have the ditch on their land but still benefitted from its being dug. The different categories of ditches disappeared, but covered drains were introduced in the text of the act. Covered drains and open ditching were regarded as equal, and one was free to choose whichever method one preferred. This gave greater freedom in forming the ditch, but every ditcher depended on the topographical premises given to him by his land. This new definition must surely have encouraged a more efficient system of ditches.

The provisions were therefore for the most part similar whether they referred to water diversion or ditch digging. A more dynamic view of nature where the flowing water was given a changing force permeated the Act. The presentation described a vibrant water landscape where the water constantly changed the surroundings and that it was impossible to distinguish between

being inconvenienced by water, waterlogged or flooded, and the different terms, fen, mire, bog, fen meadow etc., would seem all too vague [...] Moreover these different gradations change with the rainfall [...] A lake or a flowing watercourse can always be reliably recognized as such, but with regard to waterlogged land extensive scope is left for subjective impression and in doubtful cases, where the decision depends on which year's water level is taken as the norm, (Nya lagberedningens 1878, p. 65).

But nature was also altered by human agency:

As exactly the same purpose is served by digging an artificial watercourse—the ditch—as by deepening the natural watercourse, no distinction should be made concerning mutual obligation of landowners, interested in the one measure or the other, to take part according to the utility, (Lag om 1879, p. 6)

There was a high degree of compulsion in the Drainage Act of 1879. Swedish historian Torbjörn Nilsson has summarized the implications of the decision: “The protection of the individual owner’s unrestricted freedom had therewith been set aside when it was regarded as obstructing efficiency and progress.” (1994, p. 181). It took various forms. In the case of ditching, those “whose land benefits from the ditch” had the obligation to take part in the ditching, but not to contribute more than the utility they had from it.²⁵ If one wanted to lie an outlet drain through undistributed or jointly owned land the person demanding it had the final voice. The cost was distributed according to the size of the share one had in the collective. The same compulsion applied to drainage of wetlands. In that case, the cost was to be divided according to the benefit the landowner gained. In the case of “lowering or drawing water from a lake”, the principle applied that if not all the landowners agreed, those who wanted the change had to own more than half of the land that would be gained or improved. It was these compulsory provisions that had been the main point of principle in dispute. How much could the right of private ownership be restricted?

In the presentation of the Act, emphasis was placed on the fact that the system of ditches had to be maintained; this was a precondition of being able to make use of many other agricultural innovations.

The removal or prevention of harmful accumulations of water, which chill the soil, reduce its fertility and impede rational cultivation, must go before all other improvements to implements, fertilizers and methods of use, if these costs paid out are to have any benefit. [...] it is just as important, if not more important, for the soil that has already been put to use, but that is inadequately drained, to be made available by comprehensive ditching for the best cultivation as it is for hitherto totally waterlogged land to be opened up for new cultivation. (Lag om 1879, p. 5)

²⁵ 2§ “If there is a ditch that someone wants to dig for his land, which is also of use to another party’s land, and they do not agree on the ditching, he who wants a ditch shall have the last word; and each and every one, whose land benefits from the ditch, will be liable to that extent to take part in the ditching, except that a party who has not asked for the ditch shall not have to pay a contribution greater than the equivalent of the utility provided to his land by the ditch.”

The legislator was of the opinion that this mandatory law was distinctive: It meant that the party compelled to take part always benefitted from it. Compulsion was also defended on the grounds that, unlike industry that thanks to steam power and better communications could now choose where to locate its activities, the “farming industry was inexorably bound to a particular patch of earth and dependent on its natural condition” (Nya lagberedningens 1878, p. 51). Therefore a certain measure of compulsion had to be employed to enable each and every one to develop his landholding.

Lowering of lakes and larger drainage projects did not always turn out as expected (Lennqvist 2007). As early as in the nineteenth century it was realized that these initiatives were not always an unqualified success:

Lowering the surface level of lakes is also, it has been revealed by experience, the undertaking most likely to fail or to show less advantageous results than other undertakings. (Lag om 1879, pp. 32, 33)

A final stage was the building of dikes and embankments. Gravity, as had been the prime mover, then no longer powered the system: New energy had to be supplied to pumping stations to draw off the water.

