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ScienceDirect
Land Use Policy 25 (2008) 330–337
Land Use Policy
www.elsevier.com/locate/landusepol

Complex bounded rationality in dyke construction Path-dependency, lock-in in the emergence of the geometry of the Zeeland delta

Lasse Gerrits[a,*], Peter Marks[b,1]

[a]Erasmus University Rotterdam and TNO Built Environment and Geosciences, P.O. Box 1738, 3000 DR Rotterdam, The Netherlands
[b]Erasmus University Rotterdam and Ministry of Spatial Development, Housing and Environment, D.G. Environment, P.O. Box 1738, 3000 DR Rotterdam, The Netherlands

Received 29 June 2006; received in revised form 31 March 2007; accepted 4 September 2007

Abstract

In this article the theoretical concepts of path-dependency and lock-in are applied to the geometry of the Zeeland delta in the Netherlands. They are used to show that even very small and unpredictable events can cause systems to remain on a path that is practically impossible to leave because the costs of leaving are too high. As a result, systems can lock into a certain outcome based on continuous rational decisions that have been made in the past.

It is recognised that the positioning of the dykes in the Zeeland delta has locked into a geometry that is nowadays perceived as unfavourable. Non-predictability, non-ergodicity, inflexibility and path-inefficiency, which are all properties of path-dependency and lock-in, provide perspectives for examining how the positioning of the dykes has evolved over time. They also offer explanations about how decisions pertaining to the development of land in the past have led to results that are now considered to be unfavourable. As a consequence policy makers are considering investing considerable resources in order to restore a favourable situation.

Keywords: Path-dependency; Lock-in; Geometry; Zeeland; Bounded rationality; Estuaries

Introduction

Decision-makers are often facing problems created by decisions others took in the past. This phenomenon is especially characteristic for spatial policies as many major spatial issues concern the relocation, renovation or alteration of old sites that are no longer considered to be desirable or conducive to present policy goals. People may wonder why and how decisions made in the past have led to spatial elements now perceived to be unfavourable. An example of this is the debate over the geometry of the Westerschelde estuary—a part of the Zeeland delta (Netherlands)—that is currently deemed unfavourable by a group of decision-makers and scientists (Peters and Parker, 2001). Over centuries, the Zeeland delta has developed from a mosaic of islands in the southwest of the Netherlands into a severely restricted water body, whose natural state is regarded to be deteriorating. According to experts, one of the reasons for this has been that the geometry of the delta influences the natural flow of salt and fresh water through the estuary, thereby diminishing the ecological development associated with a healthy estuary (Peters and Parker, 2001). Such regression may render the estuary a channel-like water body with reduced inter-tidal areas. These inter-tidal areas, together with the mixture of salt and fresh water, provide fertile ground for many organisms and foraging areas for European birds (Slinger, 2000).

The geometry of the Westerschelde and other major water bodies in the Zeeland delta is constructed and confined by dykes, groynes and other hard points. It has been shaped by the circumstances of the past, such as the

*Corresponding author. Tel.: +31 10 408 2053.
E-mail addresses: gerrits@fsw.eur.nl (L. Gerrits), marks@fsw.eur.nl (P. Marks).
[1]Tel.: +31 10 408 2139.

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doi:10.1016/j.landusepol.2007.09.001

