POLICY BRIEF

BETTER Understanding of the flood regime and habitat change under Climate Change in Tonle Sap Lake

Executive Summary:

Climate change has been known to alter global environmental patterns. Hydrological conditions have changed in a concerning manner in the last several decades. Frequent flooding, storms, heat waves, and many other unpredictable disasters are the resulting consequences. Climate change has been well accounted for in the agenda of the development of Cambodia, especially from a management perspective of the Tonle Sap Lake. Previous studies have highlighted the alterations in flow regime of the Lake and its tributaries. Climate change could be the source of those hydrologic shifts in Tonle Sap Lake (Eastham *et al*., 2008; Kummu and Sarkkula, 2008; Kummu *et al*., 2014). Consequently, habitat covers have changed accordingly as shown in the climate change prediction scenarios of Arias *et al*. (2012). This study highlighted the effects of climate change on the surface area of the Lake. The article points out the possible consequences of habitat changes over the year for three different flooded zones of the lake. It includes Open Water (OW) area with twelve months under water, Rainfed (RF) area with one month under water, and Seasonally Flooded (SF) area with five to eight months under water. It is predicted from the study that between 2030 to 2040 habitat surface will increase from 2 to 21% for OW, and decrease from 2 to 5% and from 5% to 11% for RF and SF habitats respectively. In line with the flow regime changes, the water quality, including nutrients and other aquatic parameters, is the ultimate concern for long-term management of the Lake, once the sustainable development is prioritized in the agenda. Thus, scientific information is significantly important for evidence-based policy, typically for the management of the Tonle Sap Biosphere reserve. A correct understanding required efforts from all direct and indirect stakeholders to put more attention into investigating, collecting and screening the most appropriate methods to be proactive in the face of changes in flooding. For that reason, readiness of policy makers about the consequences including the changes of natural habitats as well as human livelihood owed to variation of flooding regime in the Lake is necessary. The correct understanding helps positively the management agencies to clearly foresee the readiness actions once climate changes are taken in account in their management scenarios. Actually, the issue of climate change has been briefly discussed in the strategic plan devised by the Tonle Sap Authority (2015). However, a concise review of this strategic plan for 2016-2020 shows that the document only highlights the general concern around climate change. It is crucial that this policy document rely more heavily on scientific evidence, particularly the alteration of habitats in the Lake under climate change. The strategic plan of the Tonle Sap Authority should include more details regarding the response to the changes of flow

regime and the consequences on the Lake ecosystem in its policy. For instance, the effects of climate change on natural habitats of the great Lake should be in the priority agenda. Moreover the stakeholders as well as local authorities should grant more importance to ecosystem conservation and restoration of the floodplain habitats in the near future.

Problem:

Climate change and its consequences are undeniable. Solutions have been shown to be adaption and mitigation. However, converting this concept to policy development or raising awareness to public has proven to be quite challenging. It is certain that the temperature on Earth keeps increasing along with great concerns for sustainable development. The commitment to the 2 degree goal among UN members has brought much awareness to policy makers. However, the understanding of the phenomena and their effects is quite poor among simple public or policy makers. For that reason, an issue remains because the policy is developed with little consideration to evidence and with an insufficient understanding about the changes of flooding conditions in the great reservoir. The photo showing the algal bloom (taken in 2004 by Tonle Sap Authority-TSA) as seen in the figure below has caused an increase in precautions taken in the management of the Lake. The extremely hot weather coupled with insufficient water in the Lake along with nutrient runoff from agricultural land, domestic waste disposal from floating communities (Burnett *et al*., 2013), aquaculture and fish processing for the making of Prakhok (Karakassis *et al*., 2005; Silva, 2015) have been assumed to be the main causes attributed to this algal bloom.

Figure 1. The growth of green algae in Tonle Sap Lake during the dry season (Picture taken by TSA-2004)

POLICY BRIEF

The floodplain of Tonle Sap River (TSR) extends enormously between the dry and rainy seasons in general. This huge change of flooding is known through general observation and research as shown in the example of Figure 2 (Siev *et al.*, 2016; Kummu and Sarkkula, 2008). However, a quantification of the impact of climate change on flood extension in Tonle Sap Lake is needed for policy development.

