Tropentag 2024
September 11-13, 2024

Conference on International Research on Food Security, Natural Resource Management and Rural Development
organised by the University of Natural Resources and Life Sciences, Vienna (BOKU), Austria

Biosphere Learning Laboratory Lake Bosomtwe: Biosphere Reserve Management in Times of Climate Change

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Introduction

The Lake Bosomtwe Biosphere Reserve, established in 2016, is one of three UNESCO biosphere reserves in Ghana. It is located in the Ashanti Region of Ghana, covering an area of almost 29,000 ha (see Figure 1). It is a crater lake and provides livelihoods for over 70,000 people in 22 communities. The local and regional population is hardly aware of the biosphere reserve status and the acceptance as a model area for sustainable development is rather low.

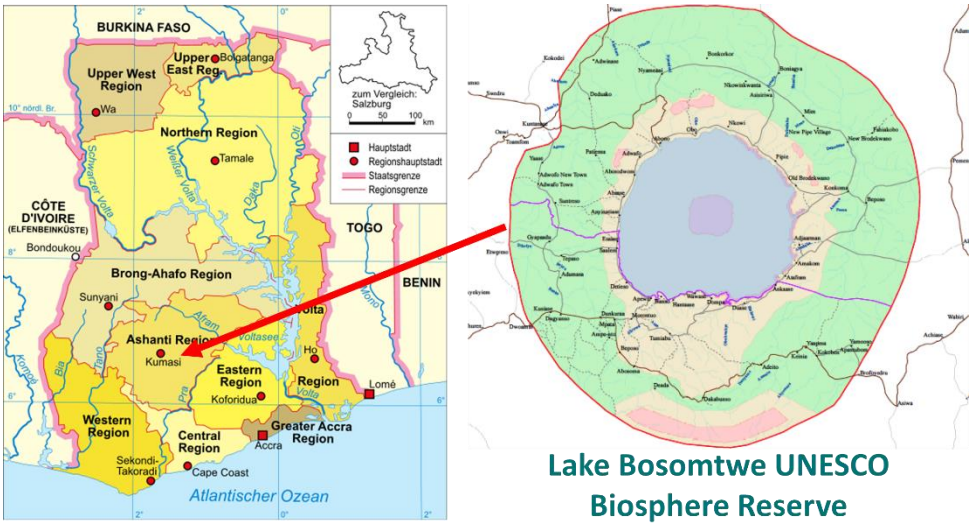

Figure 1 Lake Bosomtwe Biosphere Reserve Project Area (*Source: Environmental Protection Agency Ghana, n.d.*)

As the standard of living in the region rises, the Lake Bosomtwe Biosphere Reserve faces increasing challenges in terms of carrying capacity, over-exploitation of fish resources and

increased extraction of forest resources, leading to depletion and degradation of the fragile ecosystem. In particular, gold, diamonds, sand, clay and stone deposits, as well as timber and other forest resources are highly sought after and have been severely overexploited in the region and around the lake. Increasing deforestation is leading to other problems such as erosion, sedimentation and increased heat due to less vegetation cover. The use of fuelwood for cooking has led to serious health problems for the local population. Fish stocks in the lake are also declining, so alternative livelihoods are urgently needed to sustain households. In addition to the existing threats, climate change is likely to significantly increase the vulnerability of the ecosystem and the local population. Although an increasing number of (mainly regional) tourists visit the area, especially at weekends, there is little tourist infrastructure and services. There is also a lack of visitor management, resulting in uncontrolled use by tourists.

In general, the biosphere reserve has not been included in plans for future development. As Ghana's population continues to grow, the pressure of people living in and using the area will increase in the future. New concepts and approaches are needed to prevent further degradation of the biosphere reserve and to support the biosphere reserve in fulfilling its role as a model region for sustainable development in accordance with the aspirations and needs of the local communities. Without a harmonized research and development plan, the contribution of science will be ad hoc and fragmented. As a result, the reserve will not be able to fully benefit from its biosphere reserve status.

