The UNESCO Lake Tana Biosphere Reserve concept in higher education

A reference manual

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NABU project

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1. Key Notes

Svane Bender-Kaphengst

The Nature and Biodiversity Conservation Union

Head of Africa Program / Deputy Head of International Affairs

Dear teachers, dear students,

What does biodiversity have to do with your school? Isn't it more important to learn about maths, and how to read and write?

Well, we are all part of the global biodiversity and depend on a functioning environment providing us with air to breathe, water to drink, and food to survive. Each and every tiny plant, animal or other organism takes a place in this system. When it disappears, the whole system will deteriorate until it might collapse, leaving us without water and without food...

Doesn't it therefore sound logical that we need the essential knowledge in order to care about our environment and its fascination diversity? Shouldn't we make sure not to destroy what has been given to us as the basis of our life?

DRAFT

For over a hundred years, **NABU** (The Nature and Biodiversity Conservation Union) has been promoting the interests of people and nature, drawing on its unwavering commitment, specialised know-how, and the backing of about 640,000 members and supporters. One of **NABU**'s major aims is conducting environmental education, which is why it runs more than 70 environmental education centres in Germany. It also hosts its own youth organization, NAJU, bringing together 80,000 children and youngsters. **NABU** is the German partner of BirdLife International and closely cooperates with its BirdLife partners around the world.

This manual is designed to provide you with an overview of the complexity of biodiversity, nature conservation, and climate change. It will assist you in understanding each subject and in passing your knowledge. A wide range of formal and non-formal teaching material is at offer for your use. In teaching biodiversity and related matters, you will become an ambassador for the environment!

I would like to thank all teachers and students, our partners at Kafa Zone's Department of Education, our **NABU** team in Bonga and Ms Stefanie Gendera for contributing to the development of this wonderful Manual.

Enjoy and make use of it!

Svane Bender-Kaphengst

2. Expected outputs for incorporating the Biosphere Reserve concept in the academic curriculum

The intended outputs of incorporating the biosphere reserve concept and related issues in different departments of Gondar, Bahir Dar and Debre Tabor universities are:

- The awareness level of the students and other university community members about the concept of biosphere reserve in general an LTBR in particular is increased and thus LTBR is more likely to be understood and properly maintained,
- The university communities' involvement in various research topics related to Lake Tana Biosphere Reserve is enhanced (third function of logistic of UNESCO BRs,
- Field trips of university students to Lake Tana region take place focussing on practical examples of biodiversity conservation and sustainable development,
- University professionals apply and secure funds from international and national donors to conduct development and research related activities in Lake Tana Biosphere Reserve,
- Opportunities within the LTBR for academic institutions to implement long-term monitoring projects are enhanced.

3. UNESCO Biosphere Reserves

3.1. The concept of a Biosphere Reserve

A biosphere reserve is an area created to conserve the biological and cultural diversity of a region while promoting sustainable economic and social development. Its goal is to strike a balance between conservation and use, as people depend on intact ecosystems to survive. On the other hand, it promotes solutions reconciling the conservation of biodiversity with its sustainable use, towards sustainable development at the regional scale.

The inhabitants may use the area's natural resources in a sustainable way, while at the same time contributing to the conservation of precious habitats. And it is a place for cooperation, education and research to better understand human's impact on nature and it is a demonstration area to test new and innovative ideas for sustainable development. According to this approach all members of society, including local communities, environmental groups, and economic parties are involved and work together to address conservation and development issues.

Biosphere reserve sites are established by countries and recognized by the United Nations Educational, Scientific, and Cultural Organization (UNESCO[1]) as part of the Man and the Biosphere Program (MaB)[2]. Potential sites are nominated by national governments, and approved by UNESCO and become part of the worldwide network of biosphere reserves. Still, the sites remain under sovereign jurisdiction of the states they are located in for further protection. All biosphere reserves form a global network, the "World Network of Biosphere Reserves". This network allows the exchange of knowledge and experience among the BRs.

The UNESCO's MAB Program was launched in 1971. It is an intergovernmental scientific program that has aimed to establish a scientific basis for the improvement of relationships between people and their environments. MAB combines the practical application of natural and social sciences, economics and education to improve human livelihoods and the equitable sharing

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[1]United Nations Educational, Scientific, and Cultural Organization (UNESCO) was founded in 1945, at the end of the Second World War. As a specialized agency of the United Nations, UNESCO will, in the foreseeable future, continue to contribute across continents to the building of peace, the eradication of poverty, the improvement of health, and sustainable development and intercultural dialogue through education, scientific activities, culture, communication and information.

[2] The MaB Program is a global program of international scientific co-operation, dealing with peopleenvironment interactions over the entire realm of bioclimatic and geographic situations of the biosphere. Research under the MaB Program was designed to solve practical problems of resource management, and aims to fill gaps in the understanding of the structure and function of ecosystems, and of the impact of different types of human interaction. Key ingredients in the MaB Program are the involvement of decision-makers and local people in research projects, training and demonstration at the field level, and the bringing together of disciplines from the social, biological and physical sciences in addressing complex environmental problems (Miller, K. 1996. Balancing the scales: Guidelines for increasing biodiversity's chances trough bioregional management. Washington: World Resources Institute).

of benefits, and to safeguard natural and managed ecosystems, promoting innovative approaches to economic development that are socially and culturally appropriate and environmentally sustainable. In practice, the MAB Program is implemented in biosphere reserves. BR may be terrestrial, coastal and/or marine ecosystems which should be representative of their biogeographic region and of significance for biodiversity conservation.

3.2.Three functions of a UNESCO Biosphere Reserve

The main aim of a biosphere reserve is to implement a better land administration and to develop measures to solve present administration and land use problems. In every biosphere reserve, three interrelated and major functions are identified to achieve a sustainable development in the biosphere reserve: conservation, development and logistic functions. All three functions are equally important – successful conservation depends on successful socio-economic development – and vice versa. We need to understand conservation and development and create knowledge through research. We need to transfer the skills, attitudes and knowledge about sustainability to future generations. We need to monitor change and we need to exchange experiences. Without such knowledge-based efforts, any conservation and development will not be effective in the long run.

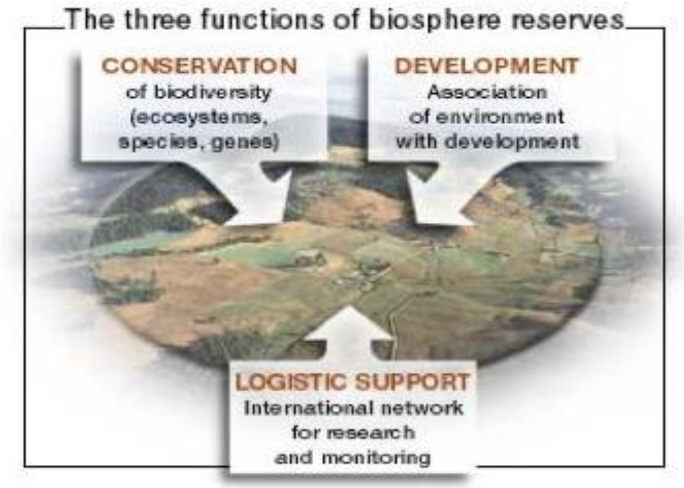

Figure 1: Three functions of a Biosphere Reserve (UNESCO 2003).

3.2.1. The conservation function of a Biosphere Reserve

Due to high pressure, exerted by humans on land and water resources, various plants, animals and ecosystems are deteriorating. This development cannot be in the interest of any party, as nature is the source of raw material for food, medicine and building materials

Taking care of the environment, conserving biodiversity and sustainably using resources in the biosphere reserve ensures that the community can benefit from it not only now, but also in the future. The activities of natural resource conservation include:

- ensuring the conservation of landscapes, ecosystems, species and genetic variations, e.g. through the establishment of protected areas, community management, reforestation, etc.;
- encouraging the traditional use systems, e.g. small-scale fishing, traditional agriculture;
- understanding the patterns and processes in ecosystems through research and monitoring;
- understanding the significance of environmental services; and
- awareness creation for decision makers, local communities and children.

3.2.2. The development function of a Biosphere Reserve

As biosphere reserves are meant to be model areas for sustainable development, it is of utmost importance that the development of the region is supported - while keeping conservation in mind.

Pilot activities for alternative land use systems, alternative income generation measures, ecotourism development and the promotion of sustainable regional products are just some examples of what a biosphere reserve can do to promote sustainable development. In addition, the community in the biosphere reserve should work on:

- Developing strategies leading to improvement and sustainable management of natural resources;
- Promoting the local level economic development which is culturally, socially and ecologically sustainable; and
- Enabling the conservation of natural resources through new strategies and systems.

3.2.3. The logistic function of a Biosphere Reserve

The third function ensures that both areas are linked and receive the necessary support. The logistic function combines the support of input, local education, studies and research, in specific the administration and all actors in the area should:

- Provide support for research, monitoring, education and information exchange related to local, national and global issues of conservation and development,
- Sharing of knowledge generated by research through site specific training and education,
- Creating awareness among the community, children, students etc., and
- Motivate the society's action on conservation of natural resources.

3.3.The three zones of a Biosphere Reserve

To carry out the complementary activities of biodiversity conservation and sustainable use of natural resources, biosphere reserves are organized in three interrelated zones: the core zone, the buffer zone, and a transition zone. The zones ensure the

conservation goals are achieved, while defining the area where sustainable development shall be supported and leave space for cities, streets and other legal human activities.

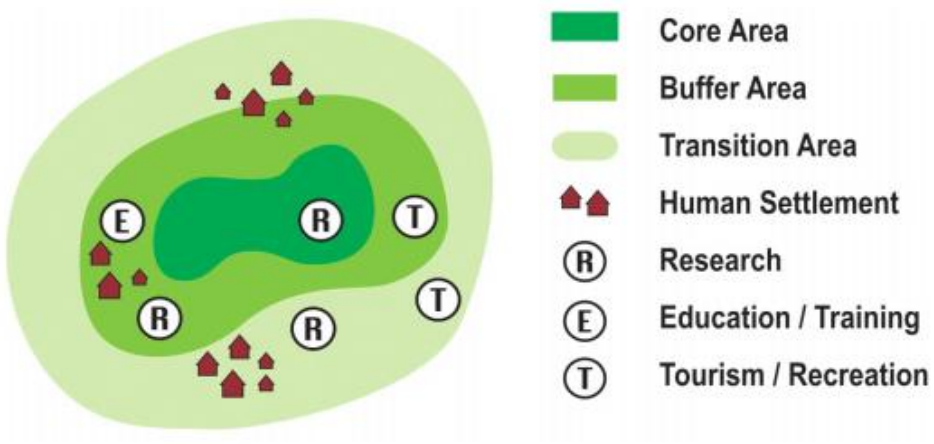

Figure 2: Zonation of a Biosphere Reserve (Source: Adopted from Kafa Biosphere Reserve management plan, 2009).

3.3.1. The core zone of a Biosphere Reserve

The core zone covers at least 3-10% of the overall biosphere reserve site and ensures the conservation function of the biosphere reserve. It includes the most intact part of the biodiversity where until now only little human interaction took place.

These zones will be legally protected from further human interaction as part of the biosphere reserve proclamation. Core zones need to be decided upon together with the local communities who agree on protecting the area in the future. Only monitoring and scientific research may be conducted in these places.

3.3.2. The buffer zone of a Biosphere Reserve

The buffer zone is ideally the area that surrounds the core zone. In the buffer zone, activities focus on protecting and securing the core zone, while offering sustainable use of natural resources to the communities. The major purpose of the buffer zone is to keep the core zone intact and prevent harmful interaction.

Activities, which do not compromise the integrity of the core zone are strongly promoted in the buffer zone, e.g. organic farming, ecotourism, sustainable community management of natural resources. Examples for such activities are: Scientific education and studies, community based eco-tourism activities, traditional fishery, improved, non-industrial agro-

processing activities, other agricultural activities that do not have a negative impact on natural resources, monitoring and evaluation, and awareness creation trainings.

3.3.3. The transition zone of a Biosphere Reserve

The transition zone is the third and usually the largest part of the biosphere reserve. Here, all legal development activities are allowed. Still, nature friendly activities, which do not contradict with the natural and cultural ressources, shall always be given priority. The transition zone is the area where the community, researchers, governmental and non-governmental organizations and other stakeholders cooperate and pilot activities to achieve the common goal: the conservation and sustainable use of resources. Transition zones usually include:

- Tourism and recreation facilities,
- Human settlement (including urban centers),
- Economic activities (as much as possible organic/sustainable) and
- Infrastructure.

The size of each zone in the biosphere reserve varies from biosphere reserve to biosphere reserve. Some biosphere reserves may have dispersed zones or they have more than one core or buffer zones in different places.

3.4. The need of establishing a UNESCO Biosphere Reserve

The main objective of establishing biosphere reserves is to promote and test innovative approaches to sustainable development challenges, especially, to combine different approaches and to examine their compatibility.

3.4.1. Main benefits of biosphere reserves

- **Conservation of biological diversity:** Human pressures on land and water resources are drastically reducing the diversity of genes, plant and animal species, ecosystems and landscapes of the planet. This threatens human welfare, as this biodiversity is the potential source of foods, fibers, medicines, and raw material for industry and building. It constitutes an irreplaceable wealth for research, education and recreation for the whole of humankind. The core areas and buffer zones of biosphere reserves serve as repositories to safeguard samples of the biodiversity of the world's major biogeographically important regions, and as reference and study sites to help improving our knowledge on biodiversity.

- **Maintain healthy ecosystems**: biosphere reserves, which may represent large areas of land and water, contribute significantly to the maintenance of the life support systems which serve to avoid soil erosion, maintain soil fertility, regulate river flows, recharge aquifers, recycle nutrients, and absorb air and water pollutants.
- **Learn about natural systems and how they are changing:** research may be conducted on the structure and dynamics of the minimally disturbed natural systems of the core areas of biosphere reserves, and compared with the functioning of human-affected landscapes in the buffer and transition areas. Such studies, when carried out over the long term, show how these systems may change over time. Setting up similar long-term monitoring plots, and harmonizing methods and measurements allows comparison of results regionally and worldwide. The information thus obtained allows us to better understand global environmental changes.

