1 Tracing back a river

Introduction

In 1993 I graduated as an irrigation engineer at Wageningen University. I must confess that I did not really consider that as strange. Obviously, as anyone, I did know that the Netherlands' international reputation is one of water excess, or drainage, not of water needs, or irrigation. Furthermore, with an MSc thesis on irrigation in the Netherlands East Indies, I knew that Dutch irrigation efforts on Java were substantial. It was not until I started working at Delft University of Technology, however, that I realized that at least two questions needed explanation. The first issue, why one could graduate in irrigation in a drainage country, seemed rather straightforward. One could still graduate in irrigation engineering in the late 20th century in the Netherlands, in Delft or Wageningen, because the Netherlands promoted its water knowledge within the international arena of development cooperation. Irrigation projects were vital elements within development policies. A second issue popped up, however, when I started looking at irrigation education in Delft. Within the lecture notes, I encountered many elements apparently taken directly from examples from the Netherlands East Indies. Specific discharge measurement structures were to be applied, and canal capacities were to be calculated according to a certain procedure. How could I explain the survival of these Dutch colonial elements within the general discipline of irrigation? This apparent persistency of colonial irrigation elements in Dutch irrigation practice and education is the main source of inspiration for this book; the Netherlands East Indian irrigation regime, consisting of explicit and implicit rules for irrigation design is its subject. Many studies discussing irrigation development in the Netherlands East Indian colony exist[1]. A study trying to understand the technical development process of irrigation seems to be missing; this book claims to fill (part of) this gap. I intend to explain two related issues: (1) how did the Netherlands East Indian irrigation school develop and (2) what happened with this school after Indonesian independence?

Persistency

Accounts of persistency of colonial irrigation practice have been made by several authors. Colonial British irrigation design and water management concepts still shape to a large extent daily irrigation practices and discourses in Pakistan and India[2]. Different 'schools' of irrigation development, similar to the British example, emerged in the context of colonies, as the Dutch did in the Netherlands East Indies and the French in north-western Africa. The American school may be the only one without colonial

connotation, although elements of Spanish influence can be detected[3]. An irrigation school is a tradition of practice, comprising information physically embodied in a community of practitioners and in rules for action which these practitioners master. Traditions define accepted technical operations and encompass aspects of relevant scientific theory, engineering design formulae, accepted procedures, specialized instrumentation, and usually some kind of ideological rationale[4]. An important mechanism in this process of preference-guided selection of design solutions is engineering education; graduating from engineering programs is like passing the preparatory demands for community membership.

In the 1960s and 1970s, irrigation engineers developed irrigation schemes applying the well-known design practices of their respective schools, which were treated as 'the best possible method'[5]. Nowadays, modern irrigation science appears to the observer as an international, homogeneous body of knowledge. There seem to be no different schools of thought; one could speak of the modern paradigm of irrigation promoted by the World Bank, the International Commission on Irrigation and Drainage and other international organizations. Perhaps this international paradigm is dominated by American irrigation science. However, when looking closer, a somewhat more complex picture showing different approaches to irrigation and its problems replaces the picture of uniformity. Within irrigation modernization discussions French-based downstream controlled demand management and American-based upstream controlled arranged management approaches seem to be contrasted[6].

With an obvious restriction in the empirical material being limited to Dutch irrigation, even such a limited focus should allow me to contribute to a continuous debate within the community of those who engage with the history of technology[7]. Traditionally, studies on histories of technologies focused on the bolts and nuts of technologies and its great inventors, with hardly clear and systematic exploration and explanation of the societal context. Brave men and their machines was the discourse. As a response, particularly in the last three decades, studies of technological systems, social construction of technology and the influence of class and gender have enriched the field of history. There is not much sense in denying that in many of the earlier studies the relation between technical development and society has been represented quite one-sided in terms of discoveries, inventions and successful applications of individuals who brought their discovery from its isolated niche in the open for society to prosper. On the other hand, though, new approaches focusing on understanding technical development as determined by societal forces allow society to determine shape and selection of technology, but technology hardly overcomes a status of passive artifact. Furthermore, daily activities of those engaging in developing technologies, our former heroes, are usually left out.

Technological regimes

When this well-known discourse between internal and contextual approaches is presented, the author usually claims that he has overcome the differences. Indeed, my claim is not very original, but I intend to do credit to both approaches in my analysis of Dutch colonial irrigation. I discuss technical development as a process influenced by societal forces as well as by successful discoveries or applications by individuals. The concept of technological regime I apply aims to link the two positions[8]. The regime concept is based on the recognition that

> 'invention and innovation are conditioned by such factors as earlier innovations, the search heuristics of engineers in an industry, available technical knowledge, market demand and industrial structure.' [9]

The regime concept bridges another gap as well, as

> '[b]etween the formalized knowledge that can be traced through courses and treatises, and the everyday decisions made by engineers, there must be for sure some kind of intermediate know-how.' [10]

This intermediate know-how, transformed in rules structuring the how and what to do, shapes a technological regime. Engineering education, transferring existing knowledge and design rules to new engineers who have no direct link with the practice in which the rules were developed, can be considered as a structuring element. Another such a structuring element closely related to education materializes in engineering handbooks. Successful approaches become examples, even blueprints for technological design. Selected examples are presented to students at engineering schools. The professional engineering organizations, including educational institutions, but also Departments of Irrigation (or generally Public Works), select, discuss and promote successful technological solutions. Gradually, a technological regime develops[11].