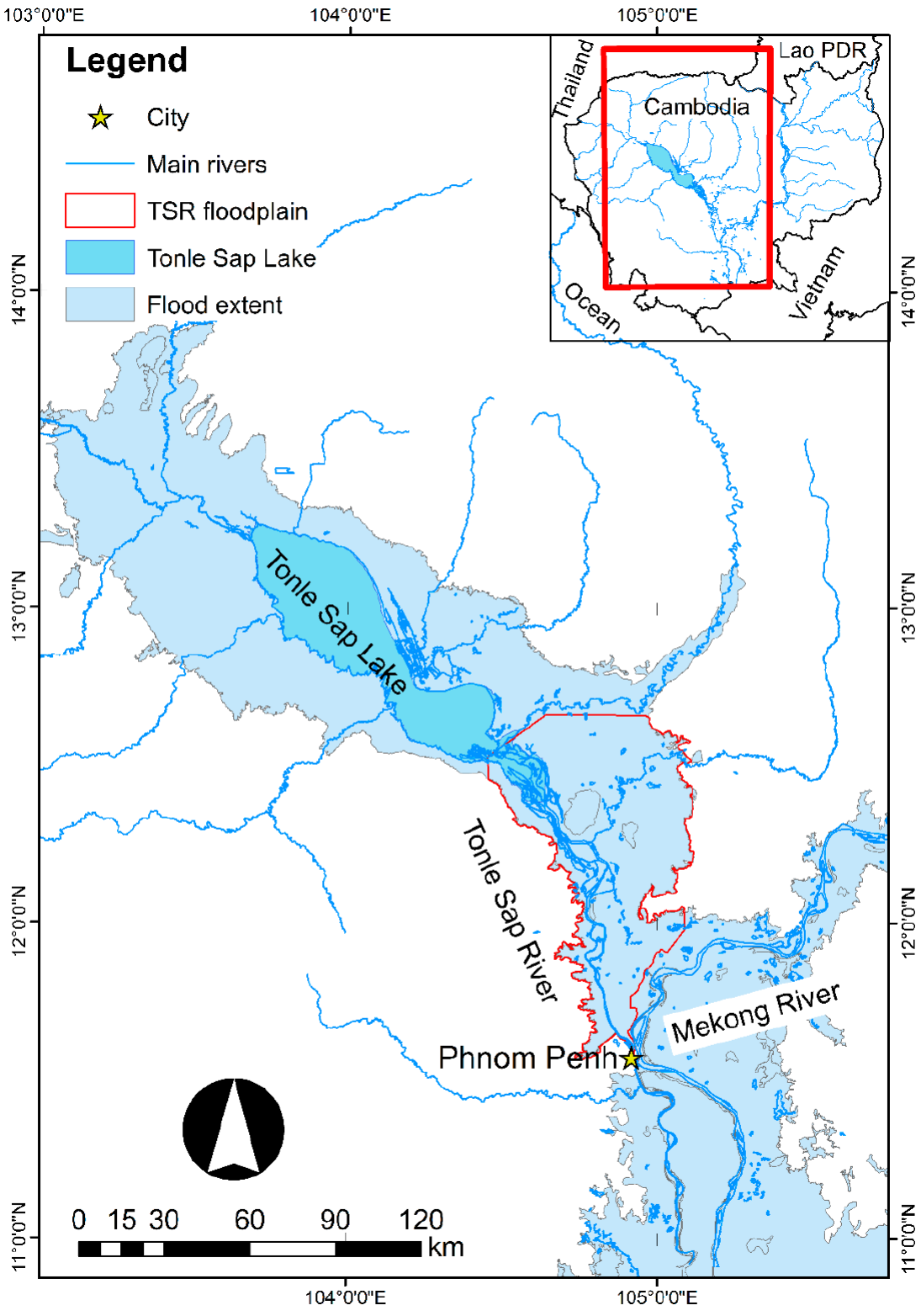

Figure 2. Flood Change of Tonle Sap Floodplain (Siev *et al.*, 2016)

It is necessary that a specific policy in response to the changes of flooding regime be established. For this reason, the readiness and awareness in terms of actions for better ecosystem conservation and restoration must be ultimately well promoted to the stakeholders including the ordinary public. For instance, the proper accountability of flood regime in the policy could be very beneficial to create an environmental resiliency as a whole and the benefits for the human ecosystem in the Lake in particular. Specifically, this policy brief emphasizes that the flood regime definitely alters the conditions of the habitats once climate change is taken into account per the results forecasted by Arias *et al*. (2012) between 2030 to 2040. Results showed the OW habitats will increase from 2% to 21% while decrease for the areas of RF habitats and SF habitats from 2% to 5% and 5% to 11%, respectively.

