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Original Articles

Flow alterations by dams shaped fish assemblage dynamics in the complex Mekong-3S river system

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ABSTRACT

The Mekong, Sekong, Sesan, and Srepok (Mekong-3S) river system, a Ramsar wetlands of international importance and critical fish migration routes, is altered by dams that distort the seasonal flow dynamics, structuring dispersal and reproduction success of fishes. Here, we investigate the temporal responses of local fish beta diversity to hydrologic modification by the upstream functioning dams in five sites of the Mekong-3S system. The sampling design adopted (two sites on the Mekong River displaying relatively undisturbed flow and three sites in the 3S displaying a gradient in flow perturbation) allows us to focus on the effect of flow alteration on local fish assemblage compositions. By analysing 7-year daily fish monitoring data (06/2007–05/2014), we found that there have been overall declining trends in local species richness and abundance, with strong temporal variability in local beta diversity. Undisturbed sites are characterized by seasonal assemblage variability, while disturbed sites are characterized by aseasonal assemblage changes. Temporal shifts in assemblage composition suggest that dams alter seasonal flow patterns and favour generalist species. This study contributes to a better understanding of the temporal changes of tropical freshwater fish beta diversity in regulated and unregulated rivers. It is thus relevant for fisheries planning and conservation.

1. Introduction

The Mekong River Basin is one of the 35 biodiversity hotspots of the world (Mittermeier et al., 2011). Fish assemblages in this basin are extremely diverse and characterized by the presence of fish species undertaking large-scale seasonal migrations (Poulsen et al., 2002). The complex seasonal flood pulses and historical biogeography of the region partly explain this high diversity and seasonality (Poulsen et al., 2002; Rainboth, 1996). Rapid changes through time due to hydropower infrastructure development in the basin may change the abiotic and biotic components of the river ecosystem, including changes in river flow, habitat, food web, species distribution, and finally the river's overall biological integrity (Li et al., 2013; Macnaughton et al., 2015; Phomikong et al., 2014; Tonkin et al., 2017).

This study covers five sites. Three sites are in the lower reach of the three Mekong major tributaries: Sekong (SK), Sesan (SS) and Srepok (SP) rivers, called the 3S; and two sites are in the Mekong mainstream: up- and downstream of the 3S outlet (Fig. 1). All sites are part of the complex Mekong-3S system, located in north-eastern Cambodia in the Kratie (KT), Stung Treng (ST) and Ratanakiri provinces. The Mekong mainstream (KT and ST) is a critical habitat for many Mekong fishes, (Baran, 2006; Poulsen et al., 2004, 2002) and the Mekong River in ST has been designated a Ramsar wetlands of global significance since 1999 (Try and Chambers, 2006). The 3S rivers on the other hand, draining north-eastern Cambodia, southern Lao People's Democratic Republic (PDR), and Viet Nam's Central Highlands, join the Mekong River in ST. According to the Mekong River Commission (MRC), they contribute ~25% of the Mekong mean annual flow at KT and play a key role in the hydrology of the downstream Mekong, including the Tonle Sap River showing seasonal reverse flows (MRC, 2005). In addition, the 3S system is the main fish migration route from the lower Mekong system (Poulsen et al., 2004, 2002).

To address the energy needs and economic growth of the region, continued hydropower development has been underway in the Mekong River Basin. Six large hydropower dams have been constructed in the upper Mekong River in China since the mid-1990s (Fan et al., 2015; Winemiller et al., 2016). In the Lower Mekong Basin (LMB), according to MRC's Hydropower Project Database 2015, two mainstream dams

