DROWNING MEN WILL CLUTCH AT STRAWS
A SHORT COMPARATIVE HISTORY OF DUTCH AND CALIFORNIAN RIVER FLOOD MANAGEMENT

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ABSTRACT

In both the Netherlands and in California, USA, river flooding has been important in the last two centuries. In the Netherlands, the rivers Rijn, Waal and Maas repeatedly flooded large areas; in California, the Sacramento River and its tributaries regularly caused heavy flooding. A shared characteristic in both regions is that early interventions against floods were local. In both the Rhine delta and the Sacramento basin, local communities tried to protect themselves against floods, without much attention for their effects on other communities or the larger system. This neglect exacerbated flooding regionally, often led to competitive escalation of levees, and occasionally led neighbouring communities to destroy flood works built by others to ensure that floods would not reach their own lands. This situation eventually led to more centrally managed flood control systems, in place today. In both regions these regional flood management systems consist of river branches and canals, bypasses and structures to drain river water, with an accompanying institutional management structure. Even though these centrally managed systems are clearly recognizable, they were not ‘designed,’ without consideration of pre-existing flood management institutions and infrastructure. On the contrary, these central flood management systems evolved from the past, and retain institutional and infrastructural elements from this past. For example, the Californian system of embankments still includes many kilometres of levees built and maintained by local communities and governments. The result has been an uneasy, but in some ways complementary, interaction between local, regional, and national institutions, each having different resources, expertise, and concerns for flood management. This paper explores the histories of these two areas in comparative perspective, with the main focus on continuity and change between local and central technical and institutional arrangements.

INTRODUCTION

The Netherlands and California both depend on rivers and water management. The Netherlands has long depended on rivers for navigation and commerce, as well as the reclamation of river deltas for urban and agricultural land. California has depended on rivers and river management for water supplies for its urban and agricultural areas, as well as hydropower (about 15% of California’s electric power). In addition, despite very different climates, both areas also are inherently vulnerable to floods. The Netherlands is largely a delta resulting from an interplay between three major rivers draining northern Europe and floods and movements from the North Sea. California’s lowlands and broad flat Central Valley surrounded by mountains are susceptible to flooding from major storms and snowmelt, and subsided lands in its Sacramento-San Joaquin Delta are susceptible to flooding from levee failures caused by floods and
Both regions and populations have had to adapt their economy, society, and institutions to these physical conditions. The other way around, both regions have adapted their physical conditions through several interventions in the water system, ranging from building embankments, draining areas and constructing dams and barriers. In this process of structuration between humans and nature, each of our two regions has been largely successful, in terms of being able to support a large population with a wealthy economy. However, this success is mixed with losses to environmental values and harm to some social groups. Furthermore, to be able to keep up with changing conditions – partially man-made – and new demands from society, both regions will have to keep investing in water management.

The dependence of these two regions on rivers also has varied with time. As their economies and societies have grown and changed, their objectives and demands for water management also have changed. This paper focuses on how these two regions have come to understand and manage their flooding problems – mainly from rivers –, how this management has changed with time and how the current situation has to be understood as a hybrid between the old and the new. In both areas, management of floods, despite its long-lived infrastructure and institutions, has adapted both incrementally and strategically to changes in economy, society, technology, and environment.

SOME WORDS OF WARNING

Comparing water management histories in these two regions is obviously a large endeavour for a small paper. California and the Netherlands differ in many ways, including geography (size, terrain), climatic conditions, economic characteristics, etcetera. When we limit ourselves to histories of more or less planned flood protection management on a certain level of collectiveness, it is clear that the Dutch have developed such management much earlier – by many centuries – than the Californians. Furthermore, as with most historical processes, the water management histories we discuss are products of human construction. We have to be careful to avoid retro-fitting, in the sense that certain ‘logical developments’ are constructed with knowledge of hindsight. Basically, history is a stream of events – some purposeful – by humans with unintended – sometimes intended – consequences on many societal levels. What we do not want to suggest is that history pops up as the description of something inevitable, as something that had to happen.

