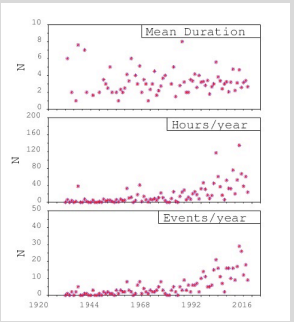
Getting Used to Slow Climate And Sea Level Changes: The Danger of not Recognizing and Planning for Thresholds

Hans-Peter Plag, Michelle Covi, Larry Atkinson
Mitigation and Adaptation Research Institute, Old Dominion University, Norfolk, VA, USA

Slow changes in climate such as sea level rise and increased coastal flooding carry the danger that we get used to them without knowing where the trends might be leading. Focus is often on the extreme events, while thresholds that might be reached due to the slow changes receive less attention. In Venice, for example, the population and tourists get used to the frequent flooding and it becomes part of the daily life (Fig. 1). In Hampton Roads, VA, the large rate of local sea level (LSL) rise causes an increase in frequent flooding, denoted as "nuisance flooding" (Fig. 2), and despite the growing economic impacts, the population learns to live with this "nuisance" without openly acknowledging the threshold when the "nuisance" will turn into an economic disaster. Increasingly large areas are barely above the present tidal range, and an accelerated sea level rise has the potential to increase hours of flooding per year and number of flooding events exponentially, with potentially damaging economic consequences.

As a result of learning to live with the immediate impacts of slow changes, preparations for the moment when a slow trend reaches a threshold receive less attention. Hampton Roads is an example of an area where the immediate problems caused by the high rate of LSL rise, including damages to property, increased flood insurance premiums, reduced air quality, groundwater saltification, and public health impacts, are on peoples mind more than the increased risk of major storm surges that could, and likely will, cause major disasters. A return of the 1933 flood (Fig. 3), they highest flood experienced in the region up to today, would today be more than 45 cm higher and could cause a major disaster.

Fig. 1: As a result of a slow increase in LSL, many streets in Venice that were built well above LSL many centuries ago are today just above the tidal range, and a small meteorological surge brings LSL above street level. Businesses and tourists have learned to live with the frequent flooding of streets and major attractions, and they even enjoy the walking on temporary boardwalks. However, there is a threshold for how much LSL rise the built environment can tolerate before the economic damage becomes unsustainable.



Above: The tide gauge record at Sewells Point, Norfolk, is used to compute the events and hours per year where LSL exceeds the level at which Hampton Blv., a major road in Norfolk, floods.

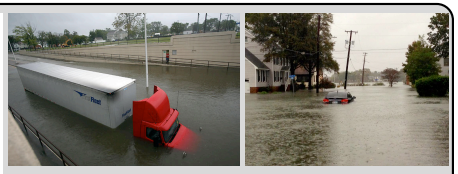


Fig. 2: Hampton Roads, VA, is experiencing the highest rate in LSL rise on the U.S. East Coast, and the number of hours per year for which LSL exceeds a level that leads to flooding of major road ways and many buildings has dramatically increased particularly since about 1980 (Atkinson et al., 2013). Continuation of the current LSL rise will increasingly impact life in Hampton Roads. Nevertheless, the population aims to cope with the current "nuisance flooding" without acknowledging the thresholds that could soon be reached making the impacts of the frequent flooding too costly. The more people get used to the "nuisance flooding," the less they become aware of the changing risk associated with major hurricanes or "northeasterns," which is exacerbated by the slow change in mean LSL.

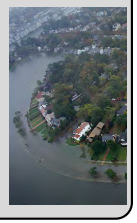


Fig. 3: The 1933 flood in Hampton Roads caused by a "northeastern" would under today's condition be far more devastating for several reasons: LSL has increased by more than 45 cm since 1933. In 1933 population in Virginia Beach and Norfolk was about 40,000, while today it is about 1 Million. Lifestyles has change and today's dependency on services for transportation, communication, food and water, electrical power, etc. has reduced resiliency and would exacerbate the disaster any such flooding could cause.

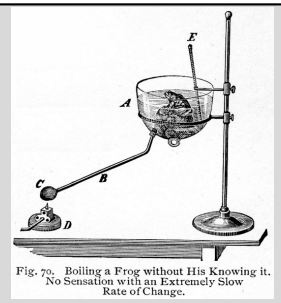
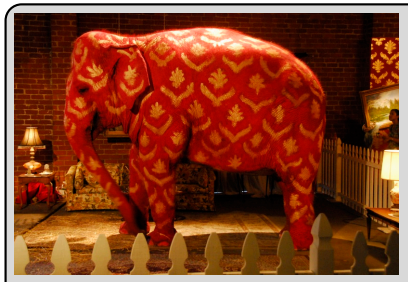


Fig. 70. Boiling a Frog without His Knowing it. No Sensation with an Extremely Slow Rate of Change.

Fig. 4: In the 19th century, several scientists claimed that a frog would not leave a slowly heated water if the heating was slow enough. This is the basis of the often used metaphor of the "boiling frog." However, newer research shows that frogs are smarter than that: they leave the water if there is a way out. Figure from http://en.wikipedia.org/wiki/File:BoilingFrog.png.

