



Planning practice in support of economically and environmentally sustainable roads in floodplains: The case of the Mekong delta floodplains



Wim Douven ^{a,1}, Joost Buurman ^{b,*}

^a UNESCO-IHE, Westvest 7, 2601 AX Delft, The Netherlands

^b National University of Singapore, NUSDeltares, 2 Engineering Drive 1, E1 #08-24, Singapore 117576, Singapore

ARTICLE INFO

Article history:

Received 13 April 2010

Received in revised form

18 April 2013

Accepted 25 April 2013

Available online 2 June 2013

Keywords:

Floodplains

Delta planning

Road planning

Environmental assessment

Mekong River

ABSTRACT

Road development in relatively undisturbed floodplain systems, such as the floodplains of the Mekong River, will impact hydraulics and interrupt the natural flow of water. This affects the ecology and environment, and the livelihoods of people who depend on fishing and agriculture. On the other hand, floods can severely damage road infrastructure in years with large floods and can cause high annual maintenance costs. Improving road development practices in floodplains is a complex, multidimensional task involving hydraulic and geotechnical analysis, ecosystem analysis, socio-economic analysis, policy analysis, etc. This paper analyses the planning practice of road development and rehabilitation and how this practice can be improved in support of economically and environmentally sustainable roads in floodplains. It is concluded that although ample technical, planning and environmental assessment guidelines exist, guidelines need updating to address cumulative impacts at floodplain level and factors hampering the implementation in guidelines should be addressed in the guideline design (process).

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1. Introduction

Many river systems in less developed countries are still relatively undeveloped with substantive floodplains in the delta regions playing a key role in supporting ecology and livelihoods. The pressure on these systems, however, in terms of population growth and development needs is often high. Population growth and development in floodplains goes in parallel with upgrading and building of roads in order to transport goods and people. There are several reasons why road development in floodplain systems requires a different approach to planning and technical design than road development in areas that are not (regularly) inundated. On the one hand, floods can severely damage roads and other infrastructure. On the other hand, roads and associated infrastructure can themselves have a considerable effect on floods as these are often built on levees above the flood level and hence fragment the floodplains and interrupt natural flow of water, sediments, nutrients and aquatic life.

This is particularly relevant for the floodplains of the Mekong River, which have a high biological diversity and support a very productive agricultural and fisheries sector (Box 1). Moreover, future developments regarding urbanisation, climate change and economic growth require higher quality roads that should be less often unusable during and after the flood season.

An overarching question for road planners in a sensitive delta ecosystem such as the floodplains of the Mekong River is how to develop roads in a sustainable manner that minimises the impacts on the benefits of the annual inundations and at the same time reduces the damage to infrastructure. This question is complex and has many dimensions: hydraulics, ecosystems, socio-economics, engineering, policy and management, etc. We found that only a limited number of studies have been carried out on the impacts of infrastructure development on floodplains (e.g. Blanton and Marcus, 2009; Cross, 2005; Ziegler et al., 2004), and even fewer on the interactions between roads and floods (e.g. Douven et al., 2012).

This paper focuses on the planning practice of road development and how this practice can be improved in support of economically and environmentally sustainable roads in delta floodplains through a study of the situations in the Mekong floodplain in Vietnam and Cambodia. Currently, guidelines, regulations and practices exist in Vietnam and Cambodia, though in most cases these are not specifically developed or tailored for road development and rehabilitation

* Corresponding author. National University of Singapore, NUSDeltares, 2 Engineering Drive 1, E1 #08-24, Singapore 117576, Singapore. Tel.: +65 65165853; fax: +65 67781087.

E-mail addresses: w.douven@unesco-ihe.org (W. Douven), joost@nus.edu.sg (J. Buurman).

¹ Tel.: +31 15 2151712.

Box 1 The Mekong River Basin.

The Mekong River basin is formed by parts of China's Yunnan Province, Myanmar, Laos, Thailand, Cambodia and Vietnam. In 2007 more than 60 million people lived in the Lower Mekong Basin, consisting of the parts in Laos, Thailand, Cambodia and Vietnam, while population growth ranged between 0.8 and 2.1 percent (MRC, 2010). The basin area in Vietnam and a large part of the basin area in Cambodia form together the floodplains of the Mekong River basin. The floodplains of the Mekong River are among the few remaining global examples of relatively intact and functioning floodplains in a large river basin. Annual floods cover large parts of the floodplains for several weeks or months and replenish the nutrients that are essential for fertile land and fish stock. It is widely accepted that this feature is one of the main reasons behind the highly productive fisheries of the Mekong, as well as its tremendous biological diversity (MRC, 2010). The productive fisheries and fertile agricultural land support the livelihoods of many, often poor, people in the basin. The Cambodian and the Vietnamese Mekong floodplain systems and their developments are quite different. In Cambodia a system of *colmatage* canals has been developed over the centuries to partially control the water flow in and out of the floodplain depressions in order to support the cultivation of rice. Still, the Cambodian Mekong floodplain is in a relatively natural state where large areas remain that are not under intensive use. This is in contrast with the much more intensively farmed Vietnamese side of the Mekong floodplain, which is organised in parcels and crossed by a tight maze of straight canals and which is the major agricultural area of the country. In Cambodia, flood protection and water management are far less intense, although this situation might evolve rapidly under the current demographic and economic development trends.