3.4.2. Specific benefits of a UNESCO biosphere reserve are:

- Manage/conserve ecosystems in a way that they can provide the environmental services needed for sustainable use for e.g. agriculture, fisheries etc.;
- Improve resource management through integration and coordination of relevant stakeholders and sectors;
- Create environmental awareness and ownership through education, local initiatives and participation;
- Conserve biodiversity, wildlife and its habitats as well as related cultural assets and restore/maintain essential ecosystem functions;
- Safeguard of last valuable, unspoiled nature sites (reference area) and gene pools;
- At the national level, biosphere reserves can serve as pilot sites or "learning places" to explore and demonstrate approaches to conservation and sustainable development, providing lessons which can be applied elsewhere;
- Attract donors and researchers to help address developmental challenges (Many scientists globally cooperate in the MAB Program – this makes biosphere reserves an attractive study site for scientists and often, research projects lead to development projects);
- The UNESCO designation makes a certain region visible to the world and to its own inhabitants. Often, the inhabitants create strong sense of identity and pride for their biosphere reserve. This often results in positive social and demographic trends;
- Tourists consider the UNESCO designation as a quality label. It has been proven that tourists will visit some regions exactly because they are designated by UNESCO; therefore, biosphere reserves provide new economic opportunities in tourism. Well-managed biosphere reserves add more income through tourism alone that outweighs the costs of administration; and
- Income from agriculture can be boosted: More and more organic and/or fair-trade products originate from biosphere reserves and are in high demand on the world market.

3.5.The global and Ethiopian trends in developing Biosphere Reserves

The UNESCO Biosphere Reserve concept was developed in the early 1970s. The first 57 biosphere reserves were declared in 1976 and today, there are 669 Biosphere Reserves in 120 countries including 16 trans-boundary sites. Currently, Ethiopia has 5 biosphere reserves: Kafa (2010), Yayu (2010), Sheka (2012), Lake Tana (2015) and Majang Forest (2017). The global distributions of biosphere reserves in 2016 were as follows:

- 70 Biosphere Reserves in 28 countries in Africa,
- 30 Biosphere Reserves in 11 countries in the Arab States,
- 142 Biosphere Reserves in 24 countries in Asia and the Pacific,
- 302 Biosphere Reserves in 36 countries in Europe and North America,
- 125 Biosphere Reserves in 21 countries in Latin America and the Caribbean.

3.6.Criteria for selecting potential Biosphere Reserve sites

UNESCO has prepared a strategic document which offers guidelines on how to achieve a sustainable development in biosphere reserves. The strategic document is known as “Seville Strategic Document”. It contains detailed criteria which each biosphere reserve site shall fulfill to qualify for a registration.

According to the UNESCO website, the general criteria for selecting a biosphere reserve are:

1. It should encompass a mosaic of ecological systems representative of major biogeographic regions, including a gradation of human interventions;
2. It should be of significance for biological diversity conservation;
3. It should provide an opportunity to explore and demonstrate approaches to sustainable development on a regional scale;
4. It should have an appropriate size to support the three functions of biosphere reserves: conservation, development and logistics support;
5. It should promote the three biosphere reserve functions (conservation, development and logistics support) through appropriate land-use planning and zonation;
6. Organizational arrangements should be made for the involvement and participation of a suitable range of, inter alia, public authorities, local communities and private interests, in the design and carrying out the functions of a biosphere reserve;
7. In addition, provisions should be made for:
    a. Mechanisms to manage human use and activities in the buffer zones,
    b. A management policy and management plan for the area as a biosphere reserve,
    c. A designated authority or mechanism to implement this policy and plan,
    d. Programs for research, monitoring, education and training.

4. The concept of biodiversity and its threats

4.1. Definition of biodiversity

Biodiversity is the short version of two words “biological” and “diversity”. It basically means variety of life that can be found on earth (fungi, plants, animals and micro-organsims) as well as the communities they form and the habitas they live in.

The article 2 of the convention on Biological Diversity defines biodiversity as “the variability among living organisms from all sources including, inter alia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems”.

Biodiversity is not only the sum of all ecosystems, species and genetic material. Rather, it represents the variability within and among them. It can be distinguished from the expression “biological resources” which refers to the tangible components of the ecosystems. Biological resources are real entities, while biological diversity is rather an attribute of life (variety of bird species, the genetic variability of wheat etc).

Biological diversity is often divided into three levels:

- **Genetic diversity** is all the different genes contained in all the living species, including individual plants, animals, fungi, and microorganisms. It occurs within species as well as between species
- **Species diversity** refers to the variety of different species (plants, animals, fungi and micro-organsims).
- **Ecosystem diversity** is all the different habitats, biological communities and ecological processes, as well as variation within individual ecosystems.

4.2. Some facts about biodiversity

Researchers have estimated that there are between 3 - 30 million species on Earth, with a few studies predicting that there may be over 100 million species on Earth. Currently, only 1.7 million species are identified, so we have a long way to go before we can come close to figuring out how many species are on Earth.

- There is more biodiversity within tropical ecosystems than temperate ecosystems. Tropical rainforests have the highest diversity. These tropical forest ecosystems cover less than 10 per cent of the Earth's surface, and contain about 90 percent of the world's species.

- The most diverse group of animals are invertebrates. Invertebrates are animals without backbones, including insects, crustaceans, sponges, scorpions and many other kinds of organisms. Over half of all the animals already identified are invertebrates. Among invertebrates, beetles are some of the most numerous species.

4.3.The contribution of biodiversity

Biodiversity contributes to many aspects of human well-being. Humans cannot exist without biodiversity as we use it directly and indirectly in a number of ways. Direct use includes things like food, fibers, medicines and biological control, whilst indirect uses include ecosystem services such as atmospheric regulation, nutrientcycling and pollination. There are also non-use values/indirect use of biodiversity, such as option value (for future use or non-use), bequest value (in passing on a resource to future generations), existence value (value to people irrespective of use or non-use) and intrinsic value (inherentworth, independent of that placed upon it by humans).

Many of these uses of biodiversity are not incorporated in economic accounts and this leads humans to under-value biodiversity. Ecosystem services and resources such as mineral deposits, soil nutrients, and fossil fuels are capital assets but traditional national accounts do not include measures of the depletion of these resources. In general, biodiversity is extremely important to people and the health of ecosystems. A few of the reasons are:

- Biodiversity allows us to live healthy and happy lives. It provides us with an array of foods and materials and it contributes to the economy. Without a diversity of pollinators, plants, and soils, our supermarkets would have a lot less products.
- Most medical discoveries to cure diseases and lengthen life spans were made because of research into plant and animal biology and genetics. Every time a species goes extinct or genetic diversity is lost, we will never know whether research would have given us a new vaccine or drug.
- Biodiversity is an important part of ecological services that make life livable on Earth. They include everything from cleaning water and absorbing chemicals, which wetlands do, to providing oxygen for us to breathe - one of the many things that plants do for people.
- Biodiversity allows for ecosystems to adjust to disturbances like extreme fires and floods. If a reptile species goes extinct, a forest with 20 other reptiles is likely to adapt better than another forest with only one reptile.
- Genetic diversity prevents diseases and helps species adjust to changes in their environment.
- Simply for the wonder of it all. There are few things as beautiful and inspiring as the diversity of life that exists on Earth.

4.4.Threats for biodiversity

Biodiversity loss has negative effects on several aspects of human wellbeing, such as food security, vulnerability to natural disasters, energy security, and access to clean water and raw materials. It also affects human health, social relations, and

freedom of choice. Biodiversity is declining rapidly due to factors such as habitat change, climate change, invasive species, over-exploitation and pollution as the primary drivers leading to loss of biodiversity. While changes in biodiversity are more clearly linked to direct drivers such as habitat loss, they are also linked to indirect drivers that are at the root of many changes in ecosystems. The main indirect drivers are changes in human population, economic activity, and technology, as well as socio-political and cultural factors. Different direct drivers have been critically important in different ecosystems over the past 50 years.

For example, in terrestrial ecosystems, the main driver has been land cover change such as the conversion of forest to agriculture. In marine systems, however, fishing, and particularly overfishing, has been the main drivers of biodiversity loss. Overall, the main factors directly driving biodiversity loss are: habitat change, such as fragmentation of forests; invasive alien species that establish and spread outside their normal distribution; overexploitation of natural resources and pollution, particularly by excessive fertilizer use leading to excessive levels of nutrients in soil and water.

There are five main causes of biodiversity loss:

- **Habitat loss** occurs when natural enviornments are transformed or modified to serve human needs. It is one of the most significant causes for biodiversity loss globally. The main types of habitat loss include cutting down forest for timber and opening up land for agriculture. Habitat loss can also cause fragmentation which occurs when habitats become separated from one another becase of changes in landscape. Fragmentation makes it difficult for species to move within a habitat, and poses a major challenge for species requiring large tracts of land
- **Climate change** is caused by high emissions of greenhouse gases such as carbin dioxed in Earth's atmosphere. Climate change alters the climate patterns and ecosystems in which species have evolved and on which they depend. By changing the temperature and rain patterns species have become accustomed, climate change is changing the traditional range of species. Climate change and its impacts are likely to be the dominant direct driver of biodiversity loss and changes in ecosystem services globally.
- **Invasive species** are species that have spread outside of their natural habitat and threathen biodiversity in their new area. The spread of invasive alien species is rising because of increased trade and travel. While increasingly there are measures to control some of the pathways of invasive species, for example, through quarantine measures and new rules on the disposal of ballast water in shipping, several pathways are not adequately regulated, particularly with regard to introductions into freshwater systems.
- **Overexploitation** happens when biodiversity is removed faster than it can be replenished and, over the long term, can result in the extinction of species. This occurs on land in the form of overhunting, excessive logging, poor soil conservation in agriculture and illegal wildlife trade.
- **Pollution (especially nutrient loading)** by human mediated increases in nitrogen, phosphorus, sulphur, and other nutrients (nutrient loading) has emerged as one of the most important drivers of ecosystem change in terrestrial, freshwater, and coastal ecosystems, and this driver is projected to increase substantially in the future. Furthermore,

though large-scale use of fertilisers has allowed for increased production of food, it has also caused severe environmental damges, such as eutrophication.

In order to overcome such challenges, conserving biodiversity is essential. The biosphere reserve concept and tool is one of the best options that can help us to achieve a balance between the often conflicting goals of conserving biological diversity, and promoting human development. This approach enables us to test various objectives, refine them and finally implement them to meet out objectives (UNESCO 2003).

5. Lake Tana Biosphere Reserve

5.1. Background information about Lake Tana

Lake Tana is located in the north-east of Ethiopia and is the largest lake in the country (see Table 1 and Figure 4 for more detailed geographical location information). The lake is situated 1,830m above mean sea level (a.m.s.l.) with its highest point at Ararat Plateau which is 1,994m above mean sea level. The lowest point of the lake is located near Bahir Dar, at the outlet of Blue Nile River from Lake Tana, which is 786m above mean sea level. According to various sources, many years back, the total area of the lake had been 6,602 sq km while now it has shrunk to 3,156 sq km. The total area of the catchment measures over 15,000 sq km. The width of the lake (from East to West) is 68 km while its length (North to South) is 73 km. The lake measures 14m at its deepest point while the average depth is estimated to be 8m. Lake Tana and its surroundings are rich of rivers, wetlands, religious and historical monasteries and churches. In addition to that, Lake Tana region is characterized by a high degree of biodiversity because of its unique landscapes and natural resources. The Blue Nile River, the major tributary to Nile River, the longest river of the world, starts its journey from Lake Tana. Due to its natural and cultural attractions, Lake Tana region also serves as an international tourist destination. The catchment of Lake Tana encompasses the region from Guna to Sekela and from Armachiho to Enjibara and parts of four zonal administrations, 10 Woreda a total of 117 Kebele and Bahir Dar city administration.

Table 1: Geographical coordinates of Lake Tana Biosphere Reserve.

Cardinal points	Latitude	Longitude
Most central point	11° 54’ 29.6’’N	37° 20’ 40.65’’ E
Northernmost point	12° 29’ 18.53’’ N	37° 31’ 20.94’’ E
Southernmost point	11° 25’ 7.66’’ N	37° 31’ 19.76’’ E
Westernmost point	11° 59’ 57.73’’ N	36° 54’ 1.46’’ E
Easternmost point	12° 7’ 25.80’’ N	37° 47’ 20.54’’ E

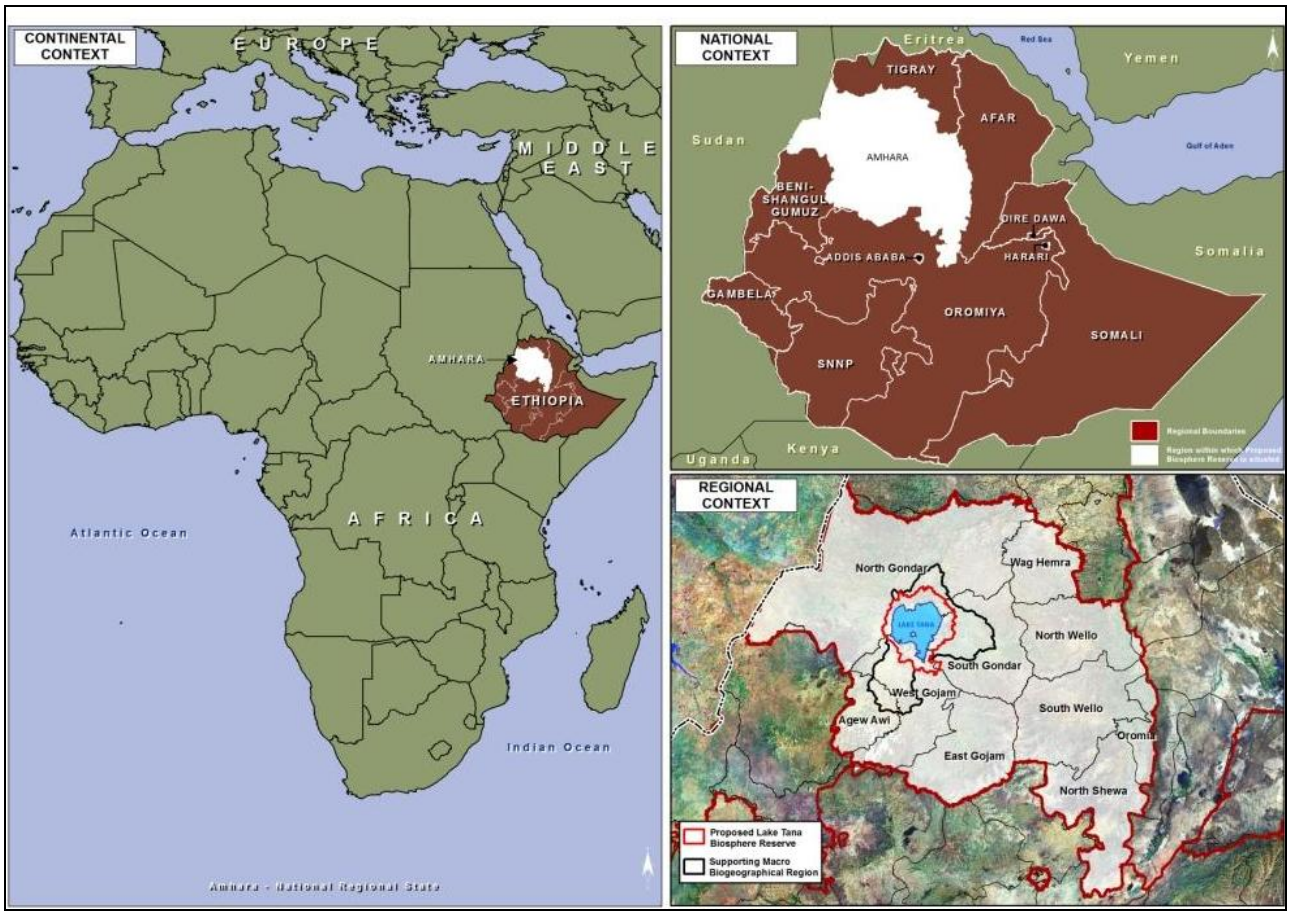

Figure 3: Lake Tana Biosphere Reserve in its continental, national and regional context.

