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Urban design principles for flood resilience: Learning from the ecological wisdom of living with floods in the Vietnamese Mekong Delta

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HIGHLIGHTS

- We report on how people live with floods in the Vietnamese Mekong Delta.
- We extract lessons from the ecological wisdom in rural context for modern cities.
- We propose three urban design principles for urban flood resilience based on the lessons.

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ABSTRACT

Despite the widespread implementation of flood control infrastructure, modern cities around the world remain vulnerable to flood hazards. Although flood management has in general placed less emphasis on structural measures, urban flood hazard mitigation continues to fixate on the flood control paradigm, the ideology that flooding must be prevented in the first place, as flooding is assumed to be disastrous. To promote urban flood resilience, this paper argues for the alternative flood adaptation paradigm, which concerns preventing damage when flooding occurs and allows flooding to enter the city. The argument is grounded on our fieldworks on the ecological wisdom of living with floods in the Vietnamese Mekong Delta in two hamlets, Vinh An and Ha Bao, where flooding is mostly harmless and brings benefits. To turn this ecological wisdom of the rural hamlets into practical knowledge, we extract lessons for modern cities: Modern cities need ecological knowledge to nurture ecological wisdom; and need to become agile by developing localized flood-response capacity, striving for timely systemwide adjustment, and turning amphibious. To make these lessons of the ecological wisdom actionable, we translate them into three urban design principles: Urban design should (1) anticipate and accommodate flooding, (2) incorporate the ecological process of flooding, and (3) reveal the flood dynamics to the public.

1. Introduction

Globally, flooding is the most widespread natural hazard, posing especially high threat to cities, where the majority of flood damage occurs (Ashley et al., 2007; Dewan, 2013). Despite the extensive implementation of flood control infrastructure (e.g., levees, dams, channelization, diversion channels, weirs, and pump stations) to prevent flooding, cities around the world remain vulnerable to flood hazards (Andersen & Shepherd, 2013). Flood control infrastructure cannot cope with extreme flows that exceed its design capacity, and it can fail unexpectedly by smaller flows. The recognition that flooding cannot be completely prevented gave rise to 'integrated flood risk management' that incorporates non-structural measures and addresses basin-scale management (Parker, 2000). However, in many cities non-structural measures (e.g., warning systems, insurance, and land-use control) only play a supplementary role to flood control. Basin-scale management, which emphasizes floodwater retention in upstream rural areas to reduce downstream flood risks, addresses neither pluvial flooding nor the eventuality of fluvial flooding in downstream urban areas. Despite the change in theory,

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flood control still dominates the practice in urban areas (Dewan, 2013). The ideology that flooding should be prevented in the first place—the 'flood control paradigm'—remains unchallenged (Liao, 2014). With increasing urbanization and flood risks associated with climate change, relying solely on flood control for hazard mitigation would make cities even more vulnerable. To promote flood resilience for cities, this paper argues for the alternative 'flood adaptation paradigm', which concerns preventing damage when flooding occurs. We explore the ecological wisdom of living with floods in the Vietnamese Mekong Delta (VMD)—an example of the flood adaptation paradigm—and extract lessons for modern cities.

The flood control paradigm assumes that flooding is disastrous in cities; however, it is not true if cities were resilient to floods. The concept of resilience receives growing attention in flood management but is often associated with post-disaster recovery. Adopting an ecological perspective (see Walker, Holling, Carpenter, & Kinzig, 2004), we consider resilience relevant in not only post-disaster recovery but also hazard mitigation. Flood resilience is interpreted as the capacity to tolerate flooding to avoid disaster when *undergoing*—not preventing—flooding; or when physical damage and socioeconomic disruption still occur, the capacity to reorganize quickly (Liao, 2012). In short, flood resilience requires either 'flood tolerance' or 'quick reorganization'. This concept is important to cities, which should plan for the uncertainties and eventuality of flooding in the face of climate change. Moreover, although globally flood fatalities have decreased thanks to better warning systems and evacuation programs, economic losses are increasing (Dewan, 2013). Most losses are building-related (Scawthorn et al., 2006), which means intolerance of floods at the property level.

This paper focuses on the aspect of flood tolerance of flood resilience. Flood tolerance is the capacity to remain undamaged and functional when flooded, which requires adapting the built environment to floods (Liao, 2012). In climate change literature, 'adaptation' often all-inclusively means adjustments to actual or expected climatic conditions and their effects (UNISDR, 2009), which also include flood control (e.g., Wilby & Keenan, 2012). Here, 'flood adaptation' contrasts with flood control, an attempt to change the flood regime. It is narrowly defined as measures to fit for the actual and expected flood regime *without attempting to change it*. The term 'living with floods' also has divergent interpretations. We interpret it differently from that of the Vietnam Government's ongoing 'Living With Floods' program, which concerns relocating landless poor households from VMD's flood zones (Danh & Mushtag, 2011). 'Living with floods' here refers to a flood-tolerant lifestyle based on flood adaptation at the property level. It is a manifestation of ecological wisdom, which we define as wise decision concerning how humans interact with nature based on the knowledge of it.