Despite all these issues to take into account, comparing these two regions can yield fruitful insights. Both regions and their inhabitants have obviously profited from the ways water has been managed, even though others may have paid some price. Both regional societies dependent significantly on clever ways to deal with water, not so much because the natural water system forces this, but because complex relations between natural conditions, human interventions, and new material conditions continuously provide new challenges. Both case studies offer an insight into the messy relations between human actions, natural environment, economical conditions, social arrangements and ideologies. Actually, such separate concepts are wrong per definition, as they only deal with a small piece of an integrated puzzle and each separate entity has complex relations with the others. We try to discuss how complex things are, with history as a discipline making our understanding of reality more complicated. Hopefully, our exploration of the changes and continuities in California and the Netherlands will bring some important questions to be answered in new environmental histories of water management. Asking the right questions should lead to finding answers for the current challenges in water management.
California’s indigenous populations were small and evolved into the seasonal rhythms of California’s Mediterranean climate, with wetter winters and dry summers. Tribes often moved seasonally among food sources and avoided seasonal flooding. The arrival of Spanish religious missions brought more established settlements and a background in more formal irrigation methods, albeit at a small scale. Settlement from the United States, eventual statehood, and the Gold Rush established a more economic growth and development-oriented society. These settlers and their social institutions came from Eastern North America, with its humid summers and colder winters, and rainfed agriculture. In a way, these eastern settlers and their governing institutions experienced abrupt climate change when they arrived in California. In the early decades of settlement, these new Californians came to understand that agriculture and settlement in California would have to be different from their traditions. Irrigation and flood management, in particular, were largely new concerns and functional needs for their relocated society. In California’s Mediterranean climate, every summer has a drought worse than eastern settlers had ever experienced. Most winters in the flat Sacramento Valley (Figure 1) brought more extensive flooding than most had ever seen.

The development of irrigation and flood management first required that the need for these functions be established. This was followed by long periods needed to develop new social institutions and technological approaches better adapted to provide these functions for this new climate under conditions of rapid population and economic growth. Growth in understanding of

1 http://upload.wikimedia.org/wikipedia/commons/f/f6/Sacramentorivermap.jpg
floods, in particular, was punctuated by the random magnitudes of annual floods. Without records of stream flow or long social or historical experience with California’s climate, floods were largely a surprise. Most flooding on North America’s East Coast occurred in summer and fall, often with hurricanes, a period of aridity in most of the Western United States. Moreover, annual floods were of varying magnitudes, levees laboriously constructed by these poor settlers to protect against a repeat of previously-experienced flooding was no guarantee of protection against floods in subsequent years. The floods of 1850 and 1862, in particular, demonstrated the need for organized responses. New forms of social action and organization were required. Sacramento Valley residents understood that they had a problem.

In California’s Sacramento Valley, early flood management was in the form of relocation further from the river – which was not always effective due to the valley’s flatness –, low levees constructed by individuals or small groups of property owners, or raising of building foundations above expected flood heights (Kelley 1989) (Figure 2). Downtown areas of Sacramento were raised about one story early in the city’s history. These actions proved insufficient. This prompted legislation in the 1960s allowing the formation of reclamation districts. This new form of government allowed local land owners to form their own local governments specifically to reclaim wetlands and protect from floods. These new local districts constructed far more effective flood protection works, but their planning and construction usually was not coordinated. As often occurs when flood projects are overseen locally, competition arose between districts in managing regional floods. Reclamation districts on either side of the river found themselves in a dilemma of escalation. The optimal levee height for each district was to construct a levee slightly higher than its neighbour’s levee. Eventually, some with lower levees found that they could reduce the height of competing levees during floods using explosives. The levee arms race had gotten out of hand.