5.2. Biosphysical characteristics of Lake Tana Biosphere Reserve

The next chapters will provide a comprehensive description of the key biophysical characteristics of the Biosphere Reserve, including the 'macro biogeographical' regions, agro-ecological regions and associated natural phenomena.

5.2.1. Topography

Lake Tana is situated in the northern highlands of Ethiopia in a wide depression of the Ethiopian Plateau which is surrounded by high hills and mountains except where the outflow leaves the lake by a narrow valley in the southeast.

The Biosphere Reserve is characterised by rugged topography and relatively elevated terrain at the top part of the Gilgel Abay, Megech and Ribb Rivers. It is a topographically closed volcanic ridge with a very small valley opening at the outflow of the Abay (Blue Nile) River in the eastern part of the basin near Bahir Dar.

The shores of Lake Tana are surrounded by floodplains and wetlands that are characterised by seasonal flooding – Fogera plain in the east, the Dembiya or Dembia plain in the north, the Kunzila plain in the southwest, and marshlands at the peripheries of the lake bordering the Bahir Dar in the south (Yohannes, 2010).

Furthermore, the topographic features include evergreen moist riverine extensive flatlands with scattered islands in Lake Tana and along the Abbay River. Dry hills, escarpments and igneous rock formations dominated the surfaced flatlands. Most of the Biosphere Reserve is characterised by cropland with scarce woodlands while only limited areas of the highlands are forested.

The Abbay River or Blue Nile meanders from Lake Tana in an easterly direction and approximately 30 km downstream from Bahir Dar are the impressive Tis Issat ('smoking water') or Blue Nile Falls located where the river plunges approximately 37 to 45 m into the Blue Nile gorge.

Figures 6 and 7 illustrate the west-east and south-north topographic cross-section A-A and B-B (refer to Figure 5 above that illustrate the cross section lines) respectively of the Lake Tana Basin.

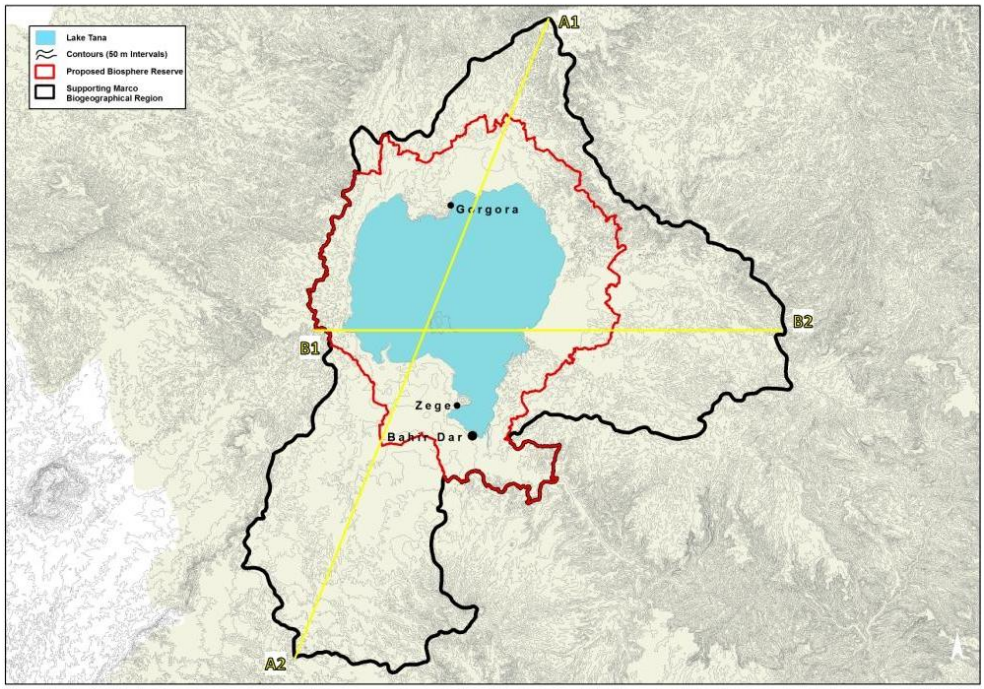

Figure 4: Topography of Lake Tana Biosphere Reserve. Yellow lines indicate the topographical cross-sections represented in Figures 5 and 6.

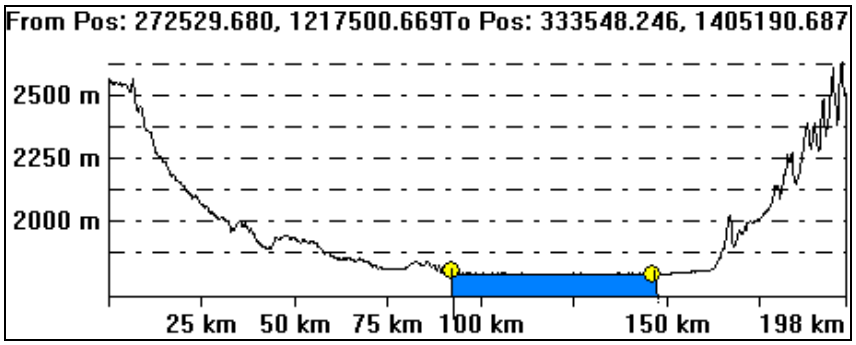

Figure 5: The topographical section of the Lake Tana basin (west to east – B1 to B2) (Source: Yohannes, 2010).

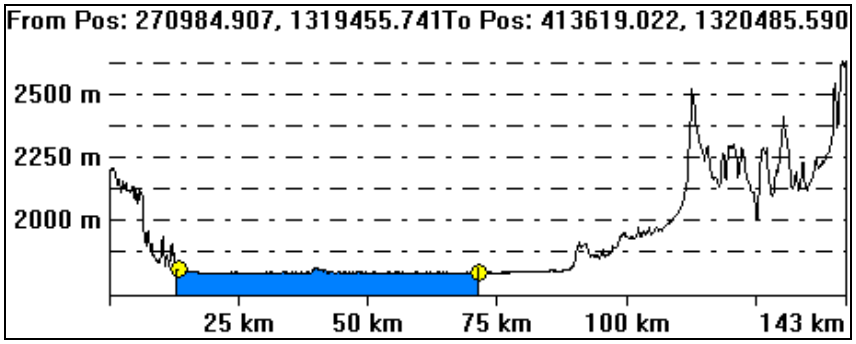

Figure 6: The topographical section of Lake Tana basin (north to south – A1 to A2) (Source: Yohannes, 2010).

The elevation in the Biosphere Reserve ranges between a minimum of 1,784 m and a maximum of 2,625 m above mean sea level. The Lake Tana has an average depth of approximately 9 m and a maximum of 14 m (refer to Figure 8).

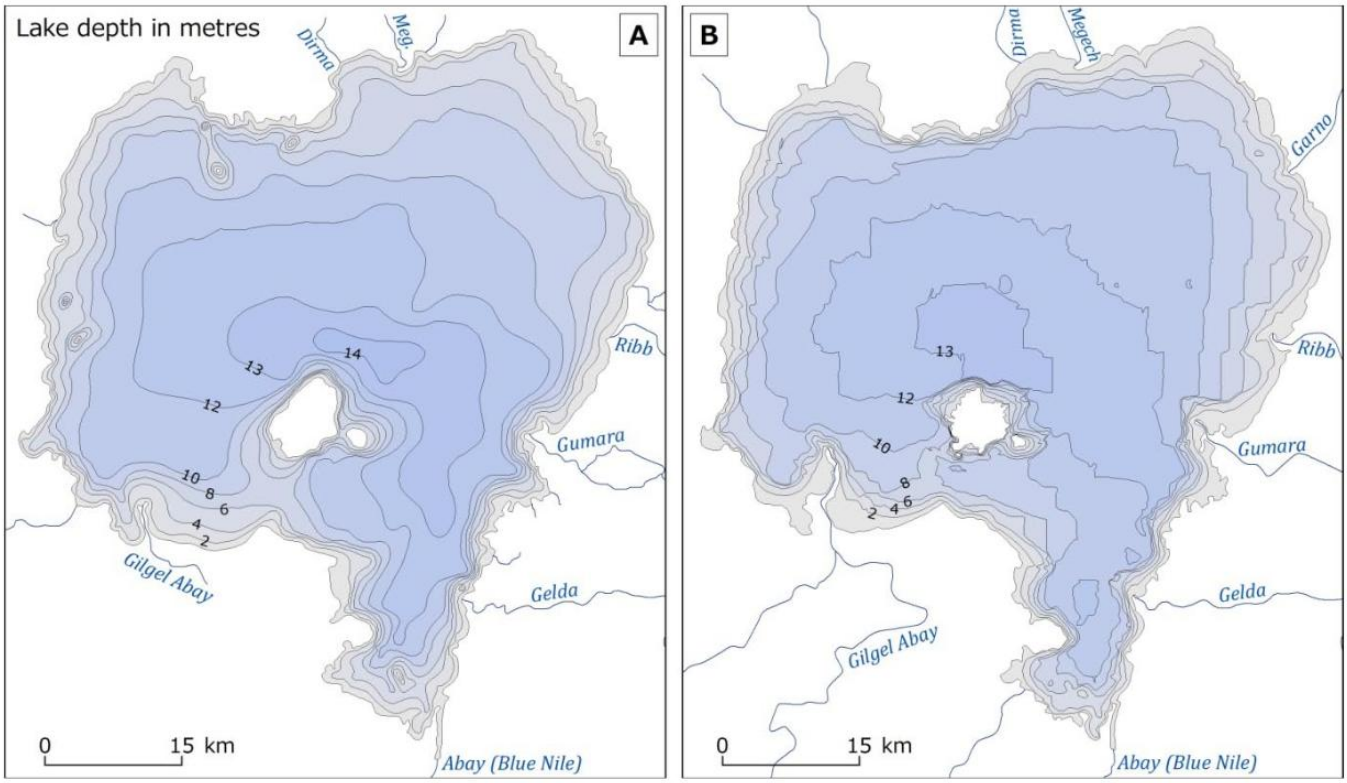

Figure 7: Bathymetric Map of Lake Tana in 1940 (A) and 2007 (B) (from Mundt 2012 - design by Stephan Busse, source of data Kebede et al., 2006 & Wale 2008)

5.2.2. Geology of Ethiopia and Lake Tana region

Dr. Asfawossen Kassaye [2] states that Ethiopia '*is a natural textbook for geological investigation'.* Ethiopia is a country with a broad range of geomorphic regions: A high and rugged mountainous core cut by deep gorges and incised river valleys, fault-bound plateaus and basins, a prominent rift valley that hosts a number of lakes, and bordering plains that range from the harshest of deserts to subtropical jungles. The geologic and tectonic characteristics of Ethiopia are strongly linked to the Ethiopian magma dome and the development of the East African Rift System.

In terms of their surface exposure, the main lithological units of the country have been grouped in:

a) Precambrian metamorphic basement rocks (cover approximately 23% of the surface of Ethiopia);

b) Mesozoic sedimentary rocks (cover approximately 25%);

c) Tertiary volcanic rocks – largely flood basalts (cover approximately 25%); and

[2] Dr. Asfawossen Asrat Kassaye is an Associate Professor of Geochemistry and Petrology at the Department of Earth Sciences at Addis Ababa University. http://www.aau.edu.et/cns/dr-asfawossen-asrat/

d) Quaternary volcanic rocks – largely ignimbrites and sediments (cover approximately 17 %).

The basement rock upon which all the younger formations are desists containing the oldest rocks in the country, the Precambrian which dates back to over 600 million years ago. The Precambrian contains a wide variety of sedimentary, volcanic and intrusive rocks which have been metamorphosed to varying degrees. At the end of the Precambrian uplifting occurred which was followed by a long period of erosion.

