

## ***Interactive comment on “Adaptation tipping points of urban wetlands under a drying climate” by Amar V. V. Nanda et al.***

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Received and published: 9 August 2017

Thank you for your interest in the research and suggestions for improving the paper. We accept the minor comments and I respond to the major comments below.

Comment 1: Review English language

Comment 2: Due to the focus on ecosystems and the different literature covered in the introduction for adaptation; we decided to refer to existing literature for the different definitions of thresholds, tipping points, and turning points (Werners et al 2013).

We propose to address the above comments as follows in lines 73-82: Thresholds and tipping points are important focal points for adaptive management (Folke et al. 2005; Rijke et al. 2012; Haasnoot et al. 2013; Werners et al. 2013), but often lack

C1

data to define exact biophysical thresholds to model complicated interactions in SES models (Schlueter et al. 2012). However, several indicators (Niemi and McDonald 2004) and policy-based approaches do exist that are commonly used in flood mitigation (Lavery and Donovan 2005; Kwadijk et al. 2010; Reeder and Ranger 2011; Gersonius et al. 2012), water resources management (Brown et al. 2011; Poff et al. 2015), and institutional adaptation (Lawrence et al. 2013, Fünfgeld 2015) to determine when the boundaries of a system are reached and future change becomes critical for the system. Despite the extend of literature, there is limited focus on defining thresholds for ecosystem processes and informing policies to how change has become critical (Hanger et al. 2013) and when interventions are needed to address different key ecosystem processes.

We propose to address the above comments as follows in lines 83-85: A policy-based approach that defines when and which objectives of a current strategy are not reached, is a starting point to adapt existing and formulate new strategies (Kwadijk et al 2010). An ‘adaptation tipping point’ is the moment when the magnitude of change is such, that a current management strategy can no longer meet its objectives.

Comment 3: Proposed amendment to line 112-114: There is a high expectancy that policies are inadequate and management authorities have the desire to understand past effects of climate change on maintaining individual socio-ecological objectives. With already a management plan available, multi-scale policies in place, and limited data availability, the wetland is suitable to apply the ATP methodology.

Comment 4: We will define effectiveness more clearly by accepting the helpful comments.

Comment 5: This paper aimed to address the difficulties to determine ATPs for ecosystems. These include to overcome a lack of data to inform management, but also addresses how to deal with management objectives (across scales) and the determination of threshold values (only partly available) that represent ecosystem processes.

C2

Therefore, to limit our focus we have adapted the original ATP methodology to only determine ATPs. We propose the following amendments to this section: Keep lines 131-134 with reference to the original methodology. Lines 134-135: We modified the original methodology to determine ATPs for different socio-ecological objectives and thresholds with the assessment of historical hydrological time series. We expanded step 3 to interpreted ATPs in conjunction with the hydrological response and variation; temporal scale ecosystem responses; and recovery rate and alternative stable state of ecological processes (Figure 1).

Comment 6: We will keep 'Mediterranean climate' as a descriptor, since Western Australia comprises of distinct climatic zones not every reader would be familiar with.

Comment 7: Delete sentence

Comment 8: 'Acceptable policy thresholds' refer to mandated Ministerial water requirements cited in line 217. Change to 'Mandated policy thresholds'. Line 209 moves to section 2 items.

Comment 9: With Eq.1 we calculated the frequency of exceedance of water levels stated in Table 1 from observed time series that were divided in two time periods (cited and explained in line 232). Each period reflects the time period for policy measures generally to be adapted.

Comment 10: We agree that 'baseline' is confusing in the context of this paper. This paper aimed to address the difficulties to determine ATPs for ecosystem and the baseline refers to existing policies and management objectives. Due to the extend and ongoing research we decided to focus on only determining ATPs. We are currently preparing research to determine alternative strategies with stakeholders to postpone or eliminate existing ATPs according to the steps of the original ATP methodology. We will also use the dynamic adaptive policy pathways approach (Haasnoot et al 2013). This will be reported in a separate manuscript.

### C3

Comment 11: There may be no shift in the social system, however, we provide a discussion among management authorities to consider management objectives and threshold values. The management objectives are derived from different sources such as the State-scale water level criteria; the national (Commonwealth) ecological objectives that are linked to the Ramsar guidelines; and the key socio-ecological objectives from the local management plan. Currently, National and state policies are monitored with only partly the policies determined on local scale. We propose to establish a clearer link (lines 372-376) to the scale mismatch of policies and the ATPs that were determined. Also, we propose to discuss ATPs and the possibilities of interventions on different scales when stakeholders act for different socio-ecological objectives (lines 387-391).

Comment 12: In the absence of a combined eco-hydrological and social model we could include ecosystem-based and policy-based adaptation measures to adapt strategies.

Comment 13: We describe under what different conditions policies fail. These include to overcome a lack of data to inform management, but also addresses how to deal with management objectives (across scales) and the determination of threshold values (only partly available) that represent ecosystem processes.

Comment 14: We propose to reword the sentences. (Lines 427-430) Despite the exceedance of critical thresholds, management has not responded adequately to changing hydrological variation of the ecosystem. We assumed climate change to be the main external driver for the ecosystem regime shift. The ATP application is adequate for ecosystems when a clear external driver of change can be determined; stakeholders agree on setting thresholds; and expand individual management objectives to objectives across several levels of policies. However, the study becomes complicated when multiple stressors are responsible for ecosystem change and stakeholders do not include objectives or thresholds defined by different policies.

### C4

Comment 15: We will expand the orange box and resize the blue box accordingly to rectify the confused dates in the lower orange and blue boxes.

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Interactive comment on Hydrol. Earth Syst. Sci. Discuss., <https://doi.org/10.5194/hess-2017-307>, 2017.