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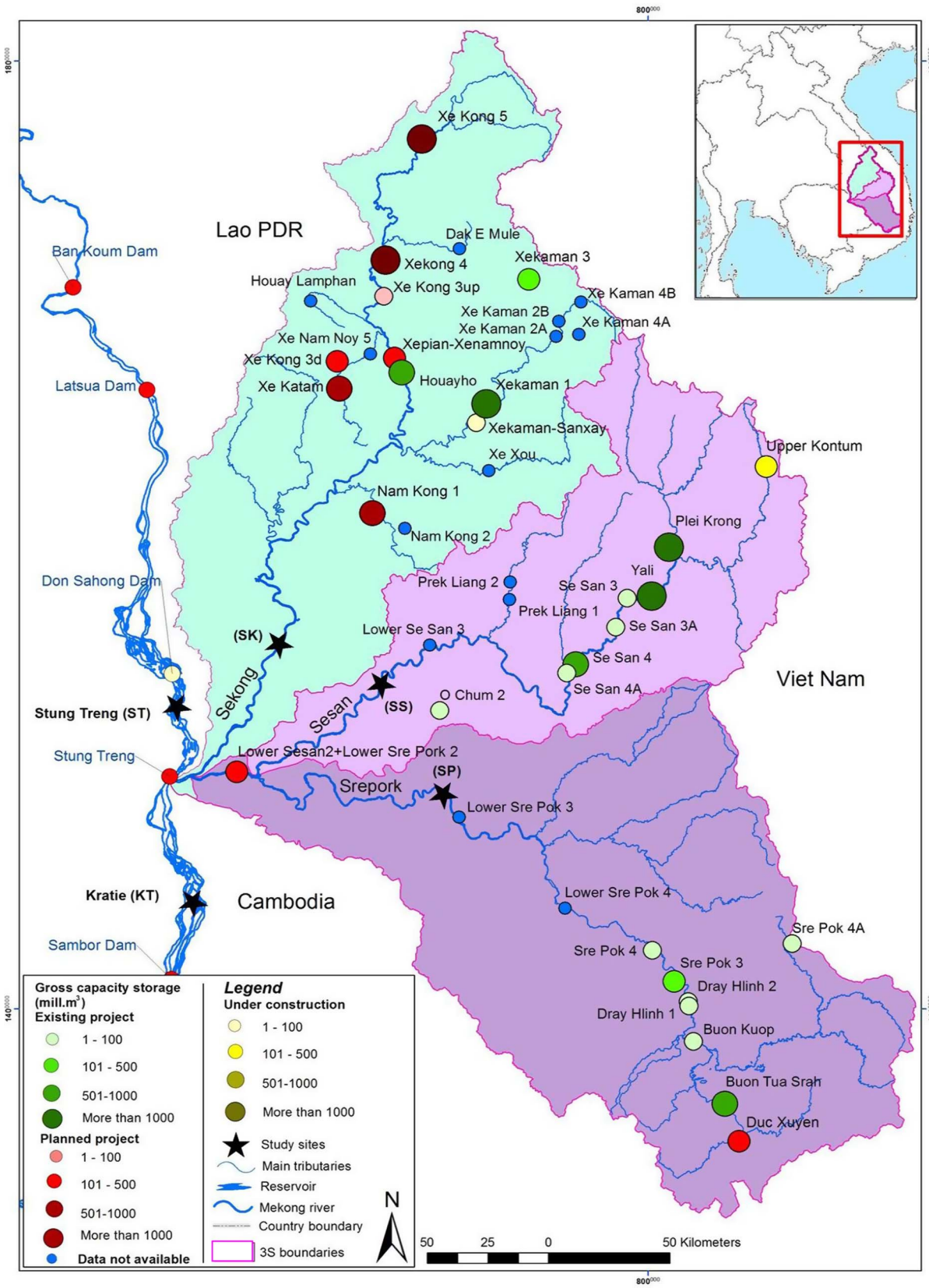

Fig. 1. Map showing the study sites and hydropower dam positions in the 3S sub-basin (Data source: MRC Hydropower Project Database 2015). Site names: KT = Kratie, SK = Sekong, SP = Srepok, SS = Sesan, and ST = Stung Treng.