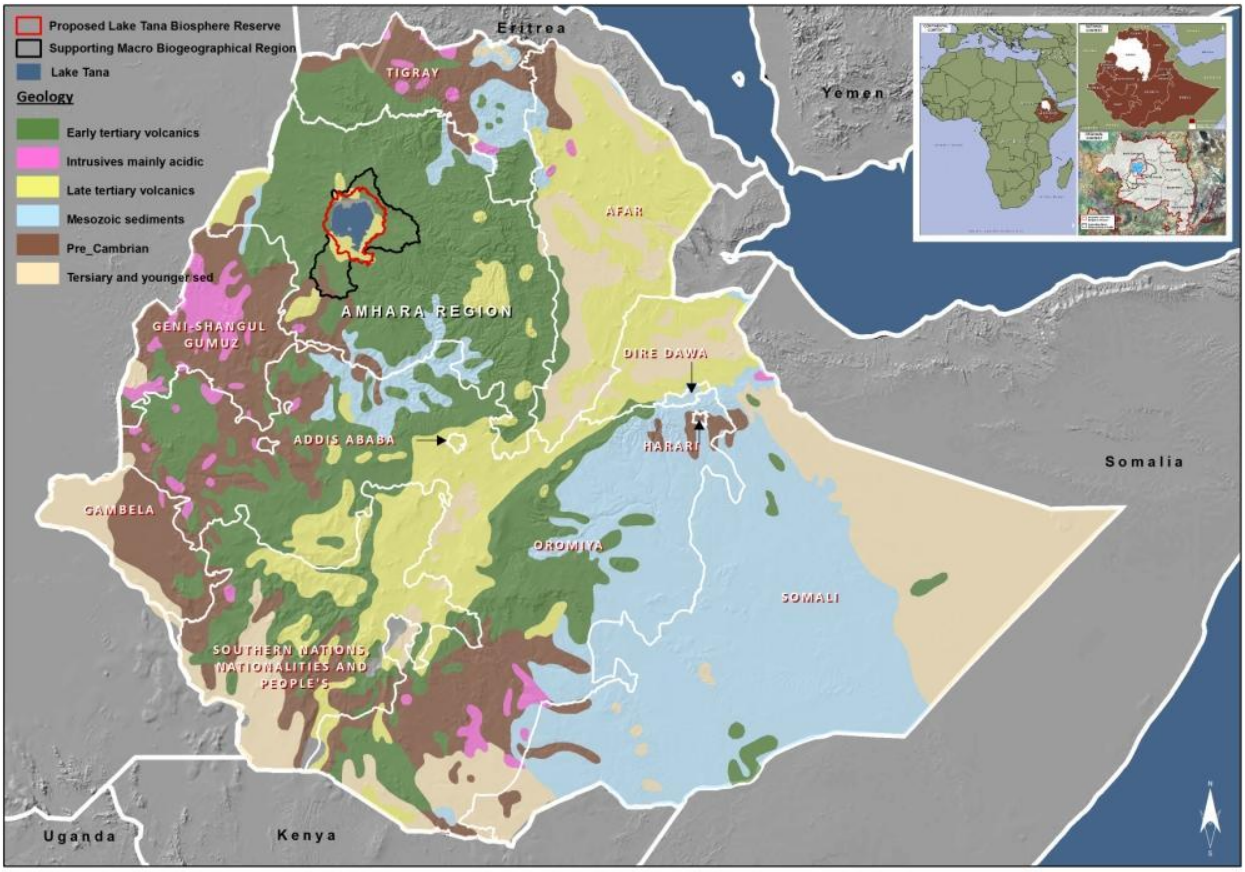

Figure 8: Geology of Ethiopia (Diva-GIS (www.diva.gis.org), MapCruzin (www.mpacruzin.com) and Geocommunity (www.geocomm.com).

Any sediments which were deposited during the Palaeozoic interval, which lasted some 375 million years, have been largely removed by erosion, except for shales and deposits partly of glacial origin laid down in northern Ethiopia towards the end of this period[3].

Conditions changed at the onset of the Mesozoic when shallow seas spread initially over the Ogaden region and then extended further north and west as the land continued to subside. Sand, now sandstone, was deposited on the old land

3 Geological Map of Ethiopia: Kazmin, V. https://sites.google.com/site/linkstogeologyofethiopia/General/kazmin (last accessed 29. August 2017)

surface with the deposition of mudstone and limestone followed as the depth of water increased. Mesozoic rocks are rich in paleontological remains and are considered to have the greatest potential for oil and gas deposits.

The same cycle of sedimentation was repeated again during the Tertiary period ending with the deposition of conglomerates, sandstones and mudstones with some inter-bedded marls, and finally erosion processes occurred as the area underwent more uplifting. Extensive fracturing occurred early in the Cainozoic, the earliest rocks dating back to approximately 65 million years. Major displacement along the fault systems which approximate to the alignment of the Red Sea, Gulf of Aden, and East African rift systems did not occur until later in the Tertiary period. Faulting was accompanied by widespread volcanic activity and the two processes, which are partly related, have largely determined the form of the landscape in the western half of Ethiopia and in the Afar Depression.

Volcanism has persisted into the present time in the Afar region. The youngest sediments in Ethiopia are of Quaternary age and include conglomerates, sand clay and reef limestone. The Cainozoic formations in Ethiopia are of potential economic importance because of their extremely large salt deposits, these include deposits of potassium and magnesium salts. Furthermore, the geothermal activity associated with many of the Cainozoic deposits has given rise to metallic mineral occurrences, copper and manganese in particular, concentrated as a result of leaching of the rocks by saline solutions. Iron ores, and possibly even aluminium ores (bauxite), developed on the volcanic structures.

Hussen (2010) states that the geological framework of the Lake Tana basin comprises a basement of Precambrian bedrock, overlain by Mesozoic sediments, Tertiary volcanic and minor sediments, quaternary volcanic and recent alluvial sediments. Ongoing tectonic activity has controlled the distribution of the rock formations and controlled the current configuration of the basin. The two main geologic and geomorphologic formations in the Lake Tana basin are the Pleistocene to recent alluvial deposits adjacent to the lake and the underlying Tertiary volcanic structures (predominantly basalt and tuffs) forming the surrounding hills.

The alluvial deposits, which form extensive plains on southern, eastern and northern sides of the lake, are comprised predominantly of lacustrine and fluvo-lacustrine sediments, the latter formations generated by streams reworking former lake deposits and the deposition of new materials eroded from the higher ground. Resistant basalts are responsible for the high to mountainous relief of the upper catchment of the Ribb and Gumera Rivers in the eastern part of the basin.

Low relief hills and low plateau features, formed from successive stratification lava flows, are located adjacent to the plains. A transitional foot slope zone, often with shallow alluvium and colluviums overlying the main formation, connects the plains with the surrounding hills (MoWE, 2010).

Furthermore, the Lake Tana basin's location is at the junction of three grabens[4]: The Dengel Ber (buried), Gondar (exposed by erosion), and Debre Tabor (reactivated) (Nadew, 2010). This forms a structural complex that was active during the formation

[4] Graben is a depressed block of land bordered by parallel faults. A graben is the result of a block of land being downthrown producing a valley with a distinct escarpment on each side.

of the mid-Tertiary flood basalt sequence into which the basin is impressed. Analysis of fault and joint patterns and satellite imagery of the Lake Tana basin suggest continuing subsidence accompanied by block tilting within the grabens (Lamb *et al*, 2006).

Lake Tana lies in a large basin formed by structural deformation, erosion, and extrusions of volcanic rocks. It is surrounded by volcanic mountains, comprising primarily basaltic lava flows with associated tuff, trachytic and rhyolitic rock types. The beds northwest of Lake Tana are sedimentary rock formations in the vicinity of the lake comprising mostly siliceous shales, sandstones, lignite beds, and cherty marl. The lake beds have been faulted and tilted, indicating relatively recent movement along the rift (Alemayehu, 2008).

Lake Tana is supposed to be formed by volcanic blocking of rivers, one of them being the Abbay River, in the early Pleistocene times, approximately 5 million years ago. It is assumed that the lava also created the 40m high waterfalls at Tis Issat, separating the Lake Tana and its headwaters from the lower Abbay River basin. The lake owes its present form to damming by a 50km long quaternary basalt flow, which filled the exit channel of the Abbay River to a possible depth of 100m. The age of this lava flow is estimated to be some 10,000 years ago (Mundt, 2012).

Historical records over the last 600 years and recent instrumental observations show that earthquakes in Ethiopia mainly occur in the Afar Depression, the escarpments, and the main Ethiopian Rift Valley. Earthquakes occur from time to time in the Lake Tana area (MoWe, 2010).

5.2.3. Geomorphology and soils of Lake Tana region

Soil erosion [5]is a serious problem in Ethiopia. Human activity has caused major damage to the soil's physical base, to its organic and chemical nutrients, and to the natural vegetation cover. According to Yitaferu (2007) the problems of soil degradation in the Lake Tana basin largely occurs in the form of water erosion and in-situ fertility depletion.

Landscapes extremely prone to erosion-based degradation were identified in areas where the steeply sloping mountain areas of the southern, eastern and northern parts of the basin were used for crop cultivation.

Furthermore, soil degradation in the Lake Tana area is a problem caused by land-use and cover change, land management practices and systems in agriculture and forestry, and by poor infrastructures such as rural roads and animal tracking. Chemical and physical properties of the soils are found to be declining in areas where the land-uses are crop cultivation and grazing (Yitaferu, 2007).

Soils of the lower plain that is characterised by wetlands and floodplains are dominantly vertisols. Cambisols are largely found in the lower plateau which extends from the south-eastern part of Lake Tana to the southern and south-western parts

[5] https://www.britannica.com/science/erosion-geology (last accessed on 21 July 2017)

of the Biosphere Reserve. The soils in this landscape are well-drained, suitable for intensive crop cultivation and less prone to water erosion. Luvisols and eutric cambisols are dominant in the foot slope areas to the northern and north-eastern parts of the Biosphere Reserve whereas the soils in the mountain systems are predominantly dystric nitosols, lithosols and regosols (Yitaferu, 2007).

The soils in most parts of the Biosphere Reserve are derived from the weathered basalt profiles and are highly variable. In the low-lying areas north and east of Lake Tana are alluvial sediments. According to Yohannes (2010) the major soil groups found in the Biosphere Reserve *inter alia* are:

a) **Eutric regosols** (sandy loam to loam excessively drained). Found in small areas of the Gilgel Abbay near Bahir Dar.

b) **Haplic luvisols** (clay to silty clay well drained). Flat and sloping topography on most of the Gilgel Abbay, Ribb, Gumarra and Megeche catchments. In the elevated areas of the Beles.

c) **Chromic luvisols** (clay moderately well to well drained). Flat and sloping topography on most of the Gilgel Abbay, Ribb, Gumarra and Megeche catchments. In the elevated areas of the Beles.

d) **Eutric fluvisols** (silty clay moderately well drained). Mid reaches of the Ribb and Meles catchments.

e) **Haplic nitisols** (silty clay to clay well drained). Highest areas of the eastern Lake Tana basin divide.

f) **Eutric cambisols** (silty clay moderately to deep and well-drained). Limited distribution in the Biosphere Reserve.

g) **Eutric leptosols** (clay loam to clay moderately deep to deep). Highest parts of the eastern and north-eastern catchments of the Biosphere Reserve.

h) **Haplic alisols** (clay favourable drainage). Highest parts of the Gilgel Abbay catchment.

i) **Eutric vertisols** (clay poorly drained). Drainage lines along the Gilgel Abbay Basin.

j) **Lithic leptosols** (loam to clay loam moderately deep to deep drained). Gilgel Abbay basin near Bahir Dar.

5.2.4. Climate of Ethiopia and Lake Tana region

Ethiopia's climate is extremely varied and despite being close to the equator does not follow the typical tropical climate patterns. One of the influences of Ethiopia's climate and weather is the seasonal migration of the *Inter-tropical Convergence Zone* (ITCZ)[6] which affects the rainfall patterns in Ethiopia and East Africa[7].

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[6] It is the area encircling the earth near the equator where the northeast and southeast trade winds come together. Variation in the location of the Inter-tropical Convergence Zone drastically affects rainfall in many equatorial nations, resulting in the wet and dry seasons of the tropics rather than the cold and warm seasons of higher latitudes. Longer term changes in the Inter-tropical Convergence Zone can result in severe droughts or flooding in nearby areas.

[7] http://www.easyethiopiatravel.com/ethiopia-climate-when-to-go.shtml (accessed on 20 September 2013)

Ethiopia has three different climatic zones (Table 11) according to elevation and each zone has its unique features in terms of altitude, rainfall, and temperature (please refer to Chapter 5.2.6 above that illustrate the land cover types of Lake Tana Biosphere Reserve):[8]

Table 2: The three climatic zones in Ethiopia.

Kolla (Tropical Zone – hot and dry)	This zone refers to areas below 1,830m in elevation and has an average annual temperature approximately 27°C with annual rainfall approximately 510mm.
Woyina Dega (Subtropical Zone – warm and wet)	This zone includes the highlands area of 1,830 to 2,440m in elevation which has an average temperature of approximately 22°C degrees with annual rainfall between 510 and 1,530mm. This is most agriculturally productive zone in the country and all the most important crops are grown in this zone. Furthermore, it includes all the remaining high montane forests of Ethiopia.
Dega (Cool Zone)	This zone is above 2,440m in elevation with an average annual temperature of approximately 16 degrees with annual rainfall between 1,270 and 1,280mm.

In addition to these above-mentioned climatic zones, one comes across *Bereha* and *Worch*, both of which refer to Ethiopia's more extreme climatic zones, the first to the desert habitats that border Somalia and Djibouti, and the second to afro-alpine areas above 3,200m[9].

Furthermore, the four seasons of Ethiopia are classified as follows:

- **Summer (Kiremt or Meher):** June, July and August are the summer season, and heavy rain falls in these three months.
- **Spring (Tseday):** September, October and November are the spring season sometimes known as the harvest season.
- **Winter (Bega):** December, January and February are the dry season with frost in the morning, especially in January.
- **Autumn (Belg):** March, April and May are the autumn season with occasional showers. The month of May is regarded the hottest month in Ethiopia.

The climate of the Lake Tana basin is '*tropical highland monsoon*' and of the total annual rainfall, approximately 70% to 90% occurs in the months from June to September (in the *Kiremt* season). The mean annual rainfall is approximately 1,500 mm, and the mean maximum and minimum temperatures of Lake Tana are 29.2°C and 10.9°C respectively (Minale and Rao, 2011).

With a mean depth of only 8 meters, the alternating dry and rainy seasons result in an average difference of 1.5 to 2 meters between the lowest (May-June) and highest (October-November) lake levels. Generally speaking, the southern part of the

[8] http://www.ethiopiantreasures.co.uk/pages/climate.htm - accessed on 20 September 2013.

[9] http://www.journeysbydesign.com/destinations/ethiopia/when-to-go - accessed on 11 November 2013.

Lake Tana basin is wetter that the western and northern parts (Kebede *et al*, 2005). For the period of 1981 to 2010 the mean annual precipitation, mean daily maximum and minimum temperature if the basin is illustrated in the table below.

Table 3: Mean annual precipitation and mean daily maximum and minimum temperatures for the Lake Tana basin in the period 1981 to2010.