Conclusion

Removing troublesome surplus water was crucial to every farm, argued Swedish Prime Minister Louis de Geer in a debate in 1878. He pointed to the special feature of drainage, namely that it was a structure that formed a part of the circulation of water in the landscape, therefore uniting those who dug ditches. In his argumentation on drainage we can find a description of a water system:

In such circumstances and since the patches of land of the individual owners do not in reality occur independently but are inseparably bound together, then preparation of an outlet for water that hinders cultivation of such land may be regarded as a matter of common interest to all the land that is burdened with water for the same natural reason (Lag om 1879, p. 9).

When a system of ditches is built that encompasses ever greater areas and thus encloses the water systems, this may be regarded as the construction of a hybrid system that extends over, encloses and binds together ever larger areas of the waterscape. In the environmental history tradition these managed water systems are labelled “organic machines”, emphasizing the melting together of culture and nature (White 1995, Jakobsson 2008). These infrastructures have changed over this long period and they have been co-ordinated with older infrastructures in the flowing water. This can of course be interpreted in a purely physical sense, but it could also be framed in a societal sense (Hughes 1987; Jakobsson 1996a; Kaijser 1998). Furthermore, as infrastructures are often described as a product of modernity (Edwards 2003), this article emphasizes the fact that pre-modern societies also built infrastructures, man-made systems, and as modern infrastructures they are, by their linking together with societal institutions, highly sociotechnical.

By applying a water systems perspective on ditching, I have been able to demonstrate the dependence built in water systems. As a consequence, when studying water systems—whether small, as in this article, or comprehensive—upstream—downstream relations cannot be disregarded. I have also demonstrated how an institutional framework is needed to manage these dependences in a water system. Reading the sources from this new

perspective and using a long time perspective, I have also established the legacy of the laws on ditch digging in Sweden for over half a millennia.

This article ended with the Drainage Act of 1879, a law that gave an institutional base for major drainage systems. This took place in a Riksdag in which at that time farming was disproportionately well represented. At this time the farmer had broken out of the village community by the large structural reforms. Simultaneously the drainage systems that extended across the hybrid landscape created new communities to which the farmer belonged, and had to manage. These communities were brought together by the objective preconditions such as topography and watersheds that existed in the landscape, and constrained by the state created rules for coordinated action. When Sweden finally got a consistent act on the defensive water rights in 1879, it contained a set of provisions that regulated all kinds of drainage and thereby opened the way to major drainage projects in the Swedish countryside. Farmers should not therefore be regarded as a group that acquiesced with nature. Farming Sweden did not hesitate to undertake major interventions in nature.

In the article I have also described how a more and more complex set of rules have been built up to keep these systems working. As seen, when the systems grow larger, on one side the rules for drainage acquired a more far-reaching element of compulsion. On the other side—to keep the system functional—more and more of the waterscape was managed by law. Even the natural water courses had to be altered by man—to get the water all the way out to the sea.

Water history is not only that of the large and mighty rivers, or grand engineering masterpieces, or the history of scarcity of water. Because it is water that is running through it, though very slowly and very quiet, water history should also deal with the least fantastic of our water systems—the ditch.

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References

- Betänkande med förslag angående den statsunderstödda vattenavlednings- och avdikningsverksamheten samt därmed sammanhängande spörsmål. Avgivet den 28 December 1936 av 1934 års av avdikningssakkunniga (1937). Statens offentliga utredningar 1937:8. Jordbruksdepartementet. Stockholm
- Bonden och vattnet (1977) Forskningsberedningen, Stockholm
- Dellapenna JW, Gupta J (eds) (2009) The evolution of the law and politics of water. Springer, Amsterdam
- Edwards PN (2003) Infrastructure and Modernity: Force, Time, and Social organization in the History of Sociotechnical Systems". In: Misa TJ, Brey P, Feenberg A (eds) Modernity and technology. MIT Press, Cambridge, pp 185–226
- Ehn W (1991) Mötet mellan centralt och lokalt: studier i uppländska byordningar. Dialekt- och folkminnesarkivet, Uppsala
- Fritzbøger B (2009) Vandets veje: Skjern Ås miljøhistorie gennem 350 år. Vandets veje: Skjern Ås miljøhistorie gennem 350 år. København: Gyldendal
- Fryksén A (1973) Debatten om vattenavtappningar och Hornborgasjöns sänkning—ett led i svensk jordbrukspolitik fram till mitten av 1800-talet. Licentiat Dissertation, Lund University
- Gadd C-J (1983) Järn och potatis. Jordbruk, teknik och social omvandling i Skaraborgs län 1750–1860. Göteborgs Universitet
- Gadd C-J (2000) Det svenska jordbrukets historia. Bd 3, Den agrara revolutionen: 1700–1870. Natur och Kultur, Stockholm
- Gadd C-J (2009) Gränsen mellan plog och årder—orsakad av naturbetingelser eller av kulturspridning? In: Liljewall B, Flygare IA, Ljunggren L, Söderberg J (eds) Agrarhistoria på många sätt. 28 studier om

