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WATER-SOCIETY RELATIONS AND THE HISTORY OF THE LONG TERM

I have shown that a water-system approach is a fruitful and powerful analytical framework in understanding fundamental shifts in history; it can help explain the 'Great Divergence' and why Great Britain and the West took the lead in the fundamental transformation called the Industrial Revolution, throw new light on British imperial strategies and the mechanisms behind the partition of Africa, make urban developments from the first cities in the Fertile Crescent thousands of years ago to the modern megapolises more intelligible, highlight historical and theoretical aspects of the idea of sovereignty and the role of Westphalia, and deepen our understanding of fundamental belief systems and rituals in the comparative study of religions. This chapter will show how the approach can be employed in analysing the long-term history and central development junctures of individual countries. For didactic reasons this chapter focuses on Norway and Egypt, because they represent polar opposites when it comes to how water runs through societies and how water has been exploited through time.

I choose these two countries not because water is more important here than elsewhere, but because this kind of comparative and contrasting analysis most clearly can demonstrate empirically how a water perspective may open up for less reductionist and more fruitful explanations and analyses of different countries' development trajectories. On the one hand is Norway, a unique 'El Dorado' of perennial running water and with thousands of lakes and rivers. On the other hand is Egypt, almost 97 per cent desert, with virtually no rainfall of its own but totally dependent upon one river fed by precipitation in far-off upstream countries.

WATER-SOCIETY SYSTEMS AND CATEGORISATION OF AGRICULTURE

Since agricultural development is to a large extent a story about how farmers have tried to improve the fertility of the soil they are tilling, a permanent challenge for all rural societies has of course been the 'issue of water'. Nothing can grow and be harvested without the right amount of water and, importantly, too much of it is just as bad as too little of it. In large parts of the world the main challenge for societies has been to bring the right amount of water to the fields in the growing season, and in many countries the priority of kings and emperors, states and local communities has been to win this struggle. In other parts of the world, and more seldom, the task has been to get rid of excess water and to adapt agricultural practices to the fields' ability for self-drainage. Since dissimilarities in agricultural activities and social organisation that have been created and recreated by variations in this variable are so fundamental, all agricultural societies can be typologised according to these two broad categories.

Major periodisations of agricultural history can fruitfully be reconsidered based on new and thorough analyses of shifts and differences in agro-water relations, since food production represents everywhere a form of adaptation to the local and regional characteristics of the physical and engineered waterscape. Of course, different food systems are also intrinsically interwoven into the social matrix of any society and political, economic, cultural and religious premises influence what is grown and how it is harvested, and also what is culturally accepted as food. But wheat and rice, goats and camels, fish and fowl – they all thrive in different waterscapes according to tolerance to drought and waterlogged soil, to degrees of water salinity and stream velocity, and so on. Precipitation will in many areas be the ultimate source of water for food production, and therefore the seasonal variations of how water runs in the landscape and through agricultural lands – annual rains or floods, the absence or presence of which types of water at what time of the year, discharge curves of rain-fed rivers – are physical premises for food production everywhere. The difference between how a nomad society in semi-arid regions or in deserts is structured in different ways from farming and fishing communities living in wetland areas is very easy to observe, but it is at the same time a clear illustration of a more complex and universal phenomenon of how confluences between water and society frame and structure food and agricultural production. Agro-water relations and agro-water variability therefore tend to structure food producing regimes and changes in the character of these confluences and interactions will therefore have profound historical implications.¹

NORWEGIAN HISTORY AND THE ISSUE OF DRAINAGE

One of the most central axes around which the reconstruction of Norway's agricultural history should be organised is the permanent struggle of farmers to establish and maintain an optimal water balance in the fields and in the soil under the almost unique watery conditions in the country. In order to understand Norway's agricultural history in the long term and in a global context, one has to study and analyse how early farming was fundamentally affected by the necessity to adapt to the self-draining ability of different types of Norwegian landscapes and soils. The research should follow and try to reconstruct how the farmers gradually learned and improved their ability to get rid of excess water and adapt to the types of seasonality in water's behaviour in Norway (water is here, albeit with great regional variations, regularly changing form from liquid water to snow/ice and *vice versa* at the same time as precipitation is perennial). The combined impact of these natural aspects of the water system – seen here as an objective but varying structure that all agricultural communities in Norway had to interact with or relate to and thus were impacted by – and the actions of the farmers *vis-à-vis* this water in their agricultural practices, had vital implications for the very fabric of agricultural societies and settlement patterns. In spite of the importance of these particular interlinkages between these two layers of the water-society system in Norway, the issue of drainage has received little attention and has tended to be overlooked in Norwegian historical research. The most influential books on Norwegian history and the history of Norwegian agriculture have rarely dealt with it. The myopic perspective that helped to make drainage an issue that has received such scant interest² has most likely been influenced by a historiographical tradition in which explicit and implicit comparisons have generally been restricted to neighbouring and in this respect basically similar countries: Sweden, Iceland and Denmark. Compared to the earliest agricultural civilisations in Asia and the Middle East (not least Egyptian agriculture) – where the most important task was always to bring water to the thirsty fields – this is, however, a very dynamic particularity of Norwegian agriculture.

The average annual precipitation in Norway is around 1,500 millimetres, or approximately double the European average. Moreover, only 10 per cent of the precipitation evaporates, whereas in certain countries, like the desert country Egypt and countries in the Mediterranean basin, have a rate of evaporation which exceeds the amount that falls as rain. The tens of thousands of rivers, streams and brooks do not take the precipitation as run-off directly into the sea because they flow from the great accumulation of snow and ice in the higher mountains, and snow on the fields melts in spring time when plants start to grow. This fairly

permanent aspect of the character of the water cycle in Norway (it has been more or less constant since the end of the last Ice Age), and the way in which water has run through the settlements and as run-off over the land, has forced the issue of surplus water on agricultural communities. Norwegian farmers could not disregard the following natural law: few useful plants will thrive with their roots in saturated soil and waterlogged land will hinder the conversion of organic matter, root development and uptake of nutrients and increase the risk of soil compaction and surface run-off. Water beyond what is needed to wet the roots to their capillary capacity will hinder growth, and the problem is that moisture is stored in the soil, and more in clay soil (which is very common in Norway) or in soil lying over impervious subsoil than in sandy soil. Oversaturation has thus been a constant problem influencing in many cases more than anything else the productivity of the soil and thus the harvest. The challenge of 'vannsjuk' or 'waterlogged' soil has therefore throughout Norwegian history been acknowledged by farmers, although it has by and large been overlooked by historians.