Weather Stations around Lake Tana	Maximum Temperature (°C)	Minimum Temperature (°C)	Precipitation (mm per annum)	Evapotranspiration* (mm per annum)
Adet	26.1	10.8	1,252	-
Bahir Dar	26.8	11.8	1,430	2,176
Dabre Tabor	21.8	9.5	1,462	1,790
Dangila	25.3	9.8	1,495	-
Gondar	26.7	13.3	1,092	2,125

*Evapotransporation is the sum of evaporation and plant transpiration from the land surface to the atmosphere. It accounts for the movement of water to the air from sources such as the soil, canopy interception, and water bodies (Source: Nigatu, 2013).

In the Biosphere Reserve the mean monthly wind speed prevailing in the basin is 1.03 m per hour with an average 7.6 sunshine hours per day. The relative monthly temperature decrement is associated with low sunshine hours, high wind speed and relative humidity.

The area is also characterised with mean monthly humidity of 59.3 % which ranges from 40.6 % in February up to 80.05 % in August (Yohannes, 2010).

5.2.5. Meteorological stations and data

In and around the Biosphere Reserve, there are 14 meteorological stations owned by the Ethiopian Meteorological Agency (EMA). EMA is classifying meteorological stations by a station code (Wale, 2008):

1. **Code one (principal stations):** Are stations at which observations are taken every three hours measuring rainfall, relative humidity, maximum and minimum temperatures, wind speed and sunshine duration.
2. **Code two (synoptic stations):** Observations are taken every 24 hours on rainfall, relative humidity, maximum temperature, wind speeds and sunshine duration.
3. **Code three (ordinary stations):** Only daily rainfall and daily maximum and minimum temperatures are observed.
4. **Code four (rainfall recording stations):** These stations only observe rainfall amount.

Table 4: Meteorological stations in the Lake Tana basin (Source: Wale, 2008).

STATION CODE	NAME	LOCATION		ELEVATION ABOVE MEAN SEA LEVEL (m)	STATION CODE
		Latitude	Longitude		
GNADD113	Addis Zemen	12.12	37.87	2,117	3
GNAYKE11	Aykel	12.53	37.05	2,160	1
GNDEBR11	Debre Tabor	11.85	38.01	2,714	1
GNDELG14	Delgi	12.23	37.03	1,865	4
GNENFR13	Enfranz	12.18	37.68	1,889	3
GNGOND12	Gondar	12.55	37.42	2,074	1
GOBAH141	Bahir Dar	11.60	37.42	1,828	1
GODEKE13	Deke Istifanos	11.90	37.27	1,799	2
GODANG11	Dangila	11.26	36.85	2,126	1
GNCHEW14	Chewahit	12.33	37.22	1,889	4
GNGASS13	Gassay	11.80	38.08	2,809	3
GOSEKE14	Sekela	11.00	37.22	2,584	4
GOZEGE13	Zege	11.68	37.32	1,786	3
GOENJA14	Engebara	11.0	36.9	2,580	4

5.2.6. Landcover types of Lake Tana Biosphere Reserve

In the Lake Tana basin, which constitutes large parts of the Biosphere Reserve, it is estimated that approximately 55% of the total land surface is under cultivation, 21.06% is a water area, 10.38% is grassland, 1.6% is under wetland/marshland and approximately 0.33% is natural forest. According to Mundt (2012), the different land-use/land cover types found in the Lake Tana basin are as follows.

Table 5: The different landuse/landcover types found in the Lake Tana basin (Source: Mundt, 2012).

TYPE OF LAND USE/LAND COVER	AREA IN HECTARES	%AGE OF AREA
Cultivated	383,112	54.95%
Water	146,831	21.06%
Grassland	72,369	10.38%
Shrubland	62,399	8.95%
Wetlands, swamps and marshes	11,226	1.60%
Plantation Forest	7,599	1.09%
Rocky outrcrops	3,695	0.53%
Natural forest	2,719	0.39%
Other and Settlements	2,510	0.36%
Woodland	2,161	0.31%
Bare Soil	1,534	0.22%
Afro-alpine	1,046	0.15%
TOTAL	697,201	100

The growing human population goes hand in hand with the growing livestock population[10], whereas the grazing area is limited, and even shrinking due to extended agricultural activities. Excessive deforestation is contributing to the land degradation in the Amhara Region and in the Biosphere Reserve. The forests and woodlands are almost completely converted into arable land and only a few areas are preserved as patches of remnant natural forests, or sometimes only single trees in the midst of agricultural land are left over.

Most of the remnant forest patches are preserved due to their protection by religious institutions (i.e. church forests) whilst others, not affiliated to religious institutions, are removed due to pressure exerted by local people (Mundt, 2012). The Ministry of Water Resources concedes a lack of reliable data on current rates of deforestation in Ethiopia, the Amhara Region, and Lake Tana basin, but several reports at national level estimate a loss of 150,000 to 200,000 ha per year in Ethiopia. Little is known about the approximate deforestation in the Amhara Region.

10 It is estimated that in the Biosphere Reserve, there are approximately 1,520,000 cattle, 340,000 sheep, 316,000 goats, 211,000 equines, 7,124 000 poultry, and 177,000 beehives.

5.2.7. Hydrology at Lake Tana Biosphere Reserve

Lake Tana is the second largest freshwater lake in Africa and accounts for 50% of the total inland water area of Ethiopia. It further feeds the Blue Nile or Abbay River which in turn contributes approximately 85% to the total flow of water in the Nile River. Water is thus the most critical natural resource in the Biosphere Reserve and it is important in ecological and economic terms, and Lake Tana and its water resources are of local and global significance. The importance of the hydrological characteristics is emphasised by the fact that the Ethiopian government has selected Lake Tana as one of the potential '*Growth Corridors*' for development and reducing food insecurity problems (Ketema *et al*, 2011).

The importance of the water resources in the Biosphere Reserve must be considered within the context of Ethiopia's climatic and hydrological setting. According to Mesele (2010), the potential of the water resources in Ethiopia are summarised as follows:

1. Ethiopia is the 'water tower' of Africa;
2. Many of Ethiopia's rivers are transboundary and water availability is highly seasonal with 70% of the total annual runoff is obtained during the period from June to September;
3. Availability of per capita renewable freshwater resources estimated at 1,900m^3;
4. Ethiopia has 12 river basins with an annual runoff volume of 122 billion m^3 of water and estimated 2.6 to 6.5 billion m^3 of groundwater potential;
5. Four river basins; i.e. Baro Akobo, Abbay, Tekeze and Omo-Ghibe account for 80-90 % of the country's water resource;
6. Ethiopia has considerable hydropower potential, approximately 30,000 megawatts (World Bank, 2006); and
7. Ethiopia's irrigation potential is approximately 3.6 million ha, of which only approximately 8% has been developed.

However, due to the large spatial and temporal variations in rainfall and lack of storage, water is often not available where and when needed. It is estimated that only approximately 3% of the water resources are used, of which only approximately 11% (0.3%) is used for domestic water supply. The Lake Tana Biosphere Reserve is the origin of the Blue Nile or Abbay River, and forms part of the Abbay River basin, and the larger *Nile River basin*[11], and consequently plays a critical role in the maintenance of the natural water cycle of East Africa. The overriding objective of water conservation is the management of

11 The Nile River basin comprises ten countries namely, Burundi, Democratic Republic of Congo, Egypt, Eritrea, Ethiopia, Kenya, Rwanda, Sudan, Tanzania and Uganda. These countries are known as the ten riparian countries due to their proximity to the Nile River basins.

the catchment areas so as to maintain an optimal sustainable yield of high quality water. Maintenance of water yield entails ensuring the capacity of a catchment area to yield water at historical flow rates.

Land-use patterns largely influence the maintenance of water yields. Interference with the natural conditions in the catchment areas, e.g. draining, cultivating areas such as wetlands, seepage areas, marshes, riparian areas, over-exploitation of natural vegetation (e.g. harvesting of papyrus) and the uncontrolled deforestation to clear land for agricultural practices is detrimental to the proper functioning of a catchment system.

The quality of the water draining to river systems of the region is increasingly being threatened by large scale erosion. It is estimated that in the highlands of the Abbay River basin, soil loss in areas cultivated through traditional practices amount to 122-128 tonnes per hectare per year. The erosive effects of rainfall are significantly augmented by Ethiopia's severe deforestation, its mountainous terrain and traditional agricultural practices of cultivating steep slopes without protective measures. The loss of forest cover, in turn, is generally associated with greater hydrological variability. Ethiopia's high-intensity storms cause significant erosion, especially at the beginning of the season when the soil is dry (World Bank, 2006).

According to Setegn *et al* (2009), the Lake Tana basin is one the most affected areas of soil erosion, sediment transport and land degradation. The land and water resources of the basin and Lake Tana ecosystem are in danger due to population growth, deforestation and overgrazing, soil erosion, sediment deposition, storage capacity reduction, drainage and water logging, flooding, pollutant transport, and overexploitation of specific fish species. It is therefore paramount that site-specific adapted land use practices, particularly as it relates to subsistence farming, are promoted in especially highland catchment areas.

Due to Ethiopia's proximity to the equator and high altitude that rises above the surrounding regions, the upper catchments of the Ethiopian river basins have high rainfall, so much so that it is in excess of evaporation and seepage resulting in surface runoff that cascades to the surrounding lowland in all directions. The complex interaction between the climate, biophysical and socio-economic characteristics of Ethiopia resulted in important features of the basins such as high level of spatial and temporal variability of flow, enormous turbidity, and tremendous potential for hydropower in the highlands and irrigation in the lowlands and sceneries along the major gorges.

Water resource management and development in Ethiopia is governed by the Water Resources Management Policy and its implementation strategy, the Water Resources Management Proclamation. In an attempt to reach the Millennium Development Goals, the Federal Government has devolved decision-making process, planning and implementation of social and economic activities down to the local levels.

Although the Federal Government has taken great strides in restructuring the water institutions with the objective of bringing approximately efficiency, effectiveness, linkages, coordination and collaboration, effective coordination among stakeholders is still lacking and needs to be improved.

As mentioned before, Ethiopia has been divided into 12 river basins which includes one lake basin and three dry basins with no or insignificant outflow. The Biosphere Reserve falls within the Abbay River Basin (refer to the figure below).

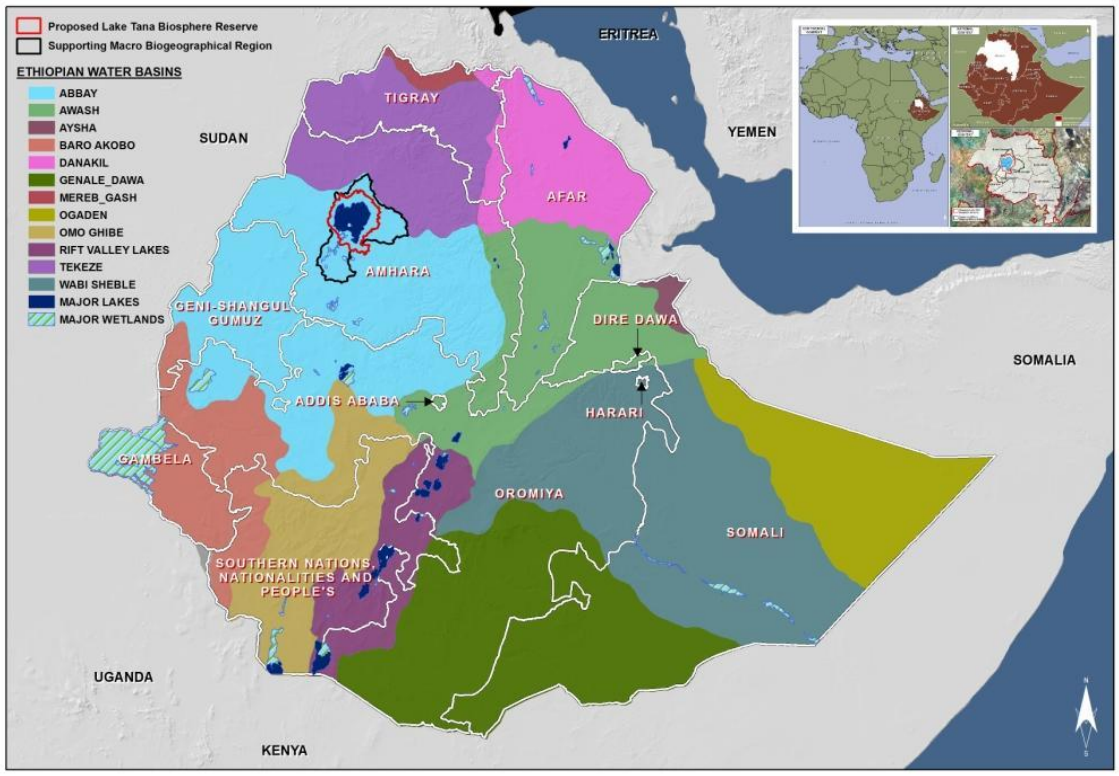

Figure 9: The Biosphere Reserve in context of Ethiopia's 12 River Basins Diva-GIS (www.diva.gis.org), MapCruzin (www.mpacruzin.com) and Geocommunity (www.geocomm.com)

5.2.8. Primary water resources at Lake Tana Biosphere Reserve

a. Lake Tana

Lake Tana occupies a wide depression in the Ethiopian plateau. This freshwater lake is shallow, was originally oligotrophic[12] (nowadays eutrophic) with weak seasonal stratification (Kebede *et al*, 2005). The Lake Tana basin has a total catchment area of 15,319 km^2 and Lake Tana itself is approximately 3,156 km^2 in area. The lake is approximately 84 km long, 66 km wide and has got a total water volume of 28,000 million cubic meters. It is regarded as a high altitude lake because it is situated at

12 An oligotrophic lake is a lake with low primary productivity, the result of low nutrient content. These lakes have low algal production, and consequently, often have very clear waters, with high drinking-water quality. The bottom waters of such lakes typically have ample oxygen, thus, such lakes often support many fish species,.

approximately 1,800 m above sea level, and has an average depth of 9m with a maximum of 14m; however it is comparatively shallow with a shoreline length of approximately 385km (Mundt, 2012).