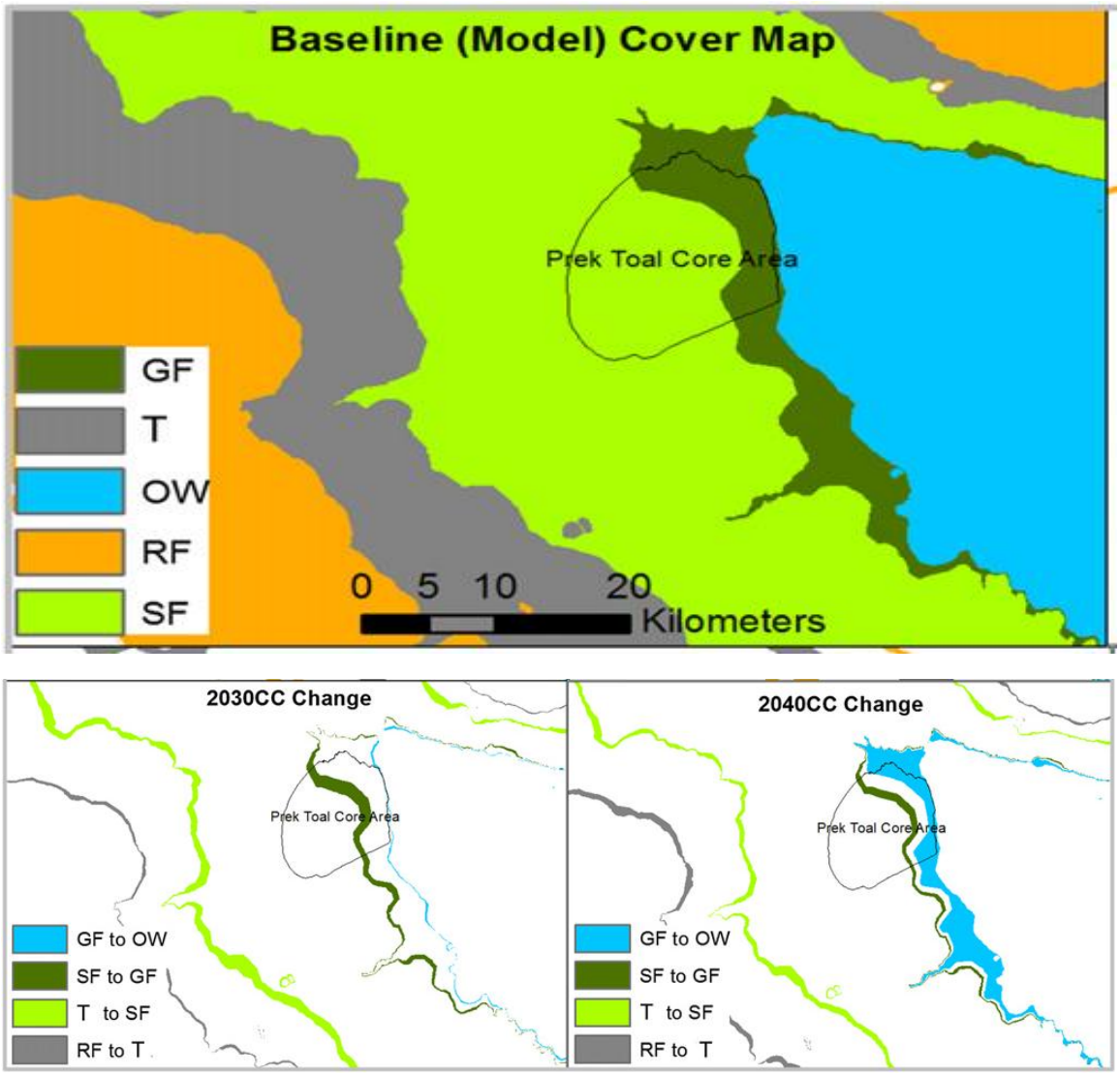

Figure 3. The analysis of climate change prediction scenario concerning the change of environmental habitats, OW habitats, GF: Gallery Forest habitats, SF habitats, T: Transitional habitats, RF habitats (Arias *et al*., 2012)