Our ability to adapt to slowly degrading situations makes us often blind for where the trend is leading us. As Robert Engelman (2013) points out, "*human resilience can have its downside. By adapting too well to past environmental loss ..., we humans have been able to keep expanding our population, leading to ever-wider ripples and denser layers of long-term unsustainability.*" The metaphor of the "boiling frog" (Fig. 4) comes to mind, and it appears like humans often behave like this frog. Newer research shows that frogs actually do not stay in the warming water if it exceeds a threshold. They leave, if they can.

The local impacts of climate change and LSL rise can also divert our attention from the "Elephant in the room" (Fig. 5), i.e. the fact that the survival of human civilization as we know it is at stake (Fig. 6). A World Bank report recently stated that "There is ... no certainty that adaptation to a 4ºC world is possible." Realizing that civilization developed during the exceptionally stable Holocene, with very little changes in climate conditions and an exceptionally stable sea level, Folke (2013) points out that the slow changes we are experiencing may push us out of the safe operating space for humanity (Fig. 7). Focusing on mitigation of, and adaptation to, the immediate impacts may keep us from seeing the "Elephant" right in front of us.



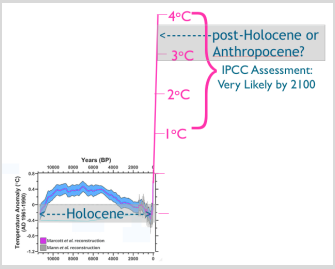


Fig. 5: The expected change in global temperature and other climate change will put the planet out of the stable Holocene and into a far more variable state not conducive for a civilization as we know it. The threat associated with the changes is as large as the metaphorical elephant in the room. Focusing on the immediate impacts of slow changes diverts attention from the long-term issue of preparing for a life outside the safe operating space for humanity. The "hockey stick" (e.g., Mann, 2012) may turn out to be a boomerang for humanity. (The temperature diagram is from Marcott et al. (2013). The picture on the left is from http://en.wikipedia.org/wiki/File:The_Elephant_in_the_Room_Bnksy_-Barely_legal-2006.jpg.

Fig. 6: While a number of authors see the planet at the edge, it is more likely that it is humanity that is at the edge. Unfortunately, we have no clear picture of where the edges are. Identifying and quantifying the boundaries of a safe operating space for humanity is still at an early stage and some boundaries are hard to quantify (Rockström et al., 2009). Nevertheless, we continue to focus on growth instead of degrowth (Engelman, 2013).

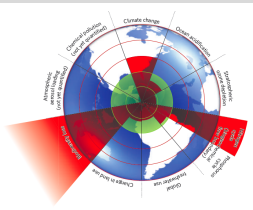


Figure from (Rockström et al., 2009).

Fig. 7: The issue at stake for our global society is broader than climate change and sea level rise. Our challenge is to understand the new role we have as a dominant force on the planet. Our recent interactions with the planet have change the way the planet works, and now we must change the way we look at the planet - and the way we look at ourself. Our goal must be to stay within the global boundaries of what has been a safe operating space for humanity during the Holocene. However, we have already crossed some of these boundaries and need to prepare for the long-term consequences - more urgently than aiming to deal with the immediate impacts of the slow changes we experience today.

To address the long-term issues of climate change, sea level rise, and sustainability of coastal communities, Old Dominion University has established the Mitigation and Adaptation Research Institute (MARI). Hampton Roads is a "natural laboratory" for climate change and sea level rise with a complex socio-economic structure. MARI will utilize its location in this "laboratory" and have a focus on the co-creation of long-term mitigation and adaptation knowledge that the societal stakeholder in the region and beyond need to cope with the existential challenge of living on a new planet unknown to our global societies. A key question relates to the possible existence of socio-economic thresholds that could lead to rapid responses of the socio-economic system to the challenge of increased meteo-tidal flooding and a growing risk of extreme events. MARI is participating in a two-year national pilot project exploring a "whole government" approach that integrate science into decision making from local to federal levels.

REFERENCES

Atkinson, L., Ezer, T., Smith, E., 2013. Sea level rise and flooding risk in Virginia. *Sea Grant Law and Policy Journal*, **5**, 3-14.
Engelman, R., 2013. Beyond Sustainababble. In Starke, L. (ed.): "Is Sustainability Still Possible? State of the World 2013. The World Watch Institute, Island Press, Washington, pp. 3-16.
Folke, C., 2013. Respecting Planetary Boundaries and Reconnecting to the Biosphere. In Starke, L. (ed.): "Is Sustainability Still Possible? State of the World 2013. The World Watch Institute, Island Press, Washington, pp. 19-27.
Mann, M., 2012. The Hockey Stick and the Climate Wars: Dispatches from the Front Lines. Columbia University Press.
Marcott, S. A., Shakun, J. D., Clark, P. U., Mix, A. C., 2013. A Reconstruction of Regional and Global Temperature for the Past 11,300 Years. Science, 339, 1198-1201.
Rockström, J., Steffen, W., Noone, K., Persson, Å., Chapin, F. S. I., Lambin, E., Lenton, T. M., Scheffer, M., Folke, C., Schellnhuber, H., Nykvist, B., De Wit, C. A., Hughes, T., van der Leeuw, S., Rodhe, H., Sörlin, S., Snyder, P. K., Costanza, R., Svedin, U., Falkenmark, M., Karlberg, L., Corell, R. W., Fabry, V. J., Hansen, J., Walker, B., Liverman, D., Richardson, K., Crutzen, P., and Foley, J., 2009. A safe operating space for humanity, Nature, 461, 472-475.