The very early history of agriculture in Norway should in the perspective of the long term be seen as a development by which the farmers learned how to adapt to and exploit the natural process of drainage and self-drainage. The first agricultural settlements in Norway were typically and out of necessity located where the soil was self-draining, as in the Jæren area, and where moraine soil was dominant, as in some parts of Trøndelag and Østlandet. The broad theory of Norwegian agricultural development that is suggested here is that the history and geographical spread of early pre-modern agriculture in Norway to a large extent is a history fundamentally reflecting adaptations to a landscape with too much water, and of finding and settling close to fields where there was soil that could be cultivated thanks to its self-draining properties. Farmers had to determine, as accurately as possible, to what extent the chosen fields were or could easily become waterlogged, and very seldom did they have to worry about scarcity of water and how that would affect their choice of plants and trees or the land value. This was, it is hypothesised, a main reason why many of the most powerful and wealthy farmers in early Norwegian history often had their farms located on hillsides, while the poorer farmers were left with the waterlogged, albeit flatter land, closer to the bottom of the river valleys. The fact that the waterscape in Norway is characterised by perennial precipitation (the timing of rainfall and its particular relationship to the constellation of labour, cropping patterns and capital requirements are crucial but neglected aspects of rural development in general), modest evaporation and natural reservoirs in the form of snow during winter meaning that the water during sowing time (in spring) is heavily saturated, has been a fundamental structuralising force

in agricultural development. It has also, of course, been a structuralising factor making the history and productivity of Norwegian agriculture very different from the history of agriculture in water-scarce countries and in many other countries with rain-fed agriculture.

From very early times, the issue of excess water has also required a proactive response, primarily the removal of excess water from the farm in one way or another by means of gravity. In the Jæren area drainage has for a long period been very important, and as new soil was turned into agricultural land the farmers also collectively took initiatives to lower lakes and rivers to be able to drain the new fields properly. One of the first big farms in Norway was called Sanner, which means 'sand'. There they had managed not to bring water to dry sand, but to make fertile soil, or 'sand', from waterlogged clay by successful drainage. The challenge in most places was to get rid of excess water and only very seldom did farmers need to bring water artificially to the fields.³ All over Norway, even in the eastern part of the country where rainfall was less than in the west and south-west, farmers have had to work to get rid of water, because if they did not do this, productivity would soon drop drastically. The size of the furrows they dug was a function of two facts and considerations; the gradient of the slope on which drainage tiles could be laid and the amount of run-off. Ploughs were used to ridge the fields, and thus the water could be drained off between the ridges. Such actions were particularly crucial in areas of heavy clay soil and special ditches were therefore not always needed to remove surface water. Presently, more than 60 per cent of all agricultural land is under modern drainage systems alone.

A problem for historians looking for written evidence or material artefacts is that drainage measures in the distant past tended not to leave permanent traces in the engineered or cultivated landscape. There are many ways of draining land, and only in a few cases do they resemble the drainage methods described in Cato's *'Di agri cultura'*, in which he talked about how big they should be and how stones should be used. Due to topography and natural run-off ditches, it is therefore easy to overlook and impossible to reconstruct accurately the drainage patterns of the past (unless these were recorded in a farmer's own journal), because open drains after a few years will have been destroyed and cannot be distinguished from the surrounding cultural landscape, and old sub-soil drainage is extremely difficult to uncover.⁴ So the fact that drainage ditches are difficult to find in historical sources or recover in nature or in cultural landscapes does not mean that they were not made.

The primacy of handling the problem of surplus water forms one distinctive category of agricultural civilisation from a water-society system perspective. This perspective also means that it will be important to study how drainage technology and drainage as a social activity

differed from place to place and from agricultural society to agricultural society, reflecting local run-off, topographies and soil types as well as the character of the social system, culture and entrepreneurial capacity. The drainage technology that was available and chosen in the diverse agricultural communities had social implications, whether the solution was just to use land that was self-draining, to dig open drains that could most easily deal with surface flows, or to establish sub-soil drainage (this is, of course, the rule in modern agriculture). Open drains were dug using spades and the task was quite easy to organise socially in Norway, not least since farms normally had a natural brook or stream nearby into which the water could be led. This made it possible in Norway for individual farmers to drain their land without the co-operation of neighbouring farmers, although it was in some cases necessary or advisable to get agreement from the downstream neighbours about drainage plans. Slopes, hillsides and mountain valleys greatly facilitated the improvement of otherwise poor drainage conditions.

Due to the way that water ran in the landscape of Norway, drainage activities were as a rule organised by the individual farmer and on a small scale compared to the projects of the fenlands in England or the polders in the Netherlands that reclaimed thousands upon thousands of acres. In Norway the individual farmer could quite easily dig the furrows or bury the necessary tiles because of the topography of most farms. Although drainage required some local co-operative effort when farmers sought to obtain a combined outlet, they were also in these cases modest in scope compared to the complex and much more hierarchical social organisation and management required, for example, by irrigation of dry land in regions with scarce water resources. The water-society nexus in Norway did not require a strong, central administration, but could usually be handled and managed at individual farm level. Solving the water excess problem therefore produced and reinforced some of the institutional and structural characteristics of Norwegian agrarian society; it organised a recurrent re-enactment of relative autonomy on behalf of the farmer.