The aim of the project was therefore to build a strong professional network of researchers and academics around the biosphere reserve and to promote relevant, practice-oriented teaching and research at the participating institutions in the area. The network should promote the exchange of knowledge between the partners involved. As biosphere reserves are places of learning for sustainable development, the long-term partnership between the research institutions and the area - in line with the Lima Plan of Action - is intended to support the management of the biosphere reserve and its sustainable development.

Results and Discussions

The DAAD-funded project 'Biosphere Learning Laboratory Lake Bosomtwe' addressed the needs and requirements for research and transfer in the biosphere reserve as follows:

At the beginning, study visits to the biosphere reserves Schaalsee (Germany) and Møn (Denmark) were conducted to discuss how biosphere reserve-related content could be presented to the public and used for educational purposes. The knowledge gained from these visits were integrated into the teaching and research activities of the participating Ghanaian universities in the following months. At AAMUSTED, for example, a new module on biosphere reserves is now part of the curriculum, and all partners are supplementing appropriate modules in their curricula with relevant biosphere reserve content.

A Zotero database has also been created, based on extensive desktop research, as a comprehensive collection of literature on the research conducted at Lake Bosomtwe and in the Biosphere Reserve. This database is openly available to the participating institutions and can serve as a basis for future research. Interestingly, it became clear that most of the research was focused on fisheries and the water quality of the lake. Up to now, there is little focus on the surrounding area and its challenges (see Figure 2). Consultations and workshops were then held with partner institutions and local communities to learn more about their research and transfer. As a result, a research outline was developed with seven priority research and transfer areas. It became clear that the topics on which local people would like to see more research revolved around the priority areas of alternative livelihoods, agriculture, forestry, fisheries and biodiversity, sustainable tourism, communication

and public health. At the same time, research fatigue could be felt in the communities and people want to experience the results of the research directly. For this reason, more detailed research topics, formulated as concretely as possible, were derived for all themes, which can be taken up in the future by the partner institutions (see Table 1).