Nowadays the living-with-floods lifestyle is only found in rural areas in developing countries (Laituri, 2000). Although such a lifestyle appears vastly different from modern urbanism, it has enlightened flood management discourses (e.g., Cuny, 1991; Thaitakoo, McGrath, Srithanyarat, & Palopakon, 2013; Zevenbergen et al., 2011). However, literature documenting in detail the physical aspect of living with floods is limited. The paper aims to respond to theme 2 "Ecological wisdom as actionable and practical knowledge" in the editorial by Xing (2014), with two objectives: first, it provides an account of the living-with-floods lifestyle in VMD, focusing on physical adaptation. Second, it draws from it practical lessons for urban design to promote flood resilience.

In what follows, we first introduce the background of VMD and the hamlets—Vinh An and Ha Bao—where fieldworks were conducted. We then report the fieldwork results of how the hamlets live with floods, followed by a discussion of the lessons for modern cities. Next we propose three urban design principles for flood resilience, and outline the challenges to the flood adaptation paradigm.

2. Background of the Vietnamese Mekong Delta (VMD)

The longest in Southeast Asia, the Mekong River runs 4,800 km through China, Myanmar, Thailand, Laos, Cambodia, and then forms a delta in Vietnam before entering the sea. VMD is a watery landscape consisting of Mekong's two main distributaries and a dense network of numerous natural and artificial channels (Fig. 1). It contributes to 75% of Vietnam's total agricultural-fishery-forestry production, over 50% of agricultural exports, and 90% of rice exports such that it is commonly called the "rice bowl" of Vietnam.

2.1. Seasonal flooding

During the monsoon season, a total area of 12,000–19,000 km^2 is naturally flooded. The flood regime varies across VMD. Near Cambodia, the Long Xuyen Quadrangle and the Plain of Reeds are two topographically depressed and deepest flood zones, where the flood could reach 3–4 m in some years.

For most people flooding implies harm; however, flooding also has economic and environmental benefits (Green, 2010). In VMD, seasonal flooding is a critical development resource (Ehlert, 2012). It serves as a source for agricultural irrigation and domestic water uses, increases wild fishery resources, brings alluvium to fertilize farmlands, washes out salts and toxins from the sulphate soils, carries away wastes, eliminates rats and insects, and recharges groundwater (Biggs, 2010; Brocheux, 1995; Le, Hoanh, Miller, & Sinh, 2007). The Vietnamese term for 'flood season' is *mùa nước nổi*, which translates directly as 'rising-water season' (Le, Hoanh, Miller, & Sinh, 2007). Far from harmful, the flood usually comes and goes very slowly that a local farmer likened it to a turtle (Ehlert, 2012). Fishermen consider the flood season as "income season" because it brings extra fish in the flooded field; some would even call it *ổng về* (he returns), implying the flood as a friend (Nguyen & Alexander, 2014).

Different floods are clearly differentiated (Le, Hoanh, Miller, & Sinh, 2007). A moderate flood (*lũ vùa*) is also called 'beautiful flood' (*lũ đẹp*) because it brings livelihood resources. A small flood (*lũ nhỏ*) and a high flood (*lũ lón*) are undesirable, for the former results in less fish and promotes weed infestation in the field after the flood and the latter can lead to disasters (Danh & Mushtaq, 2011; Ehlert, 2012; Nguyen & Alexander, 2014).

2.2. Increasing flood control and disappearing lifestyle

However, the living-with-floods lifestyle is disappearing in VMD. Traditionally, people grew the native rice variety "floating rice" (*lúa nổi*) that adapts to seasonal flooding. It can grow as fast as 5 cm/day and reach 2–3 m high to survive the rising floodwater (Catling, 1992). This single-cropping rice has been largely replaced by high-yield varieties to achieve multiple crops. Since the 1990s famers started to build low, 'semi-dykes' to prevent floodwater from entering the field until the high-yield rice crop is harvested in July, after which the dykes are overtopped or breached and the field flooded to still benefit from the alluvium deposit. Meanwhile, the Vietnam Government also started to build 'full dykes' and implemented numerous other drainage and flood-control projects to reduce the area affected by seasonal flooding to maximize rice production and improve living standards. Today in VMD there exists 13,000 km of full dykes, morn than 900 sluice gates, and over 1000 pumping stations (Vietnam-Netherlands Cooperation, 2011). Cities also have raised the overall ground elevation above the flood level.

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