![Second author standing on one of the levees in the Sacramento Delta](image)

*Figure 2. Second author standing on one of the levees in the Sacramento Delta*

Understanding that the Sacramento Valley’s flooding problems were regional and not local originated in the 1860s. However, at this time, prevailing political philosophy in the US was for local control and governance of natural resource problems, avoiding interference from state and federal governments. This had long been a productive philosophy and enjoyed widespread popular support. It was not until the late 19th century and early 20th century that the
then- ‘Republican’ idea of federal and state intervention to promote economic development at a larger and more coordinated scale became widely enough accepted to allow consideration and development of regional flood management systems. This was not a smooth transition (Kelley 1989). However, by the early 1900s, a system of rationalized levees and a major system of flood by-passes had been established in the Sacramento Valley. Major widening of the Sacramento River’s outlet by dredging also increased the ability of the system to more quickly shed flood waters and support navigation. This system was designed by federal and state engineers, but largely maintained by pre-existing reclamation districts. Old institutions were largely incorporated into the new system, as were many older levees. This was convenient politically and often practically. The city of Sacramento was much better protected and agricultural production in the Sacramento Valley was now protected from all but the most extreme floods. Also, the role of federal and state engineers and organizations, as well as more modern engineering approaches and data collection, had become well established, even if it’s funding remained sporadic.

In some ways, this transition from a hodge-podge of local reclamation districts to an organized regional flood management system reflected a change in California’s economy from one based largely on mining in the mid 1800s to one based on agriculture in the late 1800s and early 1900s (Hanak et al. 2011). In the broad flat Sacramento Valley, the rise of agriculture and agricultural wealth was limited by flooding. And flooding was caused by excessive sediments from hydraulic mining and lack of a regional levee and by-pass system. Courts in the 1880s largely ended hydraulic mining due to its downstream impacts, in some of the nation’s first environmental cases. The regional levee and by-pass system came later. Although even here, the legacy of hydraulic mining remained in the design of the levee system, as large amounts of mining sediments continued to enter the river systems and threaten the flood conveyance capacity of rivers. Much of the early levee system was designed with levees close to the river, with the understanding that higher flood velocities would scour mining sediments form the river and transport them downstream, preventing their setting in the river and raising the river bed. This decision, perhaps appropriate at the time, would come to haunt future flood management.

In California’s Sacramento Valley, the success of the flood bypass and levee system allowed for the growth of agriculture and cities, leaving mining as an insignificant relic. However, the growth of cities and an industrial and service economy also demanded space in the floodplain lands. These lands were adequately protected from typical floods for agricultural production, but were poorly protected from floods for urban settlement. Just as European settlement, hydraulic mining, and the growth of agriculture had established flooding problems in the Sacramento Valley, the growth of cities was changing this problem. Another change in the Sacramento Valley’s flooding problems arose from the success of earlier flood control in draining wetlands, constructing levees on riverbanks, and regulating water generally. The valley’s seasonal floodplains, which were historically important spawning and rearing habitat for native fishes and habitat for migratory and resident birds, had been largely eliminated; only about 5% of California’s native wetlands remain. The economic success of the flood control system, and the larger economy, also made it easier for California’s society to regret these environmental losses.

In California, urban growth, the decline in native ecosystems, recent large floods with consequent increases in the estimated probabilities of major flooding, and the deterioration of levee and bypass systems have brought realization that major changes are needed to improve flood management. The consequences of not making such improvements became apparent with the flooding of New Orleans by Hurricane Katrina in 2005 and Sacramento’s designation as one of the nation’s cities most vulnerable to catastrophic flooding. This resulted in additional state funds for improving existing levees, a resurgence and renewed seriousness for levee certification and improvement programs, and new state floodplain management legislation. These all provide incremental improvements in California’s neglected flood management infrastructure. By the end of 2012, California’s Department of Water Resources is to have a new flood management plan for the Central Valley.
THE NETHERLANDS

The Netherlands is a country famous for its water management system, both in terms of institutional arrangements – like water boards – as its physical features – the many polders, embankments and pumps. The modern Netherlands is divided into almost 100 embanked areas (Figure 3). These areas have different safety levels, with the two large embanked areas in the western Netherlands (areas 13 and 14, which include the majority of population and economic activity in the country) having the highest safety level. This apparent neatly organized and well structured flood protection and water management system still has its discussions, as was recently shown through the discussions on the latest governmental committee advising the minister on future national and regional water policies (Deltacommissie 2008). Discussion is a concept which could be used very well to understand the development history of the Dutch water system. As in the Sacramento Valley, but well earlier as it was in the late Middle Ages, inhabitants of the Dutch river area started to construct embankments to protect their lives and property from floods (Van de Ven, 1996).