The specific social character of drainage practices can be further understood by the fact that it was located within a national legal tradition marked by a water law which was built on a very rare principle of private ownership of watercourses and water. In continental law as well as in common law, state or public ownership of at least major watercourses and groundwater was normal. In Norway the principle of private ownership of watercourses was established already in the medieval landscape codes (Motzfeldt 1908; Nordtveit 2014). Norwegian farmers were also to a greater extent than European farmers owners of their own land. Even before the Reformation, individual farmers owned about 40 per cent of

all farmland. From the end of the seventeenth century until the end of the eighteenth century, nearly all Norwegian farmers became owners of their land. Individual farms could be very widely distributed throughout the countryside since neither land nor water was in shortage, and since water runs almost everywhere private ownership of water was normal. This made it possible to put new land under the plough as an individual undertaking, and the fact that drainage could also be implemented by individual farms reinforced private ownership of both water and land.

A focus on water-society systems can also from another angle show that the unusual egalitarian structure of the Norwegian agricultural society was not only or simply a product of culture and politics, as it has been suggested conventionally. Let me mention one example from the nineteenth century: when the market economy developed, many of the wealthiest farms located on the self-draining lands lost their previous competitive advantage for two reasons. They were often further away from the new roads and railways that were laid out in the valley bottoms and, even more importantly, new methods of drainage made it possible to increase the productivity on waterlogged farms, and new ploughing technology and general mechanisation made the flatness of the land suddenly an asset. The land that had previously been the poor man's land now became the better farm closer to the market. This twist countered the natural tendency in rural societies for inequality to increase.

EGYPTIAN HISTORY AND THE ISSUE OF WATERING

A permanent challenge in Egyptian agriculture has also definitely been the 'issue of water', but in a directly opposite form. Here the main task has been how to bring scarce water in the right amount and time to the dry-baked desert soil and keep it there. In Upper Egypt, in the area around the Valley of the Kings and the Valley of the Queens and the ancient Thebes, several years could pass between rainfall events. In Cairo, average annual rainfall has long been around 20 millimetres. The arid climate of Egypt is characterised by high evaporation rates (1,500–2,400 millimetres per year), and very little rainfall (5–200 millimetres per year), which leaves the River Nile as more or less the only source of water. Water must be added to the desert soil to provide the basis for building up plants' cellular tissue, to enable evapo-transpiration by plants, to help dissolve nutrients in the soil and transfer them from the absorbing organs to the rest of the growing plants and, finally, to receive accumulated salts from the root zone into the soil drainage system. Without water mixing with the desert sand, none of this will happen, and nothing will grow. From one point of view it looks like a paradox that this desert country was the breadbasket

of Rome, and the biggest exporter of wheat in the world, providing cereals to the Byzantine Empire and, after the Arab invasion in 642, to the Islamic caliphates in Baghdad and Damascus. In the late nineteenth century, it was turned into a cotton farm of the British Empire. The explanation for these agricultural 'miracles' has always been the Nile and its annual flood, and the Egyptians' ability to exploit their particular water system in the desert, and especially in the Delta.

This 'irrigation question' is therefore the axis around which Egyptian history has developed.⁵ A focus on water-society systems in interpreting the long-term development of Egypt will conceive of the River Nile as a specific, *a priori*, supra-individual structure which framed human action and development efforts in Egypt, but in different ways at different junctures of technological development. The regularity of the variations in the water discharge of the river and the amount of fertile silt that it carried down from the Ethiopian mountain plateau made the Nile Delta a green oasis, and created at the same time the particular seasonality of the Egyptian harvests and seasons, and the particular seasonal rhythm of its agricultural life. For thousands of years, the basic strategy was to adapt to the natural floods of the Nile, extending it by the rather primitive technology of flood or basin irrigation. Every autumn, after the flood had passed its maximum, banks were built to keep the silty water on the fields as long as possible in order to saturate and fertilise the soil. In the beginning, the basins were in general small and few, but as agriculture developed and use of water increased, more and more basins were built.

The Egyptian waterscape was much more productive than the rain-fed agriculture in Norway. It helped to create large agricultural surpluses, the precondition for the development of the Egyptian civilisation and the emergence of a state, of cities, of priests and scholars. Herodotus, the Greek father of history, wrote with envy about the Egyptians after visiting the Delta more than 2,500 years ago: 'It is certain, however, that now they gather in fruit from the earth with less labour than any other men' (Herodotus 1960: 111). The combination of the society's dependence on the flow of the Nile and the river's relative regularity stimulated astronomy and mathematics. The need for this kind of knowledge was obviously there, but a need cannot in itself be a sufficient explanation. It was most likely more important that experience had told the Egyptians that it must be possible in one way or another to explain and anticipate the annual cycles of the river, because the Nile flows had an amazing regularity. Artificial watering did over time encourage the development of a state administration to solve problems of a collective nature in relation to the river and its water. The development of the state was, moreover, made quite easy, since by measuring the flow of the river at the Nilometres the state erected it could decide the level of taxation, and since the Nile was

the main communication route the state could quite easily control both trade and the movement of people.

In the great debate about the emergence of state institutions Egypt has figured as an important case, and one question has been whether Egyptian irrigation initially presupposed a strong state or whether it developed in a more bottom-up manner. There seems to be a growing agreement among scholars that the strong state developed after irrigation was established. But to understand the later character of Egyptian society it is more important to analyse how the particular Egyptian waterscape affected the agricultural sector and the society at large and over a long time period. Karl Wittfogel famously suggested that Egypt should be called a 'hydraulic civilisation', underlining the prominent role of government and drawing attention to the agro-managerial and agro-bureaucratic character of the society. It was a social order with its own type of division of labour, necessitating co-operation on a large scale. He argued that what developed was hydraulic despotism; a form of 'total power spells total corruption, total terror, total submission and total loneliness'. But to describe this state power as 'total power' overlooks the potential clout of the Nile itself in weakening or undermining ruling elites and dynasties (dynasties have fallen partly due to the effects of bad Nile years). It also overlooks how important contradictions within the elite about how the all-important water should be controlled and allocated can fragment the central power. Analysing the 'limits to total power' with a water-system approach, and locating it in this way within the particular Egyptian waterscape and the water-society system that evolved, will open up new avenues of research. Wittfogel's use of his book as an argument in a political campaign against what he saw as 'oriental despotism' in Communist China and the Soviet Union made him blow out of proportion his important insights into Egyptian history and at the same time disregard the bounty of the Nile's particular hydrology, which allowed agricultural activities to be carried out without heavy involvement and control from the state.