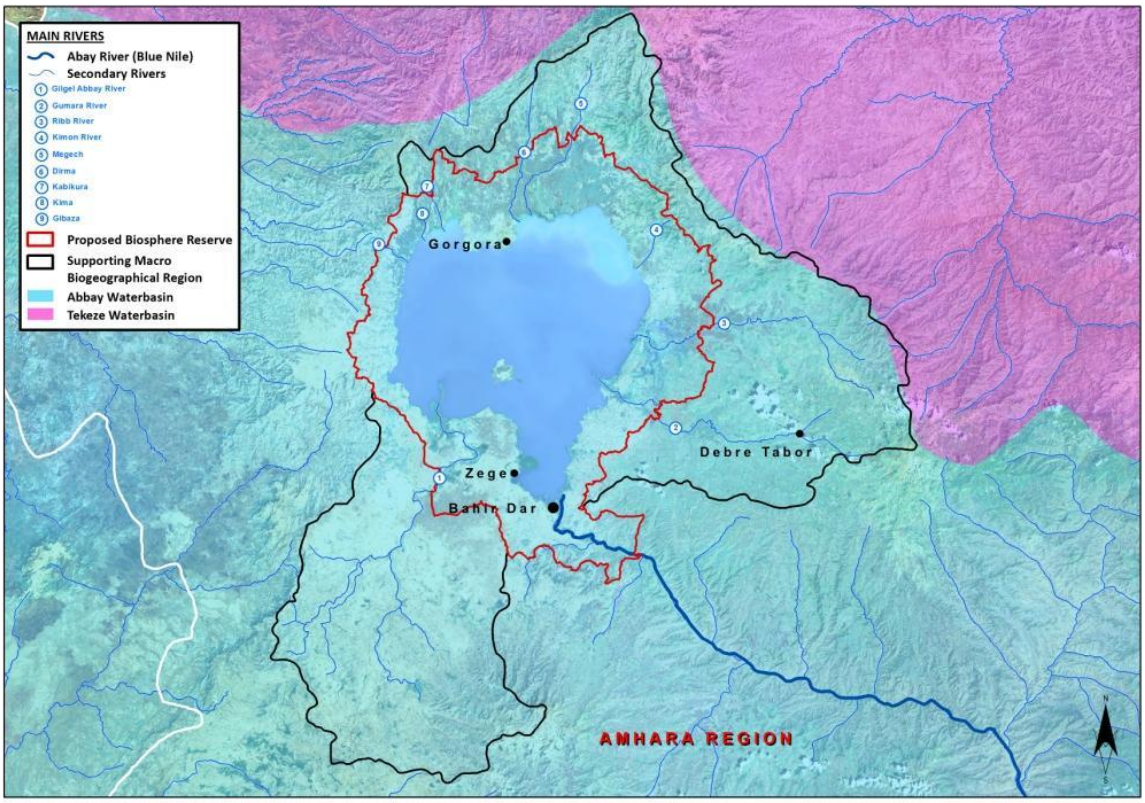

Figure 10: Primary water resources in the Biosphere Reserve Diva-GIS (www.diva.gis.org), MapCruzin (www.mpacruzin.com) and Geocommunity (www.geocomm.com).

According to MoWE (2010), the ecologically of Lake Tana can be categorised into three zones based on light penetration and distribution of life forms in the lake. These are the pelagic, sub-littoral and littoral zones:

a) **Pelagic zone**: this is the relatively deep water zone occupying approximately 70% of the lake area, with water depths of 8 to 14 m. Below 8m, light penetration and primary production are greatly reduced, and fish feed on dead and decaying matter.

b) **Sub-littoral zone**: This zone covers approximately 20% the lake area with water depths of 4 to 8m. The open water is penetrated by light and harbours phytoplankton and zooplankton, but no macrophytes (i.e. aquatic plants).

c) **Littoral zone:** The shallow littoral zone (water depth 0 to 4m) is relatively small, covering approximately 10% of the total surface area of the lake. Macrophytes are common in this highly productive zone, with swamps, lakeshore wetlands and river estuaries providing excellent habitat for fish, birds and other wildlife. Historically, the littoral was dominated by papyrus reed (*Cyperus papyrus*), common cattail (*Typha latifolia*) and common reed (*Phragmites*

karka), with *Persica senegalensis, Vossia* spp., bulrush (*Scirpus* spp.) and *Nymphea lotus* common. However, the extent of the papyrus beds has fallen dramatically in recent years and now it only remains in a few protected pockets, mainly on the southern shores of the lake, and specifically in the Chimba and Yiganda wetlands near and along the Gilgel Abbay River.

The lake is fed by four major perennial tributaries, however, altogether 61 streams flow into the lake (Mundt, 2012). Approximately 95% of the inflow into Lake Tana is contributed by the Gilgel Abbay (Little Nile River), Gumara, Ribb and Megech Rivers, and the Blue Nile or Abbay is the only natural outflow from the lake. Mundt (2012) states that Lake Tana plays a vital role in maintaining the hydraulics of downstream channels by acting as an 'emergency reservoir'.

Ketema (2011) found that Lake Tana is an important source of fish for the people living around the lake, and elsewhere in the country. Its unique and isolated landscape includes forested islands, immense and varied wetlands and high mountain areas. The region is renowned for its biodiversity, and 90% of the area's rapidly growing population depends on subsistence agriculture for their livelihoods. The productivity and sustainability of mixed farming practices depend on ecosystem goods and services, which rely on the functional integrity of the watershed's ecosystems – rivers, wetlands, lake, forests, pastures and soils.

b. River systems

The primary river systems and/or basins which fall within the Biosphere Reserve, and that flow into Lake Tana include the Gilgel Abbay River System, the Gumera River System, Megech River System, and Ribb River System (refer to the Table 5 below). The area furthermore comprises an array of streams and their associated sub-quaternary catchments and subterranean aquifers.

Table 6: Primary river systems in the Biosphere Reserve and that flow into Lake Tana.

RIVER SYSTEM	DESCRIPTION
Gilgel Abbay	It is the largest and longest river catchment in the southern part of the Biosphere reserve which drains from the highland plateau and covers an area of 4,649km^2. It has a mean annual discharge of 53.02m^3 per second. It provides approximately 60% of the water flow into Lake Tana. The catchment includes the two-gauged sub-catchments, namely the Upper Gilgel Abbay (1,654km^2) and Koga (307km^2). The dominant land-uses in this catchment are approximately 65% agriculture, and approximately 33% agro-pastoral activities (Uhlenbrook *et al*, 2010).
Gumera	The Gumera catchment covers an area of 1,394km^2 and has a mean annual discharge of 35.1m^3 per second. This catchment is of critical national significance as it has great potential for irrigation for high value crops and livestock production.
Megech	It covers an area of 462 km^2 and has a relative low mean annual discharge of 6.5 m^3 per second. It flows into Lake Tana from the north and the river originates near the Simien Mountains Park at an altitude of 3,500-4,000 meters above sea level.
Ribb	This catchment covers an area of 1,592km^2 and drains from the highlands of Mount Guna flows southeast towards the lake. It has a mean annual discharge of 15.4 m^3 per second. The Ribb River drains the western side of Mount Guna and sometimes completely dries up in the dry season. In its lower reach, the Ribb River traverses into the Fogera Plain, a very low gradient floodplain subject to annual floods, sediment deposition and river channel changes.

The only surface outflow of Lake Tana is the Abbay or Blue Nile. The '*sacred source*' of the river is generally considered to be a small spring at Gish Abbay, situated at an altitude of approximately 2,744m above sea level. This stream, known as the Lesser Abby, flows north into Lake Tana. From the Lake Tana the river flows south and then west across Ethiopia, and northwest into Sudan. Approximately 30 km south from the source at Lake Tana, the river enters a canyon approximately 400km long. This canyon gorge is a tremendous obstacle for travel and communication from the northern half of Ethiopia to the southern half. At approximately 40km from Lake Tana is the Tis Issat Falls. The Blue Nile has a total length of 1,450km of which 800 km are inside Ethiopia. The Abbay River basin covers approximately 196,770 km^2 (excluding Lake Tana) draining areas of Amhara (9 Zones), Oromia (6 Zones) and Benshangul-Gumuz regions.

Figure 11: The start of the Blue Nile River from Lake Tana that flows past Bahir Dar (Photo: DMP, 2014).

c. Wetland systems

The lake is bordered by low plains in the north (Dembia), east (Fogera) and southwest (Kunzila) that are often flooded in the rainy season and by steep rocks in the west and northwest. Wetlands are located all around the lake, with the exception of the northeast, and together they are the largest in the country and integral parts of the complex Tana-ecosystem.

They consist of permanent swamps, seasonal swamps, and areas subject to inundation (EWNRA, 2008). Lake Tana and its associated wetlands are part of the *Central Ethiopian Wetland Complex*, and include (zur Heide, 2012):

1. Lake Tana;
2. Fogera floodplains;
3. Dembia floodplains;
4. Dangela and the surrounding wetlands;
5. Bahir Dar Zuria; and
6. Kunzula.

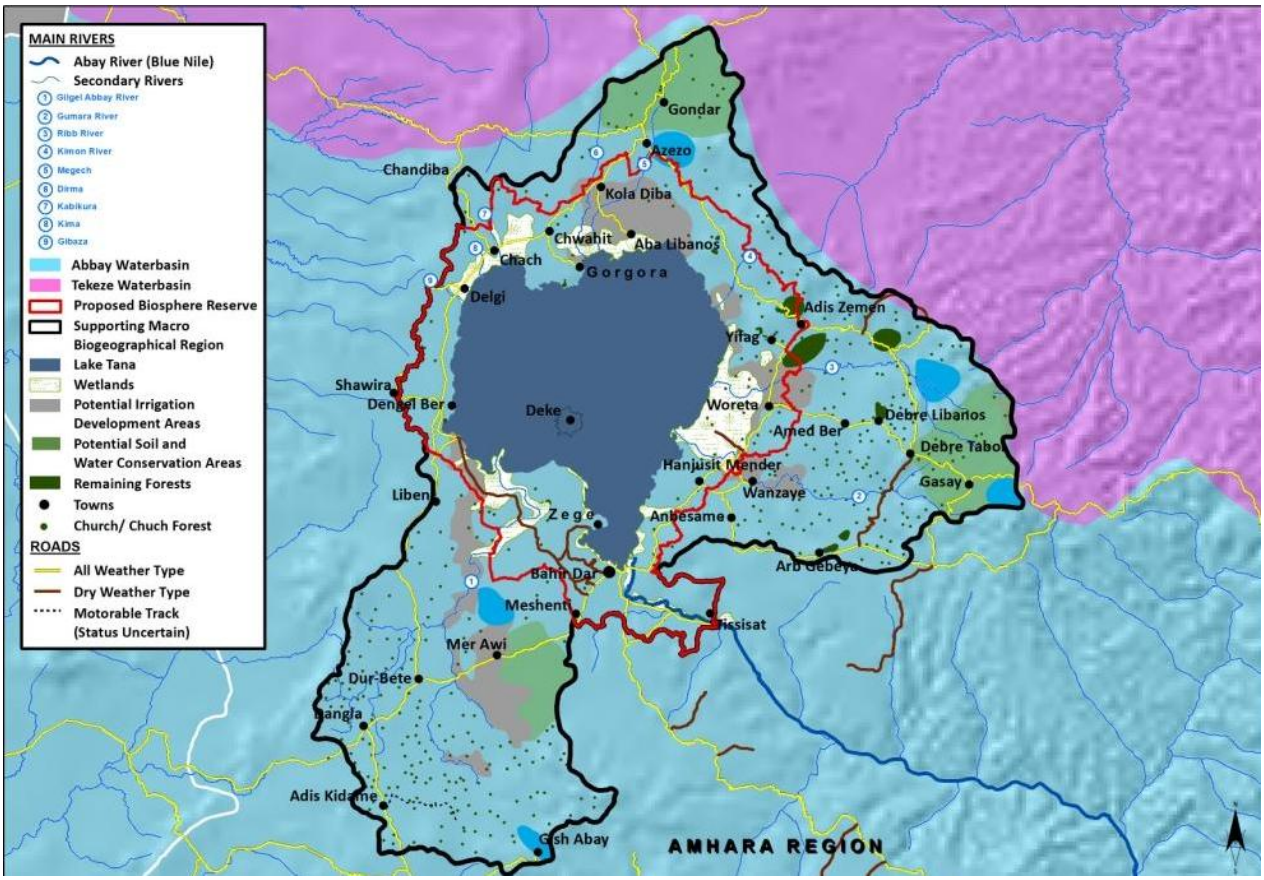

Figure 12: Wetlands, rivers, remaining forests and other important areas in the Lake Tana Biosphere Reserve Diva-GIS (www.diva.gis.org), MapCruzin (www.mpacruzin.com) and Geocommunity (www.geocomm.com).

Approximately 8 of the 15 *Labeobarbus* species and three other commercially important fish species, the Nile Tilapia (*Oreochromis niloticus*), African Catfish (*Clarias gariepinus*) and Beso (*Varicorhinus beso*), spawn in the wetlands and their juveniles feed and grow here during the first years of their life. The littoral region of the eastern and southern part of the lake is dominated by Papyrus Reed (*Cyperus papyrus*), Bulrush (*Typha latifolia*) and Common Reed (*Phragmites karaka*), whereas *Persicaria senegalensis*, Hippo Grass (*Vossia* spp.), Bulrush (*Scrirpus* spp.) and *Nymphea lotus* are also common (Muluneh, 2005). In the open water of the inshore zone, *Ceratophyllum demersum* and *Vallisneria spiralis* are the most abundant species

These wetlands during the rainy period are connected with the lake and besides acting as nurseries for most of the fish populations in the lake, they serve as breeding ground for water fowl and mammals. The wetlands are important resources that supply essential raw materials as fire wood, common reeds and papyrus. When the lake level drops during the dry season, hundreds of km^2 of the lake bottom become available for agriculture and are used by the farmers to grow crops. These wetlands have water for approximately 4 months, and it is the country's largest rice production area.