in floodplains. The scope of planning practice in this paper is the planning of new roads and rehabilitation of existing roads and environmental assessments of such projects with a specific focus on roads and floods interactions. Planning practice is defined here as regulations and guidelines, including the factors hampering their use, and common practice in management, design, etc. of road development projects. The study was carried out in the framework of a larger research project called 'Roads and Floods',² and contributed to the development of three Best Practice Guidelines for planning, environmental and technical aspects related to the development and rehabilitation of roads in floodplains.

The paper is organised as follows. Section 2 discusses the interaction between roads and floods and their impacts. Section 3 addresses guidelines in road planning and environmental assessment, factors hampering the use of guidelines, and the analytical framework of the study. Section 4 analyses the planning practice in the Cambodian and Vietnamese Mekong River basin. Section 5 contains a discussion of the results. Section 6 presents the conclusions and the recommendations to improve practice in support of economically and environmentally sustainable roads in delta floodplain systems.

² The project 'Roads and Floods: Developing guidelines for the planning and design of environmentally friendly and economically sound roads in the Mekong floodplains of Cambodia and Vietnam' was implemented by Delft Cluster (The Netherlands), the Flood Management and Mitigation Programme of the Mekong River Commission (MRC) and the World Wildlife Fund (WWF) from 2006 to 2010 (Douven et al., 2012).

2. Roads and floods: interactions and impacts

Road development and rehabilitation is closely interrelated with economic growth. Economic growth means that the demand for transportation (and also the budget for roads) increases. The reverse causality may also be true as road development can facilitate economic development. Policy makers often see the construction of roads as a means to develop regions and provide people access to markets. We can indeed see that governments and international donors have invested and are investing considerably in road development projects in the Mekong River basin (ADB, 1998, 2002, 2011, 2012; JICA, 2006; MoT/World Bank, 2005). However, road development has impacts on the natural environment. Especially in floodplain systems, such as the still quite undeveloped Mekong floodplains, roads can have a significant impact on natural flood patterns and their functions (Beevers et al., 2012). Roads fragment habitats and interrupt the flow of water, sediments, nutrients and aquatic life, thereby impacting the beneficial effects normally brought by the natural flood cycle. Roads in floodplains are typically built on dikes or levees to avoid flooding of the roads during the flood season and make the roads unusable. As a result, roads alter the floodplain hydraulics with many external effects. An example of an external effect is that roads built on levees can act as a reservoir dam to keep water for irrigation in the dry season, or roads can act as a dam to protect spring crop from the early stages of the flood. This will impact aquatic ecosystems that depend on certain water levels or absence of water for a specific duration.

When roads alter the floodplain hydraulics they can also alter the floodplain ecosystem values. The floodplain as an ecosystem regulates ecological processes that contribute to a healthy environment. This includes ecosystem protection, water treatment, pollution retention and alluvial deposition. One of the key benefits of the Mekong floodplain is that it provides resources for agriculture and fisheries, which are both essential for local livelihoods and have large economic value. For instance, the total direct-use value of the fishery resources of the lower Mekong basin has been estimated about US\$ 2 billion (Baran et al., 2007). Other floodplain values that can be affected are for instance cultural values such as recreation, aesthetics and spiritual values (Chan et al., 2012).

The effects of road development are both direct and indirect and appear both in the short and long term (Trombulak and Frissell, 2000; Findlay and Bourdages, 2000; Spellerberg and Morrison, 1998). Direct, usually short term, effects are easily seen and are easier to comprehend. In contrast, many indirect, usually long term, environmental effects of roads are cumulative and involve changes in community structures and ecological processes that may not be well understood. Yet, these long-term effects signal deterioration in ecosystems that far surpasses the visual ones in importance. For example, location of roads can interfere with fish migration routes during the flood season (Baran et al., 2007). This can have an impact on the fisheries, which in its turn directly affects the livelihood of many, often poor, residents of the floodplains. Culverts and bridges, even if properly installed, cannot avoid that hydraulic conditions will be changed.

The impacts of infrastructure in general on floodplains have been addressed in various studies, but the impacts of roads in floodplains only in few specific studies (Douven et al., 2012). Kruskopf (2006) carried out an extensive literature review on the impacts of different types of built structures such as embankments, roads, canalization, mining and fishing gear. The study found that most discussions are about dams and canalisation due to their significant impacts on floodplain environments, fish and fisheries. Cross (2005) assessed the impacts of infrastructure developments on changing flow patterns and found that several new embankments and canals can impact the floodplain hydraulics, which in its turn can impact ecological functioning.

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