End of project popular science description

Introduction

The Lake Bosumtwi biosphere reserve in Ghana, established in 2016 as a UNESCO heritage site in recognition of the need to promote conservation of this unique biodiversity and tourism hotspot is under intense climate and anthropogenic pressures. Within the biosphere reserve lies Lake Bosumtwi, an ancient, 1-million-year-old meteorite crater lake, which supports the livelihoods and nutrition of 50,000 inhabitants (distributed across 23 riparian communities) who depend on its fisheries, tourism, forest, and land resources for their livelihoods. It is also the only natural lake in Ghana, and the deepest in West Africa. However, climate warming during the past five decades has severely impacted the lake and its fisheries, resulting in low fish productivity, declining catches, and diminishing household incomes. Consequently, increased vulnerability of the local communities to the climate impacts is leading to extreme poverty levels.

The communities are desperately trying to adapt to the situation by further intensifying fishing and farming activities, a situation that is causing rapid deforestation, and increased erosion into the lake due to the steep sided nature of the crater. These actions are counter adaptive, as feedback from the people's adaptation to the primary impact of climate change is resulting in other problems, further increasing the complexities of the issues. Many conflicts have arisen from intense competition among the 23 communities over access to fishing grounds, regulations governing fishing activities, lands for farming and other shared natural resources.

The complexities of the interactions among climate, humans and the lake's resources present a monumental challenge to managers of the lake, who face increasing difficulty to find clear, sustainable development pathways for the local communities to strengthen their adaptation to climate change by promoting policy and management decisions that balance resource use with conservation to ensure sustainability of the lake and its ecosystem services. However, often, the interventions of stakeholders are limited by scientific information that provides insights into all the interconnected issues.

Past studies on the lake and its watershed, have looked at bits and pieces of the issues either focusing on climate, lake ecosystem, fisheries, livelihoods, agriculture, tourism, and socioeconomic dimensions. However, none has attempted to look holistically at the interplay of all these issues to provide a sound scientific basis for clear and effective pathways to sustainable solutions. This is where the "Building Resilience of Lake Bosumtwi to Climate Change" (RELAB), Project, funded by the Ministry of Foreign Affairs of Denmark through Danida makes an important contribution to unravelling the issues with a multidisciplinary scientific approach to provide a sound scientific basis for decision-making.

The RELAB project thus focuses on all the issues at play; climate change, lake ecosystem dynamics, fisheries, land use and socioecological dynamics, It is the most comprehensive study within the watershed to date. The project was conceived to help us better understand these impacts and their interactions, and to predict what the future could be like for the lake and for the livelihoods that depend on the lake. This has required a holistic scientific approach, combining field campaigns collecting data from the lake as well as people living in its surroundings, building advanced computer models of the lake and its landscape, and using these models to predict possible futures of the lake in response to expected climate change.

Results

When analysing a combination of historical and new data, and our advanced computers models, we found that the lake has warmed up significantly in the last five decades, disrupting its natural behaviour as well as the natural cycles and ecological processes that sustain the fisheries and the

livelihoods of the people. Our computer models also predict that this warming trend will continue into the foreseeable future and will shift the lake to a completely new ecological regime. Looking at the lake itself, we have found that water temperatures have been increasing during past five decades and will continue to increase into the future due to climate change. This will lead to less mixing of the lake and lower oxygen levels in the waters, which could induce further stress on the aquatic life. The fish populations that inhabit the lake have reduced from 11 to 5 species, likely because of a combination of climate change, causing some tributary stream habitats to dry out, and overexploitation of the fishery, where fish are caught in numbers that exceed sustainability. We also found that the landscape around the lake has changed, where especially agricultural activities, built up areas, open forests have been spreading gradually into steeper areas, including closed, pristine forests, and been a key driver for deforestation and increased erosion into the lake. This makes urgent planning by all stakeholders' imperative to strengthen the adaptive capacity of the local communities. Importantly

Data collected on algal levels suggest that the lake is currently in a relatively poor and nutrient rich state with quite high algal levels and therefore low water transparency. Predictions of the future state suggest that this is unlikely to change in the coming decades. The project team at UENR and University of Ghana have through the project have built adequate capacity and gained experiences with the latest data collection and laboratory analysis techniques and would be able to follow the trajectory of the lake in years to come.

Conclusions

In brief, the project found that a combination of climate change, reduced fish catches and shift in people's attitude and behaviour towards agricultural intensification and overexploitation of the fishery, all in a desperate bid to survive the harsh living conditions, are acting as multiple stressors on the Lake Bosumtwi ecosystem. The lake and its fish population are currently in a relatively poor eutrophic state, and this is unlikely to change in coming decades, where climate change will put increasing pressure on the system. There are opportunities to mitigate the expected impacts, however, and the projects teams in Ghana now have the required skill and competences to follow and document the effects of actions of stakeholders implemented in the field, and based on the project results. This could include changes in fishery regulation towards a more sustainable fishery by ensuring that only fish nets that do not capture juvenile fish can be used, and implementation of best management practices on agricultural lands, thus ensuring that a minimum of nutrients will be lost to the aquatic ecosystem, where these can cause eutrophication and increased algal levels.

Recommendations

Based on outcomes of the RELAB project, we recommend to:

- protect the remaining closed forest within the crater, as this will protect biodiversity and avoid erosion in high slope areas, which could contribute to nutrient exports to the lake, and degradation of water quality.
- Strictly enforce the existing by-law that establishes a 100-m buffer zone between the lake and the agricultural areas on the slopes.
- regulate fisheries so that only fishing gear that will not capture juveniles will be allowed.
- initiate an ongoing monitoring program on Lake Bosumtwi, allowing Ghana to follow the trajectory of the lake, and document effects of mitigation actions taken.
- pursue a long-term socioeconomic development programme informed by the project results and which targets sustainable alternative livelihoods and poverty reduction.
- regularly engage stakeholders to share experiences, successes, and challenges in implementing the results of the project to direct future interventions.