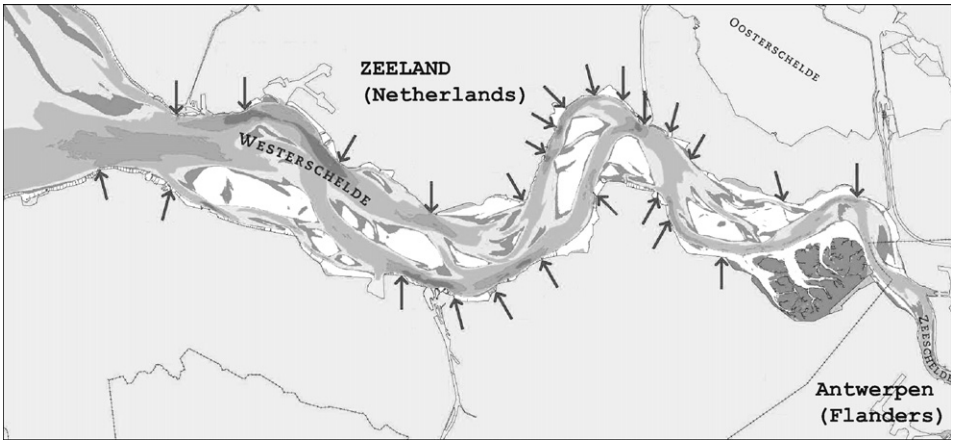

Fig. 1. Example of hard points indicated by the arrows along the Westerschelde estuary in the Zeeland delta. Adapted from Peters (2001).

economic use of agriculture land, technological advancement at the time of dyke construction and the then common practices of the construction of dykes. Investigating this dyke construction in the Zeeland delta enables us to understand the emergence of the geometry in this delta in general, and the Westerschelde in particular. Restoring the ecological state of the area would ideally require a change in the geometry of the delta (Peters and Parker, 2001). Such an operation is very difficult, both in terms of costs and changing the public perception. To change the geometry requires that some dykes and other hard points be altered, or even removed. It would also have consequences for agricultural land, which would need to be substituted for nature development in flood plain areas. Since 62.4% of the total surface in Zeeland is used for agriculture nowadays, this is against the public opinion. Indeed, it would have been easier for today's decision-makers if the dykes were not situated where they currently are, and parts of the estuary had not been converted into agricultural land (Fig. 1).

This article is an attempt to answer the question why and how decisions to construct dykes have led to results that nowadays are considered to be unfavourable. This perception of an unfavourable geometry is officially put down in broadly supported policy-documents and has brought decision-makers to consider spending considerable resources in order bring about a more favourable situation as witnessed in recent policy decisions (Zanting and Thij, 2001; ProSes, 2004; Ministry of Agriculture and Nature and Food Quality, 2005).

The following section describes the mechanisms of path-dependency and lock-in. These mechanisms are used in this article to provide explanations as to why the dyke construction of the past is no longer favourable to the current situation. Systems such as the Westerschelde have been influenced by various factors over time, both physical and social. These systems have adapted to these factors as a result, and have not retained their original form. Small and ostensible insignificant changes and decisions can change the whole system. The actors are often not in the position to interact and coordinate with each other, but their own particular decisions give shape to the geometry as a whole. The newly created geometry reduces the possible choices in the future. As Maquire and McKelvey (1999, p. 26) put it, the constituent parts of a system responding "to their own particular local contexts […] can, despite acting in parallel without explicit inter-part coordination or communication, cause the system as a whole to display emergent patterns—orderly phenomena and properties—at the global or collective level." This serves as a guiding thread throughout the article.

The "Path-dependency and lock-in" Section covers the theoretical framework. The next sections show some of the history (Dykes in the Zeeland delta Section) and the basic principles (Three principles of dyke construction Section) for dyke construction in the Zeeland delta. Data were collected through interviews with experts, study of historical records and literature studies. In "Mapping lock-in and path-dependency" Section, the four properties of path-dependency—non-predictability, non-ergodicity, potential path-inefficiency and inflexibility—are applied to show that local optimal solutions in the past eventuate in locked-in results for the system as a whole, thereby creating the unfavourable situation for current decision-makers. Addressing the problems created by path-dependency will then be discussed in the concluding "Conclusions and reflection" Section, where some recommendations are made that may help decision-makers.

Path-dependency and lock-in

Economics, as well as many other disciplines, is a field of study known for its abstract modelling of the outside world. By abstracting it is possible to focus on a limited amount of variables influencing the explananda. To study and understand the behaviour of large complex adaptive systems, abstractions of the "real system" can be made. Abstractions help to understand the mechanisms in (the abstracted part of) the complex system. "The value of an analysis without them (*complicating factors—authors*) is