Figure 3. Dutch embanked areas (‘dijkringen’) with safety level in different colours

These first attempts were collective measures, with groups of people being responsible for maintenance and management of embankments. As in the Sacramento Valley, these collective entities were local, although there were enormous differences in the scale and responsibilities of these local collective institutions – water boards. Some regional water boards

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2 National Waterplan, Ministry of Public Works, the Netherlands, 2009
managed extensive areas, but smaller ones could manage only a single polder or embankment. Local water boards had close relations to higher political powers, who also had an interest in water management, although their influence was much more arranged through conflict resolution, concessions for peat-digging, regulating the use of rivers and founding new boards. These higher political levels of government were usually not involved in daily water management. Although this decentralized system of water management did function quite well, the arrangements with numerous autonomous actors became more vulnerable over time. Progressive soil subsidence caused by drainage required stronger efforts to drain low-lying areas. One interesting inheritance from this period is still visible in the Dutch landscape. Quite a few embankments were not constructed, but were the remains of peat clearances: between different areas some of the peat was not reclaimed to allow room for drainage and to clearly indicate the borders. These drainage canals and borders did not sink as quickly as the land areas around it and remain visible today in the landscape as embankments (Figure 4).

![Figure 4. Current embankment in urban area is actually a remaining peat bank](image)

Another ‘inheritance’ from the past can be located in policy measures. Around the late 18th century, one of the biggest issues in the Netherlands was the flood threat from the rivers. Although attempts at a more national policy were already started, the establishment of the National Public Works Department by the French in 1798 was a major breakthrough in developing national river policies. Obviously, the history of river policies is very complex, but it is safe to say that in the last two centuries a strong national management system for Dutch rivers did develop. Interestingly enough, in our own times, some results inherited from decisions made in the past by this emerging central institution are no longer considered acceptable in the Netherlands. In the current discourse on Dutch river management, for example, the normalization of the rivers – mainly a late 19th and early 20th century activity – in particular is perceived as the main problem. Simple flood discharge through extra water ways as was frequently done in the past is more difficult to apply today in the densely populated parts of the Netherlands. As a response, creating room within the river bed itself and temporary measures outside the river bed are proposed as solutions. After all, the economically and demographically important western part of the Netherlands needs to be protected.

In the historical discourse on flood management (see for example Van der Ham, 2004;
Van de Ven 1996) all these elements are included too. Van der Ham concludes that in the 18th and 19th century protection of the ‘heart of Holland’ (the western Netherlands), being the lowest and the richest part of the country, had always the highest priority. Discussing and creating room for floods outside the river beds has been an element of river management in this period too (Ertsen and Ten Horn, 2005; Van der Ham 2004; Van de Ven 1996), like river diversions and spills. One of the diversions, the Beerse Maas consisted of two river stretches without embankments – one reason why it is not completely accurate to refer to the system as a side spill – of 800 and 2,500 meters (Van der Ham 2004; Figure 5). When the river discharge was high, water would flow naturally in the Beerse Maas. In 1821, a commission discussed the effectiveness of the system. The water encountered too many obstacles – hedges, roads etcetera –, and earlier attempts to clean the water course had not been very successful, although from 1828 onwards the system was functioning better (Van der Ham, 2004). Next to maintaining depth for shipping, the river normalization works in the late 18th and early 19th century in the Netherlands were executed to prevent the formation of ice dams – which were major causes of floods – through increasing the speed of flood discharge through the rivers. The Beerse Maas was closed in 1942 after the normalization of the Maas (Meuse) was realized (Van de Ven, 1996). One measure proposed in the recent flood management debate in the Netherlands to realize temporary storage and/or extra discharge capacity is reopening the Beerse Overlaat (Commissie Noodoverloopgebieden, 2002). However, both the effectiveness of the system and the impact on society were reasons not to go through with this option: the water’s path would include many more residential and industrial areas than before 1942.