The building of small basins could be done on a communal basis, but the building of large embankments on the riverbanks required collective effort on a big scale. The irrigation channels required much work, both when it came to digging them and maintaining them, and the more numerous they became, the greater was the need for a power that could distribute water among them. And the more impressive they became in length and complexity, the greater was the need for a state to manage them. The *corvée*-system of forced labour in Egypt, organised by the state with brutality and firmness, was labour primarily organised to dig and clean irrigation canals; it had a profound impact on Egyptian society. The scarcity of irrigation water especially in the spring and summer season (the *sefi* season) and, importantly, gradually more so as the irrigation

system increased in complexity, encouraged a strong state in relation to society, so that the water could be allocated in a way that served the interests of the agricultural elite and the owners of large farms, while at the same time the small farmer received enough to keep him 'quiet'.

The very fabric of the Egyptian agricultural society was structured by its physical waterscape and the Egyptians' efforts to adapt to and control it. The waterscape and the dependency on the Nile determined the seasons and defined cropping patterns; it became possible to grow cotton in summer and maize, rice and sugar in winter and spring; and it framed available and practical technological options and formed the background and justification for the most important agricultural festivals. The irrigated agriculture that developed on the banks of the Nile did not initially presuppose a strong state but, as the system developed, the state could grow in strength due to taxation. Gradually the system became so complex that a strong state was needed to maintain the basins and secure an allocation of water in line with the interests of the most powerful landowners. I have shown that studies in agricultural history can be analysed in an agro-water variability perspective.

WATER SYSTEMS, TECHNOLOGICAL DEVELOPMENTS AND INDUSTRIALISATION PROCESSES

Chapter 2 showed the relevance of studying water-society systems for explaining the development of the great technological gap between Western Europe and England on the one hand and China and India on the other hand in the late eighteenth and early nineteenth centuries. This chapter will suggest that in order to understand the different paths of early industrialisation in such diverse countries as Norway and Egypt it is also necessary to integrate in the analysis the particular interconnections and confluences between water and society. No such research has previously been undertaken, but also in relation to the industrial age it is possible to draw a fundamental distinction between two categories of countries or regions when it comes to their water-society systems: those that before the coming of the steam engine were able to advance technologically due to their ability to harness water power in one form or another and those countries that were not able to do so because they lacked appropriate water sources to exploit. The development of diverse hydraulic designs and technology cannot be understood in isolation from the waterscape it aimed at adapting to or exploiting.

Many scholars have argued that the spread of waterwheel technology was one of the major technological revolutions of the pre-industrial era.⁶ The waterwheel was able to convert the energy of free-flowing or

falling water into forms of power. Until the mid-nineteenth century, the waterwheel normally consisted of a large, wooden wheel (later, it was made of iron), with a number of blades or buckets arranged on the outside rim forming the driving surface. Waterwheels were used for a number of different production activities: milling flour, grinding wood into pulp for papermaking, hammering wrought iron, heating blast furnaces for smelting metals and crushing and pounding fibre for use in the manufacture of wool cloth. Waterwheels were often fed by water from a mill pond, formed when a flowing stream was dammed, making it possible to channel water to the waterwheel via a mill race or simply a 'race'. The main difficulty regarding the use of waterwheels was of course their dependence on flowing water, which limited where they could be located. It is therefore research on countries' proto-industrialisation and early industrialisation that will benefit from studies on the diffusion of waterwheel technology from a water-society system perspective.

A comparison between Egypt and Norway in the use of waterwheel technology is very telling because it highlights the analytical relevance of focusing on differences in water-society systems by signifying vital aspects of the countries' modernisation process in general. Norway was in a truly unique position: 160,000 lakes and tarns cover almost 5 per cent of the country's surface and form natural reservoirs, ensuring for much of the year a relatively even, silt-free water supply, carried across the land by the great number of rivers and brooks, and falling down thousands upon thousands of waterfalls carrying enormous amounts of energy. Egypt was also in a truly unique position: one river with extreme variations of water discharge from season to season, running with a heavy silt load across a very flat plain and river delta, and having one lake, lying beneath the level of the sea. The point here is again to suggest an analytical approach that can throw new light on some of the big questions in national development trajectories.

NORWAY AND THE USE OF THE ENERGY OF WATER

The tens of thousands of small rivers and streams that ran through rural communities in Norway made it possible for farmers almost all over the country to set up their own mills. In the 1830s, there were between 20,000 and 30,000 mills in the country, a remarkably high number considering the country's population. In Ringeby in the County of Oppland, half of the farms had their own mill, and this place was not unique. This meant that farmers in Norway enjoyed a high degree of control over the production not only of their crops, but also of their own food, and did not have to crowd together around mills owned by the state or the landlords

and succumb to the authority of the powerful to get their daily bread. In Norway, milling activities could not develop into an arena of social exclusion or production and reproduction of social hierarchy to the same extent as they did in France and many other parts of Europe, where the rivers suitable for turning millstones were fewer and further between and the mills therefore became easier targets for the control of the few over the many. In Norway, mills were spread all over the country as integral parts of local agricultural communities and around them and their operation new mentalities emerged. People who lived where there were no rivers, or on rivers where the current was insufficient or too strong or carried too much sediment for the waterwheel to withstand it, were, on the other hand, simply excluded from taking part in this technological revolution and the subsequent forms of labour organisation. Moreover, these differences also fundamentally influenced gender relations. In almost all countries, women have been responsible for traditional milling, using various stone tools and muscle power. The invention and spread of the watermills thus greatly relieved women's burden and reduced their workload. In fact, the watermill should be regarded as a very crucial, though overlooked step in their liberation process. In addition, the grinding process became much more efficient, and rural societies became accustomed to the waterwheel and all the things that these new 'machines' could do.