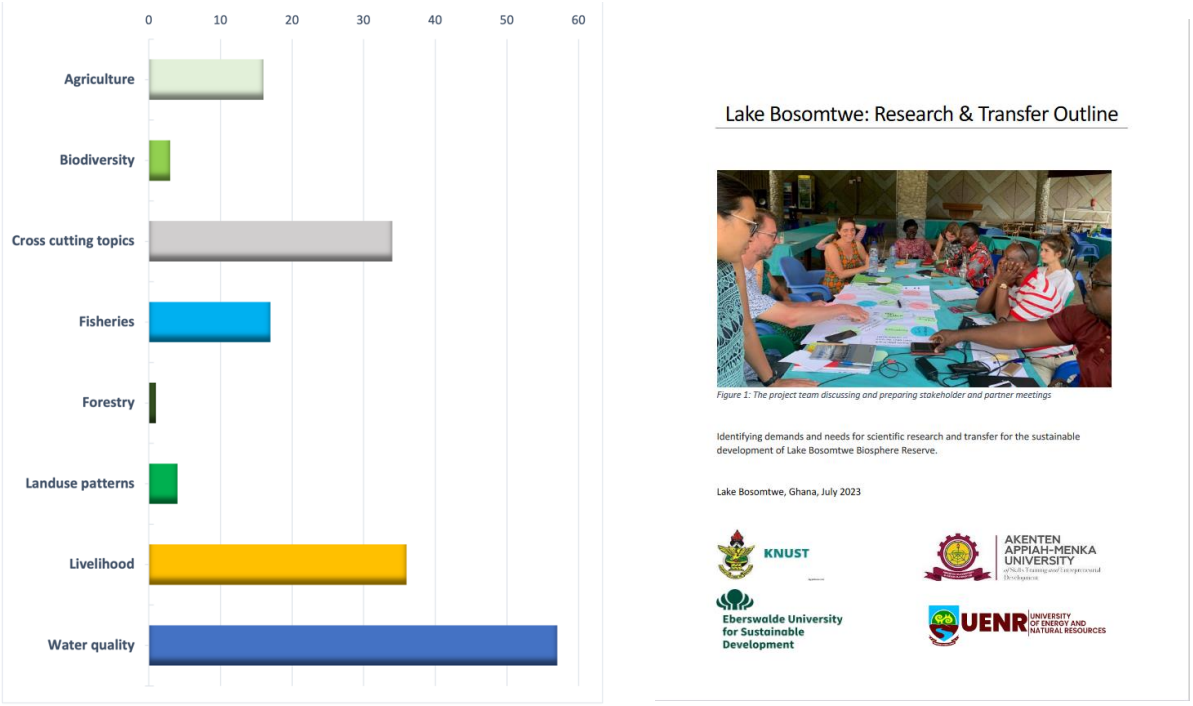

Figure 2: Main research areas of studies (n = 68) and corresponding frequency (x-axis: number of studies found); *Source: author's data based on Zotero list, 2022*

Table 1: Detailed research topics for forestry, formulated in the research and transfer outline

Economic dimension	**Socio-cultural dimension**	**Ecological dimension**	**Management / Governance**	**Cross-sectional**
Development of approaches to increase the attractiveness of less used timber species	Analysis of fuelwood use patterns of communities around the lake and development of alternative fuel sources	Development of approaches to use bamboo for erosion control	Development of strategies to reduce illegal logging	Assessment of carbon stocks of trees
Analysis of possibilities for efficient use of wood by-products such as bark	Collection of indigenous people's knowledge on forest management at Lake Bosomtwe	Analysis of biodiversity and ecosystem services of the forest area around the lake	Development of strategies to promote reforestation activities	

The research topics were addressed in the field by 10 students of the University for Sustainable Development in Eberswalde (HNEE) as part of their Master's thesis or research project. The research was carried out in cooperation with all partner Ghanaian universities or research institutes (UENR, Sunyani; KNUST, Kumasi; AAMUSTED, Mampong; and CSIR-FORIG) and their Ghanaian students. Research topics included 'Women's participation in tourism', 'Linking cultural heritage and environmental protection', 'Fisheries management' and 'Combining cocoa farming with agroforestry', to name but a few. In some cases, concrete measures have been developed, such as the construction of a prototype floating treatment wetland (FTW) for possible water purification (see Figure 3), or recommendations on how to strengthen women's participation in tourism.

Figure 3: Example of the floating treatment wetlands (*Source: Micaela Cobo*)

A final project workshop was held on the shores of Lake Bosomtwe to discuss the key findings of the research with all stakeholders and to feed them directly into the ongoing revision of the biosphere reserve's management plan.

At the same time, starting points for future research projects were discussed and applications were announced: Based on the identified research and transfer needs, a project on "NTFP domestication and cocoa systems diversification at Lake Bosumtwe Biosphere Reserve" for the development of agroforestry systems with special consideration of shade-tolerant cocoa species in Ghana is already presented as a follow-up project, and the existing networks and direct links between the stakeholders have provided a basis for its implementation.

In summary, the project directly addressed the following six SDGs through concrete actions:

- SDG 11: Sustainable cities and communities: by supporting the development of sustainable communities in the biosphere reserve.
- SDG 12: Responsible consumption and production: by supporting the responsible use of natural resources with a focus on fisheries and forestry.
- SDG 13: Climate action: by taking initial steps to increase the resilience of the biosphere reserve and reduce the vulnerability of the ecosystem and local people.
- SDG 14: Life below water: by taking the first steps towards sustainable water and fisheries management.
- SDG 15: Life on land: by promoting ideas for sustainable resource management.
- SDG 17: Partnerships for the Goals: by establishing a strong professional network of researchers and educators around the Lake Bosomtwe Biosphere Reserve and promoting relevant, practice-oriented teaching and research by participating institutions in the area.

Conclusions and Outlook

In order to improve cooperation, it is essential to increase the involvement of indirect partners through the Ghanaian partner universities. This will foster a deeper sense of ownership among Ghanaian stakeholders and encourage active participation and commitment. In addition, the direct involvement of biosphere reserve management should be strengthened to ensure better coordination and alignment with project objectives. In the future, an increased exchange of students between the Eberswalde University for Sustainable Development and Ghanaian universities will further strengthen academic and cultural ties and promote mutual learning and capacity building.