Technological regime development is a two way process between structures and actors. I define a technological regime as a set of rules structuring activities of actors involved in development and use of a certain technology[12]. Rules can vary in form and content; some are related to design of technologies, others to use, others to divisions of labor.

> 'Some rules will be explicitly laid down in requirements and technical norms. Other rules will be tacit and implicit and will be followed by the actors on the basis of habits or tacit knowledge. […] Rules in technological regimes can also be embodied in production apparatus or technological artefacts.' [13]

The totality of relevant rules shapes the technological regime. Within a technological regime different categories of rules can be ordered hierarchically; I employ five of these categories[14]. Together these five categories shape the irrigation regime (Figure 1.1). Basic founding premises are (1) 'guiding principles', which relate the design of a

technology to doctrines and values used to legitimize a tradition and its outcomes. Closely related to these principles are the (2) 'promises and expectations' about a future technology, which will be translated into more specific requirements for new technologies. I employ the term (3) 'design requirements' to describe functions to be fulfilled by an artifact and boundary conditions that are important in the design of a technology. To enable the fulfillment of requirements, (4) 'design tools' are employed, including scientific knowledge, design heuristics, technical models and formulas, design methods and approaches. Category (5) 'artifacts and operation' includes the result of any design activity; both in the meaning of physical objects as in the meaning of operation and management procedures. Artifacts may not be considered as rules, as they only fulfill functions and have to meet design criteria and requirements. On the other hand, artifacts can and certainly do function as exemplars: future designers still apply them because they are known or have been proven in practice.

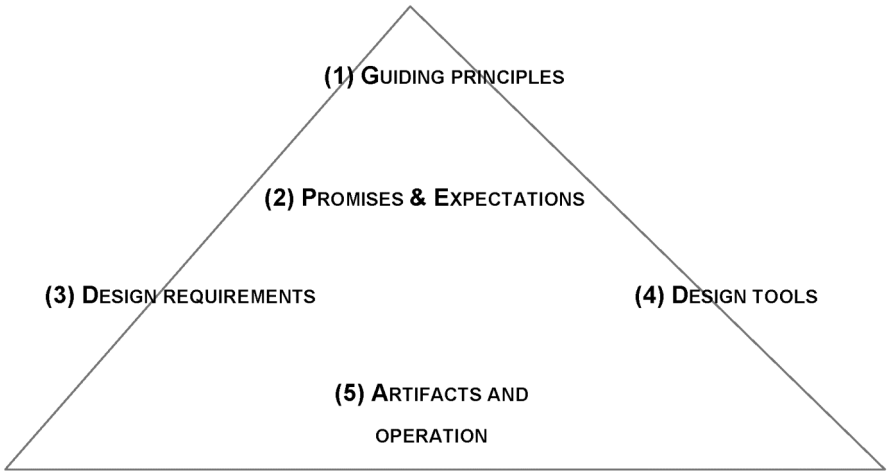

Figure 1.1 The technological regime triangle [15]

The categories are structured in a hierarchy; guiding principles are on a higher level than design tools. In the Netherlands East Indian context, higher level not only refers to the more abstract nature of guiding principles in contrast to for example design tools, but also to the larger number of stakeholders involved in and the political connotation of formulating guiding principles. As we will encounter in this book, debates on the appropriate foundations for colonial water policy involved civil servants and engineers, government and private industry. On the other hand, discussions which discharge measurement structure to be used to realize this water policy were exclusively situated within the civil engineering circle. Higher level rules structured the development process of lower level rules like design tools and artifacts.

Even though drawing boundaries exactly of a technological regime beforehand might not be needed[16], one could define regimes rather broad or rather narrow. I tend to start from a relatively narrow definition, perhaps even a rather traditional position, analyzing

the development process of Netherlands East Indian irrigation focusing on the rules that structure activities of actors involved in its development. To narrow down my approach even further: I am mainly interested in the actions, discussions and positions of Dutch irrigation engineers in shaping their irrigation design approach. Some authors would regard this as a rather restricted interpretation of the concept of technological regime, but I will show that such a restricted regime concept has strong explanatory power to understand the development process of Dutch irrigation. I would even like to claim that my restricted concept has more explanatory power than a broader conceptualization, as restriction allows pointing out key elements of the regime and explaining preferences and actions of the main actors involved much better.

Structuration

The extremely simplified description of regime development given above has some apparently functionalistic connotations: rules on one level shape rules on lower levels. Such a description obviously will not do at all for a better understanding of technological regimes. Functionalism is the last thing I want to defend; humans, not abstract forces, created the irrigation works and knowledge in the Netherlands East-Indies. I am much more interested in conceptualizing technological traditions in the way Giddens discusses the concept of structure[17].