An understanding of the structural importance of the particular Norwegian water-society system will have relevance for a host of historical questions. One reason why Ester Boserup's famous thesis on the relationship between population density and development does not fit Norway very well is Norway's particular waterscape. The growing population, that in other countries had to find work within the traditional agricultural production system, could in Norway move into other rural activities such as milling, timber export and sawing, or into fishing. In Norway and other countries where water had for rather a long time been quite extensively used to turn millwheels, the same type of water-driven technology was also employed for many other purposes, such as iron smelting and glass making. Waterwheels were absolutely crucial in this process, because they powered the bellows needed to create the necessary heat to form the metals and the glass. While this form of proto-industrialisation with the help of the waterwheel was virtually impossible to develop in Egypt, in Norway the waterscape lent itself to technological improvements on many fronts. While the Egyptian waterscape had served the country well in the era of agriculture, the seasonality of this mighty and sluggish silt-laden river crossing a flat desert landscape had now become a comparative drawback. The many all-year and quite small Norwegian rivers, on the other hand, became the working horses of a number of industries starting from the beginning of the sixteenth century,

especially iron industries located on rivers and where water powered the wheels that powered the bellows of the blast furnace, which again made it possible to create cast iron. Due to the fact that all these rural activities were linked to water, the character of the Norwegian waterscape made it possible for all these types of economic activities to take place within farming communities,⁷ an aspect of Norwegian society that came to be formative in the transformation process from agricultural to industrial society.

The rivers became the key to the production of sawn timber, Norway's most important export industry for more than 300 years, from the sixteenth century and well into the nineteenth century. Rivers could be used as a transport route for felled trees, from deep inside the forests down to the fjords. And, most importantly, at the same time they provided the power that could run sawmills. Both England and the Netherlands needed at the time building materials for houses and boats. Previously, planks and boards had been cut with an axe and shaped using hand-adzes. The new boats and buildings required more refined materials. While other countries lacked either the timber or the rivers that were suitable for driving gate-saws, Norway had plenty of forests and rivers that could quite easily be exploited for this purpose. The first saw driven by water was as far as we know operating in Germany in 1337, and the technology came to Norway around 1500. It was immediately put to use on a comparatively large scale. The mechanism was simple. A transmission from a waterwheel moved the saw up and down. The heavy, primitive saw-blade was dependent on a river with sufficient power to keep the vertical waterwheel (sometimes undershot, other times overshot) moving. Norway had the rivers that made it possible to float the logs to the ports on the fjords and, more importantly, these rivers could also drive the gate-saws and in places close to the ships that carried them to markets in the rest of Europe. Norway was able to become Europe's leading exporter of sawn timber thanks to these properties of its rivers; Norway had a waterscape that Sweden and Finland, with their slow-running rivers on flatter lands and estuaries, lacked. The existence of these rivers was of course not the cause of the success of Norwegian timber exports, but they could not have happened without them.⁸

When the rest of Western Europe underwent a further intensification of the Industrial Revolution by the use of coal, few factors were of greater importance in Norway than 'white coal'. After the discovery of electricity and the invention of the turbine, Norway could industrialise on a large scale and very rapidly thanks to the country's great number of waterfalls that could now be exploited for the new technology. Hundreds of rivers and streams descend from relatively high altitudes, and in order to produce 1 kilowatt per hour of electricity, a cubic metre of water must

fall approximately 400 metres. It is no poetic exaggeration to call Norway 'the land of a thousand falls', since there are around 4,000 of them. The latent energy in the water from rain and snowmelt in the highlands is therefore much greater than in most other countries, and due to the fact that precipitation falls as snow for part of the year, the country enjoys natural storage of water easing year-round power generation. Norway's rivers, streams and brooks descend in stages, through many nooks and crannies, from a wealth of large and small lakes, and onwards into an even greater number of streams and rivers, day in and day out, year after year. River systems are, moreover, spread out across the entire country, and run in all directions. There is not one river that dominates, gathering in the water from a single extensive catchment area, as does the Nile in Egypt, creating a similar type of ecology and also a similar framework of economic opportunities. In Norway the great pluralism of river systems and waterscapes enabled a relatively diversified, yet locally based industrial and entrepreneurial development.

Norway could have been the first country to be electrified due to its water power, but still the best illustration of the country's waterscape is the fact that, already by the end of the 1920s, there were about 2,000 power stations scattered about the country, while many other countries had only one or very few. Today, Norway is still one of the biggest producers of hydroelectric power in the world, and it was the rivers and the enormous and quite cheap power they produced that created communal wealth and made Norway attractive for foreign investments in the industrial sector. The special relationship between foreign (first European and later American) capital – that was invested in heavy industry located in Norway due to its cheap hydropower – and the Norwegian state, can be seen as a functional, adaptive response to Norway's comparative advantage in the world market based on its waterscape.

EGYPT'S INDUSTRIALISATION AND THE QUESTION OF THE ENERGY OF WATER

A number of studies have been carried out on Egypt's history of industrialisation, but none has given any weight to the issue of its waterscape and how this limited available options and hindered the country's development.

The spread and use of waterwheels for different purposes were fundamental ingredients both in proto-industrialisation processes and in the development of the first modern factories in the European textile industry. Egypt had virtually no such waterwheels primarily because it had nowhere to site a wheel that could be powered by water. Along the

Nile there were no places with a sufficient or appropriate fall of water or where mill races could be dug. The only place in the country where one could find a watermill was in the Fayum depression, away from the Nile proper, lying below sea level, but a place where there was a periodic Nile waterfall that could drive a waterwheel (Willcocks 1889).⁹ In more recent times, some watermills were also established in connection with the barrages built across the river to even out the flow so as to increase the area under all-year irrigation. With the technology available up to the middle of the nineteenth century it was simply impossible to use water as a general source of power in Egypt. Men or women therefore had to use muscle power and a couple of stones to make flour for their bread. And there was no alternative to muscle power in driving the spinning wheels or heating potential blast furnaces.