POLICY BRIEF

Introduction

The current strategic plan till 2020 of Tonle Sap Authority pays remarkable attention to climate change. However, the strategy incorporates less information about the management of the lake once changes of flooding in the reservoir are taken into account. The strategic direction of the lake management should include a stronger focus on the consequences resulting from the climatic changes. The SWOT (Strength, Weaknesses, Opportunity, and Threat) analysis is broadly mentionned in the strategic plan of TSA. However, the threats of climate change to habitats are not specifically discussed for immediate action. For this reason, the implementation of the strategy might not respond well enough to the actual need for long-term management. Thus, the incorporation of habitat changes due to climate change in the TSA strategic plan should be urgently described prior to action. For instance, the policy makers should take into consideration how the habitats will be altered for OW, RF, and SF between 2030 or 2040. Such proactive response will definitely support the long-term management of the Biosphere reserve.

Since Tonle Sap Biosphere reserve sizes amongst one of the great lakes in South East Asia with a diversified ecosystem, the environmental management for conservation and restoration has proven to be complicated. The uniqueness of the hydrological regime in terms of reversal flow between the Lake and the Mekong River have drawn interest among many local and international stakeholders. The surface area of the Lake has been known for increasing ten times during the rainy season compared to the dry season. A clear management role for accountability purposes should be implemented concisely and in a manner that ensures that each stakeholder can understand their tasks and their responsibility well. The challenges for water resources and environmental challenges, including overexploitation of resources and expansion of agricultural land in floodplain forests, are briefly discussed in the TSA strategic plan 2016-2020. However, responses to those challenges are behind the actual need. For instance, the SWOT analysis shows that the cooperation among stakeholders has not been smooth. As a solution, a stronger enforcement of policy framework of the TSA should be in place. Research results through interviews with key informants who are knowledgeable about the Lake showed that the enforcement of laws and regulations is one the challenges to overcome (Nuorteva *et al*., 2010). In addition, the focus should be expanded toward various policy options of response and the promotion of readiness for the changes of water regime and habitat changes due to environmental and climatic pressure. In action, the local authority and main stakeholders responsible for the lake management may find it difficult to control wide areas and the complex ecosystem of this freshwater body. Thus, maintaining the ecosystem or restoration through better law enforcement should be prioritized.

Solution

As studied by Arias *et al*. (2012), climate change contributes to alterate flooding, resulting in changes in natural habitat surfaces. The analysis of scenarios taking in account climate changes between 2030 and 2040 shows that the open water habitat of the lake could increase spatially from 2% to 21% as well as the decrease of rainfed habitats of 2% to 5% and habitats of 5% to 11%. For such changes readiness should be in place. The first option could be a more concise policy in regard to the management and reduction of the changes of water surface of the Lake. Second option could be the adaptation to the changes through raising awareness among key stakeholders and the public or readiness for the changes and choose the other best options to maintain the natural existing ecosystem in the Lake. To make these options possible, a practical approach in terms of monitoring in time series the water regime changes and the change of habitat conditions in the lake would be recommended. Once a better understanding in the matter of changes of flooding and their relative consequences is reached, it will be a good time for proper policy to be established. As a result, the establishment of environmental conservation for long-term management in lake will confidently and sustainably yield a good result for the next generation. Furthermore, the control and management of the Lake will give more room for flexibility once the possibility of future environmental pressures is considered.

Author

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Short Bio

Dr. HUL is a teacher-researcher at the Institute of Technology of Cambodia, the top engineering school in Cambodia. For the longest time, this profession has been his dream. One of the strongest drive of Dr. HUL lies in doing research on water quality under the current pressure of mankind and climate change, mainly in the Tonle Sap Lake of Cambodia and the Mekong River. His current challenges are to diffuse the research outputs to policy makers and the public

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