- människan och jorden. Festskrift till Janken Myrdal på hans 60-årsdag, Kungl. Skogs- och Lantbruksakademien, Stockholm, pp 151–172
- Gadd C-J (2011) The agrarian revolution in Sweden, 1700–1870. In: Myrdal J, Morell M (eds) *The Agrarian History of Sweden. 4000 BC to AD 2000*. Nordic Academic Press, Falun, pp 118–164
- Gustafsson Y (1955) Några historiska notiser om dikning. Grundförbättring nr 2–3
- Hughes TP (1987) The evolution of large technological systems. In: Bijker W, Hughes TP, Pinch T (eds) *The social construction of technological systems. New directions in the sociology and history of technology*. Cambridge, MA, pp 51–82
- Håkansson A (1997) Dränering, sjösänkning och ängsvattnig. In: Larsson B, Morell M, Myrdal J (eds) *Agrarhistoria*. LT, Stockholm
- Jakobsson E (1996a) Industrialisering av älvar. Studier kring svensk vattenkraftutbyggnad 1900–1918. Historiska institutionen, Göteborg
- Jakobsson E (1996b) Vårt till så betydlig del af watten genomskurna Land”: Svensk vattenrättshistoria i ett internationellt perspektiv. In: Linnér B-O, Svidén J (eds) *Miljöhistoria på väg. Artiklar presenterade vid Miljöhistoriskt Möte 1995*. Tema V Rapport 22, Tema Vatten i natur och samhälle, Linköpings universitet, pp 82–93
- Jakobsson E (1999) Introduktionen av WC i Stockholm—ett vattensystemperspektiv på staden. *Polhem. Tidskrift för teknikhistoria* 1999(2–4):118–139
- Jakobsson E (2008) Narratives about the river and the dam. Some reflections on how historians perceive the harnessed river. In: Hauken Å D (ed) *Technological society—multidisciplinary and long-time perspectives*. Seminarrapport Utstein kloster 2008. Haugaland Akademi, Stavanger
- Jakobsson E (2010) The history of flowing water policy in Sweden: from natural flow to industrialized rivers. In: Tvedt T, Coopey R (eds) *Rivers and society: from early civilizations to modern times, in a history of water, series II, vol 2 (Series Editor Terje Tvedt)*. I.B. Tauris, London, pp 424–439
- Kaijser A (1998) Att tämja naturen. De nederländska vattensystemens utveckling under tusen år. In: Blomkvist P, Kaijser A (eds) *Den konstruerade världen. Tekniska system i historiskt perspektiv*. B. Östlings bokförl. Symposion, Eslöv, pp 299–322
- Kongl. Maj:ts Nådiga Förordning, angående wissa wilkor för watten-afledningear till beredande af samfällig jords odling. Gifwen Stockholms slott den 30 November 1841 (1841) *Svensk författningssamling* 1841, no. 62
- Kongl. Maj:ts Nådiga Förordning, angående ändring eller utrifning af Wattenwerk, som genom updämning skada Jord eller hindra desz odling: Gifwen Stockholms Slott den 20. Januarii 1824 (1824) Kungl. Tryckeriet, Stockholm
- Kongl. Maj:ts nådige Förordning, Huru Sjöar, Strömmar och Åar öfwer alt i Riket årligen böra wårdas, til skadelige wattendämningars afwärijande. Gifwen Stockholm i Råd-Cammaren then 20 februarii 1764 (1764) Kongl. Tryckeriet, Stockholm
- Kongl. Maj:ts nådige Kungörelse, angående Strömrrensningars verkställande samt Strömars och Åars öpne hållande. Gifwen Stockholms Slott den 28. December 1822 (1823) Kongl. Tryckeriet, Stockholm
- Kongl. Maj:ts Nådige Kungörelse Så Wäl Om Kongl. Maj:ts Befallningshafwandes rättighet at uptaga klagomål öfwer nya Wattnwerks olagliga anläggning eller gamla Wattnwerks obehöriga förändring, som angående tiden för wattendämning om hösten. Gifwen Stockholms Slott på Riks-salen den 6 augusti 1815 (1815) Kongl. Tryckeriet, Stockholm
- Lag om dikning och annan afledning af watten, utg. af G. B. A. Holm och Wilh. Huss (1879) Stockholm
- Lennqvist J (2007) *Våtmarkshistoria: Hjälmarens och Kvismarens stränder under 1800- och 1900-talen*. Universitetsbiblioteket, Örebro
- Lindgren J (1988) *Varat, staten och diket: tre historieteoretiska uppsatser*. Opuscula Historica Upsaliensia 2, Historiska institutionen, Uppsala
- Magnus Erikssons landslag i nuvensk tolkning av Åke Holmbäck och Elias Wessén (1962) Holmbäck Å, Wessén E (eds) Nord. Bokh., Stockholm
- Morell M (2011) Agriculture in industrial society, 1870–1945. In: Myrdal J, Morell M (eds) *The agrarian history of Sweden. 4000 BC to AD 2000*. Nordic Academic Press, Falun, pp 118–164
- Myrdal J (1985) *Medeltidens åkerbruk. Agrarteknik i Sverige ca 1000 till 1500*. Nordiska museet, Stockholm
- Myrdal J (1999) *Det svenska jordbrukets historia. Band 2, Jordbruket under feodalismen: 1000–1700*. Natur och Kultur, Stockholm
- Myrdal J (2011) Farming and feudalism, 1000–1700. In: Myrdal J, Morell M (eds) *The agrarian history of Sweden. 4000 BC to AD 2000*. Nordic Academic Press, Falun, pp 72–117
- Nilsson T (1994) *Elitens svängrum: första kammaren, staten och moderniseringen 1867-1886*. Almqvist & Wiksell International, Stockholm
- Nya lagberedningens förslag till förordning angående torrläggning af jord (1878). Samson & Wallin, Stockholm