This situation naturally had an impact on the economic development of Egypt and also on what has been described as the conservatism of Egyptian village life, because there was no technology that could break the patterns of the past. In Egypt there were no substantial advances in available technology between the coming of the Arab Muslims in the seventh century and the arrival of the French under Napoleon at the end of the eighteenth century. Within the orientalist tradition this is often explained in terms of social variables like Egyptian conservatism and religious fatalism, but this is clearly insufficient as an explanation. The structural constraints imposed by the Nile and the Egyptian waterscape should not be overlooked.

The story of Egypt's drive to industrialise in the nineteenth century is very telling from a water-society perspective. Muhammad Ali, the Albanian soldier who had seized power in Egypt in 1805, tried hard to intervene in Egyptian markets in a drastic attempt to foster industrialisation. He purchased cotton and wheat at low prices and sold them on world markets at much higher prices, replacing tax farming with his own land taxes, and using part of these revenues to finance manufacturing investment. His Government also supplied flax and cotton cheaply to encourage domestic textile manufacturing. Muhammed Ali subsidised industry and used non-tariff barriers to exclude foreign competition from domestic markets. In the literature there is still discussion as to whether or not Muhammed Ali was successful in his drive to industrialise Egypt, and to the extent that he failed, what the reasons were.¹⁰ Most agree that he was adamant that he had a clear goal, but that he did not succeed. The question is why?

Most research on Egyptian industrialisation efforts in the nineteenth century has concentrated only on social factors, or on what can be explained by social variables, such as (a) the high level of capital accumulation (Issawi 1982: 188; Rivlin 1961: 61), and the fact that (b) Egypt had 30 spinning mills for the cotton spinning and weaving

sector, each with an average of 15,000 spindles, and employing some 15,000–20,000 people (Batou 1993: 184); and (c) Egypt's textile output was consumed not only domestically, but also exported. Some researchers have noted that the factories and technology were labour-intensive, small-scale operations, and that the machinery was not driven by power sources other than human and animal muscle power (Owen 1981:72). It has been suggested that this mode of production was the result of a chosen policy, being rational because labour was cheap while energy and machinery were expensive; Williamson and Panza 2013). The result was that, by 1834, Egypt was competing with Spain for the fifth highest spindle/population ratio in the world (Batou 1991: 183–4), and local factories were able to drive imports of lower-quality textiles out of Egyptian markets (Rivlin 1961: 197). Egypt imposed tariffs on foreign goods and subsidised domestic industry so that it could compete with European industry. There can be no doubt that the British especially resisted these industrialisation projects, since they wanted Egypt basically to be a cotton farm for the Lancashire textile industry. Britain pressured Egypt to open up its economy to free trade. But what is interesting from the perspective of the water-system approach is that the whole discourse on Egypt and its industrialisation has overlooked a striking comparative characteristic of the country: it had no places where water power could be used to propel its infant textile industry. The physical waterscape encouraged and enabled a social practice in relation to the most important and varying resource in the society that reproduced rather than eroded the economic and social patterns of the past.

The country was entirely dependent on the Nile for all the raw materials for its factories. As a producer of these raw materials the river 'delivered'. But the same river failed Egypt as a power source. Egypt had no history of watermills, or of a waterwheel-based industry, or of technical devices outside the irrigation sector, or a history of proto-industries as in Europe. When the steam engine was introduced, it had a very weak industrious or industrial foundation upon which to develop, but then the Egyptians slowly developed their own industry, liberated from the prohibiting power of the Nile.

In Norway, the particular waterscape helped to create a sequence of social development, as, for example, a milieu in which technological experiments and non-agricultural activities at local level all over the country helped to pave the way for the economic processes of industrialisation and a mind-set for modernisation. Moreover, Egypt lacked sites where it could build hydropower plants in the late nineteenth or early twentieth centuries,¹¹ during the period when Norway was industrialising and modernising. Neither of the two countries had coal, so their sources of power had to be different from that which was

driving the Industrial Revolution in continental Europe and beyond in the second half of the nineteenth century. Egypt's only river could not be harnessed for hydropower due to its hydrological and topographical character and existing and available technology. The Nile was too mighty and too seasonal in its fluctuations to be tamed for power production at the time, and to harness it to produce a regular, all-year power supply that became so crucial as production input in the industrial age was virtually impossible. In stark contrast to the situation in Egypt, there are, for example, more than 20 waterfalls within the city limits of Oslo alone that could be exploited as a source of power in the early part of the nineteenth century, as well as hundreds of waterfalls in the country as a whole that could easily be exploited for running the new turbines of the latter half of the nineteenth and the early twentieth centuries. Furthermore, the widespread conflict of interest between irrigation (requiring water to be stored from the wet season to the dry season) and hydropower production (hydropower generation requires a relatively steady flow of water all year round) was no issue in Norway, due to two factors, mainly: the dominance of drainage in agriculture and the fact that the waterfalls that were most efficient as producers of hydropower were often situated in mountain areas, far from the main centre of agriculture. In Norway, because of this waterscape agriculture and industry could develop side by side, to their mutual benefit.

