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Hydrology and Earth System Sciences
Discussions

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

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

Comment 1: 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. Therefore, to limit our focus we have adapted the original ATP methodology to only determine ATPs. In our last comment, we refer to preparation of research to determine alternative strategies with stakeholders to postpone or eliminate existing ATPs

according to the steps of the original methodology.

We will change sections in the introduction: Add to lines 73-82: 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.

Add to 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

We propose the following amendments in the method 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 2: Threshold values are stated in the Ministerial water requirements policy cited in line 217. The values represent the height of the water table expressed in mean Annual Height Datum (mAHD) with 21.6 mAHD representing the lake bed. A value of 22.0 mAHD represents a water depth of 40cm. No exact critical point of change can be determined, however, during the 1990s the lake's hydrology altered (more frequent dry spells, longer drought duration). This is consistent with observations in other studies cited in the discussion section.

Comment 3: We propose to move section 2.2.1 (lines 162-177) to section 2.1 and remove the redundant text in lines 140-157. Section 2.1 will be renamed to 'case study area'. Lines 178-187 move to section 2.1 and redundant text in lines 147-157 will be

removed. Delete lines 188-193 and mention in discussion section. Move lines 193-194 and figure 4 to results section. Keep section 2.2.2 and add refer to case study area (section 2.1) as step 1 of methodology. Keep section 2.2.3 in methods section.

Comment 4: We consider including a detailed discussion about the scale differences of current policy and management strategies in section 4.1. In section 4.2 we will add how different management authorities are responsible for different policies and how the ATP methodology helped to bridge the different views of stakeholders that are involved in the execution of the management strategy. We propose to include in section 5 the importance of reviewing a range of policies to enable discussion among stakeholders to determine existing and new management objectives/thresholds.

Comment 5: We will extend the caption and text with a reference to threshold values that are stated in the Ministerial water requirements policy cited in line 217; and that values represent the height of the water table expressed in mean Annual Height Datum (mAHD) with 21.6 mAHD representing the lake bed. A value of 22.0 mAHD represents a water depth of 40cm. 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 6: We will change the figure. Prior and post will be reversed and the threshold definitions will be mentioned in the figure. In this way, we can still show that the lake has dried prior to 1995, but not considered to be a dry period according to the policy definition.

Comment 7: Prior and post will be reversed. Also add 'time' to x-axis.

Comment 8: That is correct and this indeed causes confusion. Policy requires drying not to occur before April/May. We will remove the summer period and instead mark April/May in the figure as the earliest moment for the lake to dry that is currently allowed.

Comment 9: Yes, that's correct. We also tried to explain how the drought frequency increase is related to the policy objectives. Therefore we included the start month of a dry period and the duration of each dry period. We also tried to include that drying of the lake occurred prior to 1995, however, too short according to the policy definition of 3 consecutive months.

Comment 10: The shift from permanently to seasonally inundated has already been shown in previous studies, including such a time series plot. We address the shift also in Figure 7.

Comment 11: We included ecological objectives from the local management plan and Ramsar objectives. Water level thresholds are determined by State level government and defined according to regional scale hydrology of the wetland systems of the Swan Coastal Plain. We aim to make a clearer connection of policies across scales in the revised methodology section (Section 2.2.2) and stakeholder representation that followed from the institutional organisation.

Comment 12: The timing of an ATP cannot be determined precisely and for ecosystems need to be interpreted with other data, such as bird counts, macro-invertebrates counts/species composition, and number of weeds. Suggestion for change: Lines 363-371: We will add that management responses take time. When ATPs have occurred, these do not immediately translate in ecological degradation due to lag response of ecological processes (as a result of water decline). The current framework does not account for ecological lag response and the time that is needed to implement new actions. Lines 353-354: We combine the available ecological data with ATPs which could be used to prioritise management actions.

Comments 13 and 14: Delete sentence

Comment 15: accept

Comment 16: Change to: "water level requirements under groundwater management

policy" (cited in line 217)

Comment 17: Change sentence to: "Management interventions were not triggered due to gradual water level decline over several decades. However, the observed ecosystem shift occurred in a relative short period."

Comment 18: No shift in the social system, however, provides a discussion among management authorities to consider management objectives and threshold values.

Comment 19: Ineffective policies in case study area (line 376-377) and compared to other studies (lines 377-381)

Comment 20: Delete sentence

Comment 21: Without a combined eco-hydrological and social model that captures the feedbacks between these two domains.

Comment 22: Change lines 428-420: future research could assess... We are currently preparing research to determine alternative strategies with stakeholders to postpone or eliminate existing ATPs according to the steps of the original methodology. This will be prepared as a separate manuscript. 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.

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