- Pisani DJ (1992) To reclaim a divided west. Water, law, and public policy, 1848–1902. University of New Mexico Press, Albuquerque
- Runefelt L (ed) (2008) Svensk mosskultur: odling, torvanvändning och landskapets förändring 1750–2000. Kungl. skogs- och lantbruksakademien, Stockholm
- Schneider D (2011) Hybrid nature. Sewage treatment and the contradictions of the industrial ecosystem. The MIT Press, Cambridge
- Strömberg LG (1990) Var slutar en sjö? Livsvillkor och naturuppfattningar kring Hornborgasjön 1900–1990. Dissertation, Gothenburg University
- Svenska landskapslagar: tolkade och förklarade för nutidens svenskar. Ser. 1, Östgötalagen och Upplandslagen (1979a) Wessén E, Holmbäck Å (eds). AWE/Geber, Stockholm
- Svenska landskapslagar: tolkade och förklarade för nutidens svenskar. Ser. 2, Dalalagen och Västmannalagen (1979b) Wessén E, Holmbäck Å (eds). AWE/Geber, Stockholm
- Svenska landskapslagar: tolkade och förklarade för nutidens svenskar. Ser. 3, Södermannalagen och Hälsingelagen (1979c) Wessén E, Holmbäck Å (eds). AWE/Geber, Stockholm
- Svenskt vattenarkiv. Sänkta och torrlagda sjöar (1995). In: SMHI Hydrologi nr 62. SMHI, Norrköping
- Sveriges rikets lag: gillad och antagen på riksdagen år 1734 (1984). Inst. för rättshistorisk forskning, Stockholm
- The Agrarian History of Sweden, 4000 BC to AD 2000 (2011) Myrdal J, Morell M (eds) Nordic Academic Press, Falun
- Tvedt T (2010) Water systems, environmental history and the deconstruction of nature. *Environ Hist* 16(2) s.143–166
- Weibull CG (1923) Skånska jordbrukets historia intill 1800-talets början. Gleerup, Lund
- White R (1995) The Organic Machine. The Remaking of the Columbia River. Hill&Wang, New York
- White R (2004) From wilderness to hybrid landscape: the cultural turn in environmental history. *The Historian*, 66 no. 3 (Fall 2004):557–564
- Winiwarter V (1999) Landscape elements in the late medieval village: can information on land-use be derived from normative sources? *Medium Aevum Quotidianum* 41(1999):22–42