Figure 5. The system of spills in the province of Brabant in the 19th century

DISCUSSION

The Sacramento and Netherlands show similarities in their histories, for example in terms of stakeholder conflicts, but also in showing that different circumstances, changes in social contexts, value patterns, etcetera could stimulate changes in approaches to deal with floods; new technological measures could be developed, other techniques may become obsolete (see also Morgan (1950) and compare with historical developments of water supply and wastewater infrastructure and institutions as discussed by Tarr (1984) and Pisani (1986)). That is not to say that everything changes. Although in Dutch river management the measures proposed recently differ from those applied in the last 50 years of the 20th century, these same measures are not new, however, as they were known, discussed and applied before in the 18th and 19th century. It is clear that the time frame one takes into account appears to be important: what may be

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3 From Van der Ham, 2004
perceived a rather drastic change on a short time scale could become a much more gradual development on the longer time scale (Ertsen and Ten Horn 2005).

Flood management systems, like many other long-lived infrastructure systems, evolve with time, from existing institutions, perspectives, technology, and infrastructure. Such evolution both maintains the expertise, resources, and political commitment of existing flood management systems, and reduces resistance to change from these individuals and groups. Most change in flood management systems is incremental, with small changes adapting to slow changes in society, economy, technology, and the environment. Under some conditions, incremental changes can be maladaptive, and lead the region into an increasingly dis-functional and risky condition, as was the case of competitive levee escalations in California and the Netherlands. The emerging result of these incremental changes, however, can be quite large, as can be seen with the current levels of the Dutch western region and the Sacramento-San Joaquin Delta, which are below sea level in many places in both regions. These low levels are mainly the result of human efforts to drain the land in a response to wet conditions. Draining the land caused the lands to sink through consolidation and oxidation of peat soils. As is now well known, the short term effects may be mild, but over decades and centuries, the land subsidence proves to be considerable. At the same time, major events have proven to provide reasons and opportunities for major changes. Catastrophic floods as experienced by both regions discussed in this paper generated political attention gearing major changes and investments in Dutch and Californian flood management systems. At the same time, these new attempts in flood management systems also reflect the prevailing social and political conditions at the time, and created conditions for changing these conditions. In the Sacramento Valley, for example, regionally organized infrastructure and institutions for flood management were not feasible until national politics developed allowing larger scale state and federal involvement in solving local problems (Kelley 1989).

Long-term development and change in flood management infrastructure is made difficult be the immense expense of making major changes to such extensive infrastructure, especially as land becomes developed and occupied by valuable properties. In the late 1800s and early 1900s, levees in the Sacramento Valley flood management system were placed by riverbanks to increase scour of sediments from Gold Rush hydraulic mining. By the early 21st century, most hydraulic mining sediment has passed through the system, so this scouring now threatens levee stability. The development of economic activity behind the existing levees also makes moving these levees back from the rivers more expensive and politically difficult. As we have seen, even though the economic reason behind it was – as centuries before – to protect the economic heart of the Netherlands in the western areas – the measure proposed to realize temporary storage by reopening the Beersche Overlaat was not feasible given the increased value of residential and industrial properties in the proposed pre-1942 planning area itself. Whatever the developments will prove to be in both the Sacramento Valley and the Netherlands, each with their own histories of different length, the challenges of flood management in these two flood prone regions continue to change, as economic and population growth continues in levee-protected areas, sea level rises, and changes in water and sediment hydrology occur as a result of upstream changes in land use and climate.

REFERENCES