Within the Lake Tana region four major wetland ecosystems are classified (zur Heide, 2012):

a) **Riverine freshwater wetlands:** These wetlands include all permanent and seasonal rivers and streams, and their inland deltas and floodplains. There are seven large permanent rivers and more than 40 small seasonal rivers which induce their water into the lake by different geomorphological processes. As a result of different climatic seasons, flooding occur in the rainy season corresponding with a high input of alluvial soils mixed with nutrients and massive sediment accumulations along the river beds. Of the riverine freshwater wetlands, the Gilgel Abbay, Gumara, Rib and Megech Rivers are frequently perturbed by such dynamic processes at their lower reaches. All these permanent and seasonal feeder rivers and streams are ecologically significant in providing habitats as breeding and spawning grounds for riverine migrating fish species, especially endemic fish stock. Generally, the various riverine freshwater wetlands are important ecological units in conserving biodiversity because of their natural dynamics.

b) **Lacustrine freshwater wetlands:** The entire water body of Lake Tana can be classified as a lacustrine freshwater wetland. With regard to limnology, the ecological areas of the lakes are divided into litterol, sub-litterol and pelagic zones, based on light penetration. All these zones are interlinked and provide habitats for the various fish stocks and other aquatic lives.

c) **Palustrine freshwater wetlands:** These wetlands include permanently or seasonally flooded freshwater marshes and swamps growing on inorganic soils. The various palustrine wetland ecosystems, located on-shore and off-shore of the lake and rivers and streams, are among the valuable ecological units that conserve important genetic resources and biodiversity species. The various vegetated wetlands have important ecological linkages between the water realms of the lake and terrestrial lands and hence require their joint management as they perform keystone ecosystem functions in reducing point and non-point source pollutants, regulating flood velocity, providing important habitats for waterfowls and breeding and spawning grounds for fish species. The various natural and near-natural palustrine freshwater swamp wetlands are ecologically significant in conserving the water-tolerant vegetation communities of the *Cyperus papyrus-Typhae latifola.*

d) **Agricultural flooded freshwater wetlands:** This refers mainly to the seasonal Fogera floodplains which are located east of Lake Tana and span an estimated size of 28,000 ha. These wetlands have been part of the lake, but during the pluvial period they have been changed into the present land forms due to high sediment loads, eroded by inflowing rivers to Lake Tana. The Ribb River is the most important river that overflows its banks to form seasonal wetlands. The habitat structure of the flooded wetlands includes both semi-natural and arable wetlands which are critically important in agro-biodiversity and wild diversity conservation. The Fogera floodplain is utilised for rice cultivation and threatens the biodiversity of the area. Furthermore, the Fogera floodplain provides habitats for wildlife species, especially for waterfowls and seasonally migrating fish stocks for spawning. The ecological significance of this area is manifested by its international recognition as an Important Bird Area for its support of globally threatened bird species. However, this area is threatened by ecological degradation stemming from drainage and channelling, invasion by alien species and farmland expansion.

The recognition of the essential roles that wetlands play for ecosystem integrity as well as for creating various direct and indirect socio-economic benefits should have the following policy implications (zur Heide, 2012):

1. Wetlands are assets whose values in their natural state should be recognised and valorised;
2. The benefits of wetlands derive from both their ecological functions and the socio-economic values, and the products they produce;
3. The various ethnic groups in the Biosphere Reserve benefit differently from wetlands depending on whether the wetlands are in their natural state or converted by drainage;
4. The conversion of wetlands by complete drainage reduces the overall range of benefits produced by wetlands and involves a trade-off of benefits, with some gains and some losses;
5. Wetlands are often degraded in terms of their hydrological, pedological and biodiversity characteristics by conversion and end-up as rough grazing areas;
6. The protection and re-establishment of wetlands in valley bottoms contribute to flood control, reduction of stream flow and buffering and filtering of pollutants and sediments (siltation);
7. The conversion of wetlands into arable land has to be evaluated against the loss in social and ecological benefits;
8. The role of wetlands in climate regulation, adaptation and mitigation and the impacts of climate change on wetlands have to be recognised; and
9. The conservation and wise use of wetlands have to be designed to contribute to climate mitigation and adaptation.

The following measures are recommended in the Biosphere Reserve for the conservation and wise utilisation of the wetland resources (zur Heide, 2012):

1. Raising awareness in the local communities of the wise use and ecological benefits of wetlands;
2. Implementing water conservation activities for the soil erosion control;
3. Controlling of livestock grazing (i.e. reduction of free grazing), crop production and *Eucalyptus* plantations;
4. Reduce the excessive use of papyrus;
5. Extending area closures, reforestation, planting different tree and grass species;
6. Developing water springs; and
7. Improving livestock breeds to reduce the ever-increasing stock number.

The Biosphere Reserve will promote an all-embracing approach towards wetland management where the sustainable development challenge is addressed in an integrated and holistic manner. The Biosphere Reserve will provide the appropriate platform for all concerned stakeholders to, in an organised manner, work together, think carefully approximately the potential and problems of their region, and in particularly the wetlands, and take actions agreed upon by all concerned.

d. Impoundments and water supply schemes

As indicated by zur Heide (2012), the vast water resources of the Biosphere Reserve are not efficiently utilised with only 30% of the total population having access to potable water aggravating the occurrence of water-borne diseases. It is estimated that the Lake Tana basin has a total of 1,946 water sources for domestic use, of which 1,135 (58.3%) are hand-dug wells, 735 (37.8%) are springs, 63 (3.2%) are shallow wells, and 13 (0.7%) are boreholes. The Lake Tana catchment area has a significant share of the country's irrigation and hydropower potential with an estimated irrigation potential of 250,200ha, of which currently only 4% is used. Therefore, most of the food and cash crops are produced from a single rainfall season. This results in that farmers are enforced to expand their cropland to marginal land in order to produce adequate amounts for their subsistence.

MacCartney *et al* (2010) states that of the estimated 517,500ha cultivated in the Biosphere Reserve, traditional small-scale irrigation is practised on only a small fraction (i.e. approximately 500ha). The following water development projects have so far been constructed in the Biosphere Reserve (MacCartney, 2010):

- In 1964, the Ethiopian Electricity Light and Power Authority (EELPA) constructed a hydropower plant at Tis Abbay (i.e. Tis Abbay-I). Located close to Tis Issat Falls, the station was initially used to provide electricity for a textile factory and for domestic supply to Bahir Dar. The installed capacity of the power plant is 11.4 Megawatts and it originally relied entirely on the diversion of the natural flow of the river.

- In 1996, a dam was completed to regulate the outflow from Lake Tana with two gates with each having a capacity of $70m^3s^{-1}$. In 2001, an additional five gates were added with each gate also having a capacity of $70m^3s^{-1}$. A second hydropower station (i.e. Tis Abbay-II) was added at the same time with an installed capacity of 72 Megawatts, 100m downstream of Tis Abbay-I.

- The Chara Chara weir regulates water storage in Lake Tana over a 3m range of water levels from 1,784 meters above sea level to 1,787 meters above sea level.

These ongoing water development interventions have implications for the hydrological regime and consequently for ecosystems (Zur Heide, 2012). The following environmental stresses may occur due to the planned and/or constructed water use and water infrastructure systems such as the Chara weir and the Tana-Beles tunnel:

- The Tana-Beles tunnel diverts approximately 2,985 Mm^3 of water, and it is estimated that the mean annual water level of Lake Tana will be lowered by 0.33m and the average surface area of the lake will decrease by approximately 2,300ha. This is likely to have significant impacts on the ecology of the lake.

- The increased application of fertilisers due to the increase of areas under irrigation in combination with the degradation of wetlands is likely to further negatively affect the quality of the lake water, seriously affecting all aspects of the lake ecosystem and consequently the fishing industry.

- Large-scale irrigation schemes will modify the wetlands of Lake Tana by changing the hydrological regimes, and the sensitive flora and fauna adapted to the wetlands. The huge eco-tourism potential (e.g. bird watching), the fisheries resources and the papyrus stocks for construction could be severely impacted.

- Massive irrigation schemes constructed at Lake Victoria, Lake Chad and the Aral Sea provide valuable lessons to the planned interventions at Lake Tana since these above-mentioned water bodies are regarded as examples where the over-exploitation of water resources destroyed the regional ecology with severe consequences.

It should be noted that the Biosphere Reserve provides a platform whereby planned and existing irrigation schemes could be managed in a sustainable manner to limit negative impacts to the water ecology and natural ecology of the rivers, wetlands and the lake itself.

Currently large irrigation dams along the tributaries of Lake Tana are being constructed and/or planned which are at the core of Ethiopia's plans for economic development. The Koga irrigation project, Megech pump scheme, and Ribb irrigation scheme are under construction. Furthermore, the Seraba pump and Robit pump irrigation schemes are also under construction which will provide 5,254ha and 6,000ha of land under irrigation, respectively.

Table 7: Irrigation development in the Lake Tana basin (Source: MacCartney, 2010, and zur Heide, 2012).

Irrigation Scheme	Irrigable area (ha)	Estimated annual gross water demand (Mm^3)	Estimated net water demand (Mm^3)	Large dam storage (Mm^3)	Stage of development
Gilgel Abbay	12,852	104-142	88-121	563	Feasibility study done
Gumara A	14,000	115	98	59.7	Feasibility study done
Ribb	19,925	172-220	146-187	233.7	Construction commenced
Megech	7,300	63-98	54-83	181.9	Construction commenced
Jema	7,800	57	48	173	Feasibility study
Koga	6,000	62	52	78.5	Under construction
Northeast Lake Tana	5,745	50-62	43-53	Withdrawals from the lake	Pre-feasibility studies done
Northwest Lake Tana	6,720	54	46	Withdrawals from the lake	Identification
Southwest Lake Tana	5,132	42	36	Withdrawals from the lake	Identification

The following recommendations are provided for the design and implementation of water development in the Biosphere Reserve (zur Heide, 2012):

1. Valorisation of fragile ecosystems that are perceived as not vital and compared with expected benefits from water development investments;
2. Avoiding the use of external inputs that create further dependence and pollute the late, and instead promote the local modes of nutrient recycling (e.g. composting);
3. Maintaining and managing those wetlands that are important for buffering pollution and siltation;
4. Support and promote sustainable agriculture; and
5. Strengthen the enforcement of environmental impact assessments.

5.2.9. Biological characteristics – main habitat types of Lake Tana Biosphere Reserve

Naturally, a vast diversity of ecosystems and vegetation types in the biosphere reserve would occur. Apart from scattered agro-pastoral lands in the middle ranges of the mountains (approx. 1800 – 2500 m asl) which have been cultivated for thousands of years, the area mainly used to be covered by forests. Wetlands and (papyrus-) swamps occurred extensively around the lake. Some bare and rocky parts in the Western part of the area were natural as well.

The natural forest type of Lake Tana Region is a Dry Evergreen Afromontane Forest with characteristic trees such as *Juniperus procera, Podocarpus falcatus, Croton* sp.*, Olea sp.,* and *Ficus* sp. 460 woody plants have been recorded (Friis et al. 2011). In the lower and more humid parts around Lake Tana, a Combretia Terminalia Woodland amongst Freshwater Marches and Swamps, Floodplains and typical lake shore vegetation would occur, while along the affluents of Lake Tana typical riverine vegetation is found.

According to Mundt (2012), due to deforestation activities not much is left of the pristine vegetation in the Biosphere Reserve, and only few reports approximately the wetland vegetation within the Lake Tana basin have been prepared. Furthermore, there is a lack of detailed information on the classification of the different vegetation types/habitat occurring in and around the Biosphere Reserve. In this regard, reference is made to the statement of the Institute of Biodiversity Conservation (2005) that '*attempts to identify or classify habitat types and its associated vegetation types have been limited or nonexistent thus far*'. Further research on this regard will be a function of the Biosphere Reserve.

However, for the purpose of this application the description of the habitat types and associated species that occur *in situ* within the core and buffer areas is adequate. It is reiterated that a number of highly conservation worthy vegetation types and habitats occur, the most notable of which are the following (Mundt, 2012):

1. **Afroalpine and Subafroalpine Habitat Type:** This habitat type is found on mountains between 3,200 and 4,620 m mean above sea level, and only limited areas of the Biosphere Reserve fall under this habitat type – mostly on the periphery where the topography is high. The original afroalpine and subafroalpine natural communities are now restricted almost entirely to scattered and not easily accessible areas which are surrounded and isolated by agricultural areas. Many of the natural faunal and floral resources are threatened due to severe encroachment by human and domestic animals.

2. **Aquatic Habitat Type:** The Biosphere Reserve includes Lake Tana which includes the only remaining stock for Barbus flock in the world and also an important fishing resource for Ethiopia. This aquatic habitat type serves as a feeding site for large number of resident and migrant birds, and reptiles like the Hippopotamus. Threats to this ecosystem include: pollution, the introduction of exotic species, over-exploitation of fish stocks, damming and diversion of rivers and indirect influences such as the removal of vegetation cover of drainage basins for agriculture. Conservation efforts directed to the aquatic ecosystems of Ethiopia are very limited. In the light of environmental and sustainable development, no significant work has been done on the Aquatic Habitat Type (CBD, 2009).

3. ***Combretum-Terminalia* Woodland Habitat Type**: This drought resistance vegetation type can be found between 500 and 1,900 m mean above sea level and is characterised by small to moderate-sized trees with broad leaves, often deciduous. Indiscriminate fire, settlement/resettlement of people, overgrazing by domestic livestock and inappropriate agricultural investment practices are the major threats to this ecosystem.

4. **Wetland Habitat Type**: Lake Tana is surrounded by internationally-recognised and very important wetland systems which include swamps, marshes, and floodplains. These wetlands in the Biosphere Reserve support a wealth of flora and fauna, including many endemic plant species and several of Ethiopia's endemic or near endemic birds. According to CBD (2009) wetlands are basically assumed to be less important than any other irrespective of the many services they provide, and are regarded as 'free goods'. Threats to these ecosystems include conversion to agricultural land, over-utilisation, pollution, unregulated management, siltation, improper irrigation and construction of dams.

From a species diversity perspective, a wealth of plant, animal, bird, fish and invertebrate species occur in the Biosphere Reserve. According to Birdlife International (2013)[13], the area of the proposed Biosphere Reserve (i.e. Lake Tana and the wetlands) is internationally recognised as an *International Bird Area* for their bird diversity and the importance as a roosting site for migratory birds such as the Common Crane (*Grus Grus*), Northern Shoveller (*Anas clypeata*) etc., and it provides a habitat (i.e. roosting, feeding and breeding) for several endangered/endemic species such as the Lesser Flamingo (*Phoenicopterus minor*), Rouget's Rail (*Rougetius rougetii*) etc. Mundt (2012) states that Lake Tana can hold much more than 100,000 wetland birds during the migratory season.