At the beginning of the twentieth century, Egypt and Norway had by chance two of the biggest dams in the world – the Aswan Dam built by Cromer and the British imperialists, and the Vemork and Møsvatn Dam on the Måna (Moon River) in Norway, initiated by a Norwegian entrepreneur but erected with the aid of European financial capital and technological know-how. Comparison of the two dams for water control provides new insights into the two countries' different paths of development and how these were related to different waterscapes. The Egyptian dam was for irrigation and was built and owned by the state. The Norwegian dam was for hydropower and was built and owned by a private capitalist. The Egyptian dam was of course on the Nile, the only place it could be built, and meant a revolution in Egyptian society since it made possible all-year irrigation in much of the country. The Norwegian dam was on one of the very many remote rivers running in the middle of nowhere, and meant the start of the modern industrial revolution by generating electricity on a large scale (in this case to produce saltpeter or potassium nitrate). The Egyptian dam was built by the imperial state at the height of its power, financed by European capital, and was intended by the British to be a symbol of imperial might and 'Western methods' *vis-à-vis* the 'oriental mind'.¹² The Norwegian dam was built by the country's biggest capitalist and

financed by European capital, and soon became one of the most potent and cherished national symbols of what an individual entrepreneur could achieve. From a superficial point of view the 'text' of the two dams symbolises only modernity and water control, but more fundamentally they express and point to different long-term development trajectories framed by different water-society systems.

POLITICAL DEVELOPMENTS AND WATER SYSTEMS:
'DEMOCRATIC' RAIN AND 'AUTHORITARIAN' RIVER

A very important, albeit neglected, factor in understanding Norway's institutional and political history is that the localisation and seasonal patterns of precipitation in Norway can be described as 'democratic'. Rainfall has, of course, not by necessity turned Norway into a democracy, because rainfall in itself does not shape institutional aspects of societies in this direct way. The point here is that in order to comprehend the development path that Norway eventually took from quite an early stage, and how it is sharply distinguishable from other regions or countries, we need also to comprehend the 'windows of opportunities' created by the structural fact that water has always fallen everywhere and on everybody's 'head' or land. We need to penetrate further and deeper than tautological explanations explaining democracy and communal autonomy and power by referring to the strong position of democratic ideals and communal autonomy. The success of such political institutions and normative systems in Norway cannot be properly understood without bringing into the picture the long-term structural impacts of the waterscapes on the fabric of agricultural and industrial societies; an exogenous factor that has permeated ecosystems, technological options and systems and forms of social interaction in a number of ways.

The different water-society relations that actors experience as routine will also be reflected in their acts, often 'behind their back', because these kinds of everyday experiences are usually conceived of as normal, as part of life, so to speak. It is precisely for this reason that they are often overlooked. In Knut Hamsun's Nobel Prize-winning novel, *The Growth of the Soil* (1917), the main character is Isak Sellanrå. Sellanrå is able to turn his back on society, walk into the forested wilderness and single-handedly cultivate new land. This fictional character is not the universal figure literary critics have seen him to be, but a farmer whose social act reflects a way of thinking that rationally can develop only in an environmental context where water is no limiting factor to the location of farms. It was an act that was possible only within a specific waterscape, dominant in north-western Europe or in the Eurasian raincoast states. In areas, however,

where access to even limited amounts of water has presupposed extensive co-operation and organisation, laying new land under the plough would always involve bringing in the authority of a strong state or leader or some sort of collective, communal organisation. In such a waterscape an Isak Sellanrå would either perish or be forced back into the fold, while in Norway, where Hamsun set his novel, an individual farmer could start on his own and make the soil yield its bounty.

In Norway neither feudal lords, local kings nor the state could monopolise water sources and thus exert vital power over the farmers. The nature of precipitation and the river systems made it possible for the Norwegian peasantry to obtain and maintain considerable economic and political independence relative both to the state and the agrarian elite. People could, moreover, cultivate the soil almost wherever they liked, without having to co-operate with others and without having recourse to a complex social organisation in order to do so. Due to the unreliability of the weather, watery soil and an unfavourable topography, agriculture was always difficult, but at the same time it was possible to pursue farming as an individual activity, or to put it differently; individual ownership of farms became possible because in Norway every farmer had virtually full control over all the crucial production inputs, including the water that made growth possible. The distinctive 'ødegarder' ('homesteader' is perhaps the nearest equivalent concept) bears testimony to this notion; farms were often located far from any other village or farm. The question of why the farmers have enjoyed unusual freedom since about 1200 has been raised before; Ernst Sars explained it with political variables and the terrain, which made it difficult for the aristocracy to subdue the farmers.¹³ Kåre Lunden explains this unique situation basically using an economic model, focusing on the soil/work quotient.¹⁴ These explanations may both be useful but they both overlook the fundamental issue: the farms could be organised independently of each other since no one had to succumb to a system of allocation of absolutely necessary common water resources, and nobody could control the small farms by simply controlling the amount of water they needed.

The strong communal autonomy and the relatively decentralised nature of Norway's economy and political institutions reflect the waterscape of the country; or to be more precise: Norway could not have developed the way it has, had it not been for this waterscape. Modern factories and heavy industries, often established by foreign capitalists' investments, could be located close to hydropower sources all over the country, because of the geographical spread of waterfalls producing cheap energy. Municipalities all over the country could generate high income and become rich, because they owned hydropower plants. This fact also made the municipalities as institutions and as a group much stronger

politically in relation to the central state than was the case in most other countries. It is difficult to overestimate the importance of the fact that in the industrial era of power they owned their own power sources.