> "Structure' refers to 'structural property', or more exactly, to 'structuring property', structuring properties providing the 'binding' of time and space in social systems. […] [t]hese properties can be understood as rules and resources, recursively implicated in the reproduction of social systems.' [18]

Structures do not exist; they manifest themselves through the constituting moments of social systems. This

> '[…] implies recognising the existence of: (a) knowledge – as memory traces – of 'how things are to be done' (said, written), on the part of social actors; (b) social practices organised through the recursive mobilisation of that knowledge; (c) capabilities that the production of those practices presupposes.' [19]

Regime development is a social activity; in social interaction human actors construct technological regimes as they construct society.

> 'Human social activities, like some self-reproducing items in nature, are recursive. That is to say, they are not brought into being by social actors but continually recreated by them via the very means whereby they express themselves as actors. In and through their activities agents reproduce the conditions that make these activities possible.' [20]

Generally, in daily practice we reproduce existing, historically grown sets of rules by applying and changing them. To know a rule is to implicitly know what one is supposed

to do in particular situations and rules are widely used and sanctioned. Although they show a tendency to be stable, rules are not static[21]. Rules do not develop by themselves, nor are they followed simply because they are there. Actors, real people, make and break rules. Actors will follow the relevant rules, or in my case act within the technological regime, not just unconsciously or routinely, but also because they think they have something to lose by not acting in accordance with the rules, or something to win if they do[22]. Human activities are recursive. Structures, regimes or rule sets, do not exist as patterns in time and space by themselves, but only become concrete through human action; society is reproduced through human action. What remains somewhat unclear from the discussion above is where the action actually is. In this book, the social construction process of the irrigation regime is located in the East Indian colony between 1830 and 1940, and after World War II in independent Indonesia and the Netherlands.

This book

Stressing continuity[23] in the social construction process of the Dutch irrigation regime does not imply that the regime developed like some external force, with a will of its own, without any possibility for actors, either engineers, farmers, civil servants or any other, to influence its course. Fierce debates took place in the colony and the Netherlands, in particular on the issue of water allocation, regulation and distribution. Different social groups disputed over policies to develop, about the rules for irrigation development. Actual outcomes of this confrontation between social groups have been influenced by changes in colonial political, economic and institutional settings. I intend to show throughout this book, that the basic guiding principles of Dutch colonial irrigation and its related design practice were set relatively early, that is before the First World War, and have not been transformed afterwards, despite continuing debates. Furthermore, I will defend the position that irrigation engineers were the dominant group to determine requirements, shape and format of colonial irrigation systems and consequently of most of the colonial irrigation regime.

In Chapter two, I discuss guiding principles and promises/expectations for colonial irrigation development processes in British India, British and French Africa and the Netherlands East Indies. Irrigation development in colonies did not only have to serve the colonial powers, but also the colony itself; it would not serve mere exploitation, but also become an element of a policy of productive imperialism. I take the analysis to a more detailed level in Chapters three and four, when I discuss the process in which guiding principles, design requirements and artifacts in the Netherlands East Indies developed. The agrarian policy of the Dutch colonial powers is vital in explaining why a Netherlands East Indian approach could develop. The most important founding element in Dutch colonial irrigation, or guiding principle, was the mutual presence of food and commercial crops, respectively rice grown by peasants and sugar cane by the industry, in the same irrigated area. Consequently, the need for adjustable water control

was defined as a design requirement; to realize such control two types of artifacts were needed: management regulations and structures.

In Chapters five and six, I discuss the design of the West-Javanese Tjipoenegara irrigation system. The period in which this system was designed and built, roughly between 1920 and 1935, is a key period for two reasons: from a theoretical point of view a closer analysis of the timeframe sheds light on the question of regime construction and continuity; from design point of view this timeframe brought a series of new elements. Most design decisions appear to have been the responsibility of engineers; most of them relate to the regime categories of design requirements, tools and artifacts. An important design rule appears to be anticipation on the presence of sugar cane next to rice in the irrigated area, requiring control over flows varying in time and space in the irrigated area. Within this guiding principle, the engineers constructed their design approach.

In Chapters seven and eight I discuss irrigation planning and engineering after World War II, when Indonesia became an independent republic. The case study of the Lampung area, Southern Sumatra, shows that irrigation activities in Indonesia were influenced by design rules developed by Dutch engineers in colonial times, even when representatives of other irrigation regimes were involved. Although Dutch irrigation engineers started working in other regions, irrigation education at Delft Polytechnic did not reflect such interest for a long time. Delft irrigation education remained based on the colonial technological regime up to the 1980s. In the conclusions, I will distinguish between two phases in the development process of the Netherlands East Indian irrigation regime. Between 1870 and 1910 the guiding principles, promises/expectations and the majority of the design requirements took shape. The focus in this phase was on developing prescriptions for irrigation design. The phase between 1910 and 1940 was an elaboration phase, in which tools and artifacts to translate general rules into infrastructure were defined. Focus was on perfecting tools and artifacts applied in irrigation design.