This short analysis of Norwegian history from a water-system perspective has also direct relevance for more general efforts to understand social transformation. Given the historical fact that people throughout the world have varied enormously in how they articulated their interests and aspirations, the question of what determines the concrete political means and outcomes that different groups of people actually have available to them has always been at the heart of social science. Different forms of reductionism have influenced efforts at answering these questions, among them the reduction of political means and outcomes to the simple expression of the population's 'interests' or to a vague but all-encompassing 'political culture'. Some of those who objected to these research traditions suggested ways out that have relevance to our discussion of waterscapes and water-society relations and Norwegian political traditions. The political scientists Stein Rokkan and Seymour Martin Lipset turned increasingly to complex historical explanations for why peoples were 'put on' different paths of development. In the influential Rokkan-Lipset theory of political cleavages in Europe,¹⁵ it was argued that the main cleavages can be linked to national and industrial revolutions. According to this theory, national revolutions produced the classic centre-periphery conflict between dominant and peripheral cultures. The Industrial Revolution gave birth to rural-urban and class cleavages. They insisted that the interaction of economic, political, religious and demographic factors grounded major variables in history. They aimed at explaining the political systems of peripheral areas such as Norway as cumulative consequences of their regions' connections to the chief differentiating processes, and in the view of the authors what they called the Industrial Revolution was such a process since it transformed Europe as a whole. They use Norway as an important case, and one problem with their theory is that it overlooks a crucial empirical trait of Norway's industrial geography and contradicts perhaps the most important aspect of Norwegian society in a comparative context; some of the most important industries of the Industrial Revolution in Norway were rural, or located in a predominantly rural setting due to the central pull factor and geography of the power-producing rivers. The Rokkan-Lipset theory was concerned with the impact and role of geography, but a further tracing of the geographical variations identified by their conceptual maps will not yield large intellectual returns. The search for the origins of the political means and outcomes available to different groups of people in different geographical regions at different junctures in history should continue, but water-society relations should be focused, since such relations had

fundamental but as yet little known cumulative consequences in the regions' connections to chief differentiating processes.

Just as precipitation patterns and waterscapes must be integrated into an analysis of democratic development in Norway, precipitation patterns (the desert climate) and waterscapes, and the dominant role of the River Nile, must be integrated into a similar analysis of democratic development in Egypt. It should be noted that the water-system approach suggested here has nothing to do with specific theories, as for example the idea that historically a strong and authoritarian state was a prerequisite for early irrigation societies.¹⁶ The approach is a methodology and an analytical frame, and does not imply specific theories about causal relations. In the case of Egypt it will highlight that as the population increased and the economy developed, the state became more and more important as provider of the most crucial resource. In modern times, as the state and its engineers control the amount of water in the Nile and in the irrigation canals at any time, the state has also become the sole actor responsible for the amount of water reaching the farms. The modern state gets both the acclaim and the blame for the water on the farms, as it controls and distributes all the country's water. With the Aswan High Dam, formally inaugurated in 1971, the authorities ultimately decide how much water the Nile brings, and how much water each peasant farmer is allocated. No longer can the rulers blame the gods or Isis or her tears for failing to provide water for the *fellahin*. Now everybody knows as a fact that it is the state and the water engineers who decide not only how much water the individual farmer can have, but if he is to get any at all. By focusing on the relationship between society and water it makes clear that the individual farmer is left with no choice: any farmer who is not part of an organised social system where water is allocated will get no water. The current relationship between the state and the farmer has thus developed over time, encouraged by the role and character of the Nile, the forms the control over the waterscape has taken, and the role of the Nile in the Egyptian national psyche.

In the 'age of power' the ownership of power sources has been of great social significance for the relationship between society and the state. In Norway the waterfalls were locally owned by municipalities and even by private entrepreneurs, while in Egypt the state became the sole owner and manager of the country's most significant waterfall, the power source of the Aswan Dams. In Norway there were 2,000 hydroelectric plants as early as 1929, spread over most of the country. Water and waterfalls were often even privately owned, while in Egypt the water was conceived of as a gift of Allah and managed by the state, and no individual could own a stretch of the Nile. While the waterscape in Norway made it possible to create a society with multiple centres of power and a decentralised

industrial landscape, in Egypt the waterscape stimulated a development with one strong centre. The water-system approach makes it possible to analyse this long-term development by focusing on the interconnections of the different analytical layers and the co-evolution of the waters and the societies created political entities with extremely different social structures, giving widely varying options for democratic development and institutional pluralism.

LONG-TERM HISTORY AND THE PRISM OF WATER

In order to understand the widely differing long-term development of Norway and Egypt it has here been argued that it is vital to analyse the character of waterscapes and the inter-relations between water and society. This chapter has suggested that a hydro-historical approach can offer new explanations to central historical issues and raise new questions and suggest hypotheses about issues not yet researched. It has also discussed how such analyses can be carried out, and indicated that the water-system approach requires knowledge of subjects like meteorology, hydrology, sedimentation processes and the potential of dam and mill sites in order to make sense of long-term historical and social development. The empirical analysis illustrates how social facts can and must also be explained by non-social facts and non-social variables, like the (changing) nature of a river or rainfall patterns, or the character of the local, regional or national hydrological cycle. A history that aims at broad, inclusive analyses cannot be confined to the study of written sources or the enactment of past thoughts alone. It shows that 'nature' or the 'water system' should not be relegated to a 'passive' background or arena for human actions in an introductory chapter, because such systems change over time and the same systems play different roles at different times because societies' ways of relating to them differ and change. On the other hand, it strongly objects to the environmental determinism inherent in some of the aspects of Karl Wittfogel's theory of hydraulic society that stated that both too little and too much water leads necessarily to centralised water controls and governmental despotism.

Different development trajectories should not be seen as a mechanical, necessary outcome of the structure of waterscapes, be it the dominant position of the Nile in Egypt or the 'democratic' precipitation in Norway. The actual history of any country should be understood as the result of an active process, accomplished by, and consisting of, the doings of subjects and their interaction with water over many generations. Individual actors dealing with taming or controlling large rivers or waterfalls, like the engineer William Garstin in Egypt and the capitalist Sam Eyde in

Norway, initiate and push through often dramatic changes in the history of countries. Alterations in hydrosocial cycles have often very far-reaching social implications. In some cases the very formative structure of river systems is changed, translated into new structures by human actions. But it is only when located within these structures that entrepreneurial ingenuity or the revolutionary aspect of water engineering can be understood and appreciated. This permanent and enduring relationship creates a process of emergent causation within ever-changing water-society relations – once-optional actions or additions become more or less obligatory or rational for specific actors and, over time, new arenas and frameworks for social actions are continuously created, but always embedded in historically contingent relations between water and society.