The Biosphere Reserve will contribute to the preservation of these wetland habitats without which a number of bird species cannot exist – 'if those wetlands would be lost many species would lose habitats essential to survive (Mundt, 2012)', and will give practical effect to promote Lake Tana as a Ramsar site.

[13] BirdLife International, 2013: Important Bird Areas factsheet: Bahir Dar – Lake Tana – accessed on 19 November 2013. http://www.birdlife.org

5.4 The three zones of Lake Tana Biosphere Reserve

The boundaries of the core areas and buffer areas as illustrated by the Biosphere Reserve Plan (refer to Annexure 1) were determined in terms of the Statutory Framework of the World Network of Biosphere Reserves (1995). Figure 4 below is a larger-scale copy of the Biosphere Reserve Plan.

Ecological considerations that informed the delimitation of the core and buffer areas include the following:

a) Incorporation of entire ecosystems;

b) Comprising large enough tracts of conservation-worthy areas to provide a sufficiently large gene pool for ensuring the survival of indigenous species and their habitats; and

c) Accommodating the natural processes essential for the maintenance of these habitats, without interference by humans.

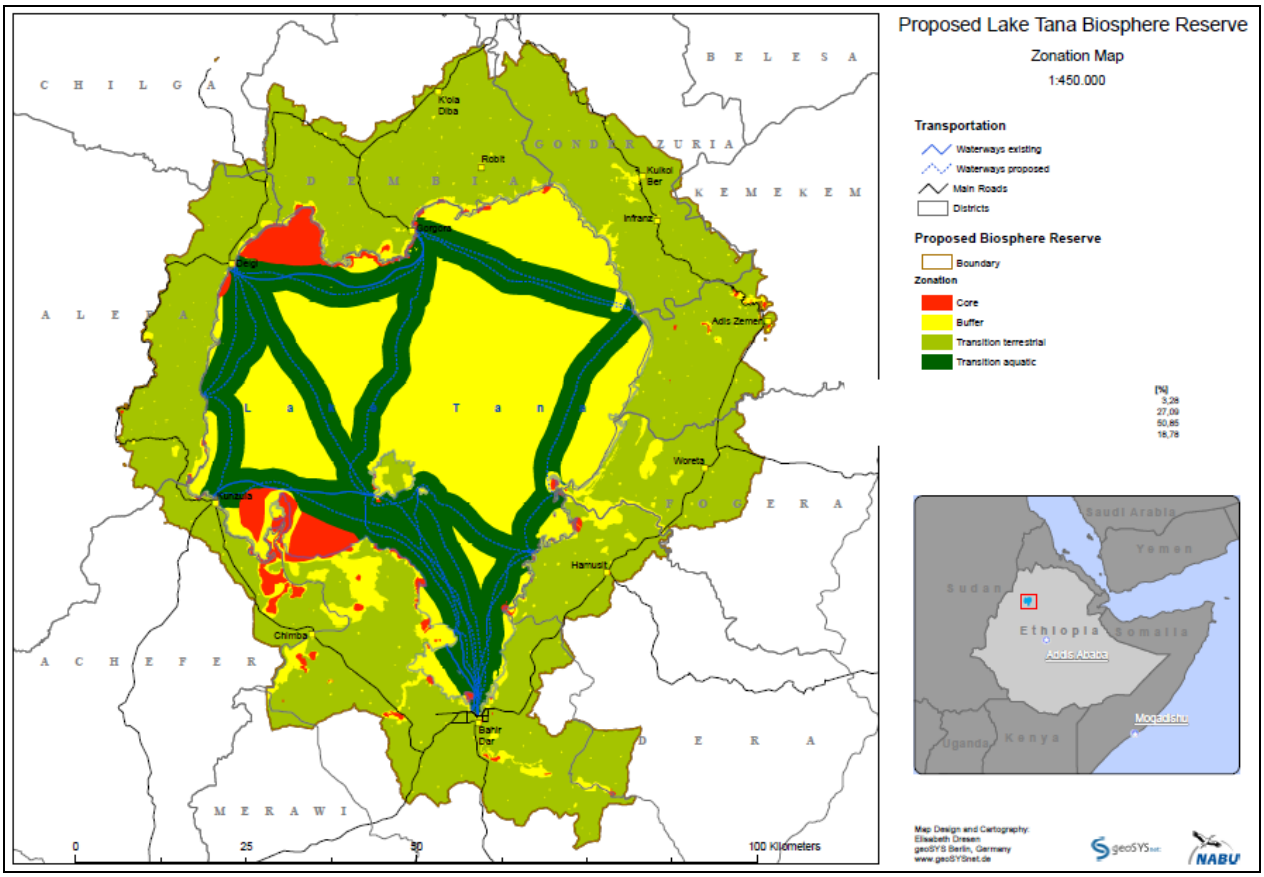

Figure 13: Biosphere Reserve Plan (larger copy attached under Annexure 1).

As illustrated by the Biosphere Reserve Plan, the entire Lake Tana and large parts of its associated wetlands and floodplains fall under the Biosphere Reserve. The northern boundary includes parts of the Megech River catchment, the eastern

boundary includes the parts of the Ribb and Gumura River catchments whilst the Bahir Dar Blue Nile (Abbay) River Millennium Park forms the south-eastern part of the Biosphere Reserve as it includes the Tis Issat falls, and parts of the impressive Blue Nile gorge. Parts of the Gilgel-Abbay river catchment form the southern part of the Biosphere Reserve. The western boundary of the Biosphere Reserve is a thin strip which follows on the Lake Tana basin's boundary. The proposed Biosphere Reserve covers a total area of approximately 6 972 km2 or 697 201 ha (hectares).

Table 8: The size of Lake Tana Biosphere Reserve and its three zones.

	TERRESTRIAL	AQUATIC	TOTAL (HECTARES)
Extent of Core Areas	7,699.619	16,457.905	24,157.524
Extent of Buffer Areas	30,968.976	156,597.689	187,566.665
Extent of Transition Areas	354,297.400	131,179.406	485,476.806
TOTAL	**392,965.995**	**304,235.000**	**697,200.995**

NABU supported an expert program for the identification of biodiversity hotspots in ecologically sensitive areas and compiled the data in a map including information on habitat types and threats. Taking these sensible areas into account, the participatory planning process for the demarcation of the core and buffer areas was conducted (refer to Chapter 4 in Part I).

5.3. The three zones of Lake Tana Biosphere Reserve

5.3.1. The core area of Lake Tana Biosphere Reserve

As stated previously, the designated core area of the Biosphere Reserve consists of a mosaic of many small areas, which cover part of the water body of Lake Tana with associated wetlands and river systems, church forests, and other remaining natural forests which are of regional, national and international importance. It also includes the Bahir Dar Abbay (Blue Nile) River Millennium Park that is declared as a protected area according to the IUCN Category IV protected areas criteria.

a. <u>Size:</u>

The core areas cover an area of approximately 24 157 ha or 3.46 % of the Biosphere Reserve (refer to the Biosphere Reserve Plan). This comprises a terrestrial area of 7,699.619 ha and an aquatic area of 16,457.905 ha.

b. <u>Configuration:</u>

The core area comprises portions of the lake, the relatively pristine shoreline wetlands of the lake (a narrow strip along Ambo-Bahir-Gubiza to Gilgel Abay siltation zone and its frontier rocky/muddy substrate and water logged vegetative areas of

the littoral zones and sub-littoral and pelagic zones of the deep central part of the oligotrophic water body of the lake), and the littoral zones of the river mouths of Gilgel Abay River plains (including its alluvial siltation zones and swamp peat-forming papyrus and related species communities).

The core area includes the last remnants of the natural forests such Tara Gedam and Zegie. The church forests dotted across the Biosphere Reserve constitute highly endangered, vulnerable and conservation-worthy habitats that have been designated as core areas.

Most of the islands on Lake Tana have been settled by people and the lake itself is intensively utilised by fishermen and water transport occurs across the lake to various ports on the shoreline. However, Lake Tana is an important water resource of global significance, as the islands are home to unique cultural and heritage sites of the Ethiopian Orthodox Church, Important Bird Areas of international significance, unique and endemic fish species, an important source of food and income to the communities in the Biosphere Reserve, and a valuable tourism resource. Without Lake Tana the surrounding wetlands will also cease to exist. Furthermore, Lake Tana is the source of the Blue Nile or Abbay River, the only outflow from Lake Tana and the largest water source of the Nile. Currently, Lake Tana has no official protection. Taking into account its importance for local livelihoods and development as well as national and international water supply, regulatory functions and conservation, wherever feasible, portions of the water body of the lake have been designated as core area.

The core area also incorporates the waterfalls of the Blue Nile River (i.e. Tis Issat) and the remnant forest wetlands along its upper basin systems, from Bezawit to the falls and their immediate surroundings. Also included as core areas are the important river mouths and the river courses of the Gumera, Rib, Gilgel Abbay, Megech rivers. The Bahir Dar Blue Nile River Millennium Park is heavily degraded and includes growing local communities. However, it has protected status which justifies its designation of core area.

5.3.2. The buffer areas of Lake Tana Biosphere Reserve

Lake Tana Biosphere Reserve includes a number of core zones and buffer zones. This is due to the heterogeneity of the area. In essence, the buffer zones include much of the lake area, wetlands (in parts seasonally closed to function as a breeding grounds for birds), river mouths and rivers (also seasonally closed for fishing during the spawning period), church forests with inhabited monasteries, and corridors between woodlands.

a. Size

The buffer area covers an area of approximately 187,567 ha or 26.9% of the Biosphere Reserve (refer to the Biosphere Reserve Plan). This comprises a terrestrial area of 30,968.976 ha and an aquatic area of 156,597.689 ha.

b. Configuration

The buffer area constitutes the following:

a) Portions of the lake;

b) A contiguous 500 m zone around Lake Tana. The key purpose of this buffer area is to protect the lake from incoming silt and uncontrolled human-induced impacts. It is proposed that farming activities in this buffer zone strip be minimised and that ecotourism activities is promoted;
c) Areas containing natural vegetation, worthy of conservation, including forests;
d) Parts of Deq Island which include forests of significance;
e) Zegie Peninsula which includes some of the last remaining natural forests in the Biosphere Reserve, and historic churches;
f) Areas containing unique landscape features;
g) Areas that contain important archaeological and cultural-historic sites;
h) Rivers or riverbeds that function as ecosystems;
i) Rivers, riverbeds and continuous tracts of natural vegetation that link major ecosystems. Any natural area within these areas that are conservation worthy, especially areas of indigenous vegetation and/or sensitive ecosystems, riverine vegetation, cultural-historic sites, etc. which could form linkages between core areas;
j) Farming which includes Eucalyptus and *Juniperes* plantations; and
k) Wetland systems consisting of seasonal swamps and perennial marshes and riverine areas (even though many of these areas are heavily modified).

It is envisaged that various portions of state, communal and/or private land within the buffer area could, in future, be included into the core area if agreement is reached with respective local communities, government departments and/or owners pertaining to the affording of statutory conservation status to such land.

The buffer area includes various sites or features of historical and cultural significance which include several waterfalls, historical caves, hot springs, old churches and monasteries, and cemeteries (refer to Chapter 5.3.2). The merits of applying for the recognition of certain areas falling within the Biosphere Reserve as a World Heritage Site in terms of UNESCO's World Heritage Convention should be investigated. The Biosphere Reserve would serve as a robust framework for any such World Heritage Sites.

5.3.3. The transition areas of Lake Tana Biosphere Reserve

a. Size

The transition area covers an area of 485,477ha or 69.6 % of the Biosphere Reserve (refer to the Biosphere Reserve Plan).

a. Configuration

The transition area includes a diversity of landscapes, ranging from tracts of natural vegetation, to highly modified man-made (cultural) landscapes, where the most intensive land and water uses, such as urban settlement and its associated human activities and transportation, occur.

These categories have been grouped as follows (refer to the Biosphere Reserve Plan):

a) An aquatic transition area which constitutes approximately 131,179 ha of the lake surface;

b) A terrestrial transition area of moderately and intensively cultivated agricultural areas covering in the order of 354,297ha; and

c) Urban areas and villages which accommodate a range of intensive land-uses.

A primary role of the transition area is that it represents the urban-rural interface, which largely affects the sustainability of the aquatic, rural and the urban environments.

5.4. Biodiversity, natural and cultural resources at Lake Tana Biosphere Reserve

Lake Tana region is home to 28 fish species, 300 different birdspecies, 16 different mammal species, 179 plant species and many other species of high importance for the local as well as the international community. The monasteries and churches on the islands of Lake Tana are of high architectural value. They serve as tourist attractions due to their paintings, church service serving materials, manuscripts, dress of former Empresses and annual religious celebrations. As indicated by various studies, Lake Tana and its surroundings are endowed with artificial, natural and historical resources. Among these resources are the water body, wetlands, islands, historical and religious monasteries and churches as well as the composition and number of flora and fauna:

1. **Water Resources:** The main water sources of Lake Tana are ground water, surrounding springs, rivers and rain water. More than 60 springs and five big rivers (Gilgel Abay, Rib, Gumara, Megech and Arno Garno) tribute to Lake Tana. Blue Nile (also named River Abay) is the only river springing from Lake Tana and running 35 km in South-East direction, before it forms a wonderful tourist attraction called Blue Nile Falls. The water of Lake Tana is used for irrigation, fish production, transportation, tourism, hydro-electric power generation and as a source and home for many plants and animal species. It is a fundamental source of living for communities living around the lake. Because of that the area is considered to be one of the growth corridors at a federal and regional level.
2. **Wetlands:** Wetlands are lands which can hold water temporarily or permanently. They are located at the side of lakes, next to rivers and at ditches far from other water sources. There are many wetlands in and around Lake Tana as listed in Table 8. The wetlands in Lake Tana region are of importance because of the following reasons:

    a. **Functions:** Wetlands prevent floods, soil erosion and the entrance of waste, e.g. from towns. They also purify water, support the nutrient cycle and thwart carbon dioxid output and climate change.

    b. **Products:** Wetlands provide fish, firewood, lumber and animal food. The reed that grows near the lake is used to build roofs. Papyrus, a grass available in wetlands around the lake, is used to produce household goods, souvenirs, reed boats (*tankua*), to build fences and to decorate the houses during celebrations.

    c. **Attributes**: Lake Tana region is attractive for tourists because of its impressive and diverse landscapes and biodiversity.

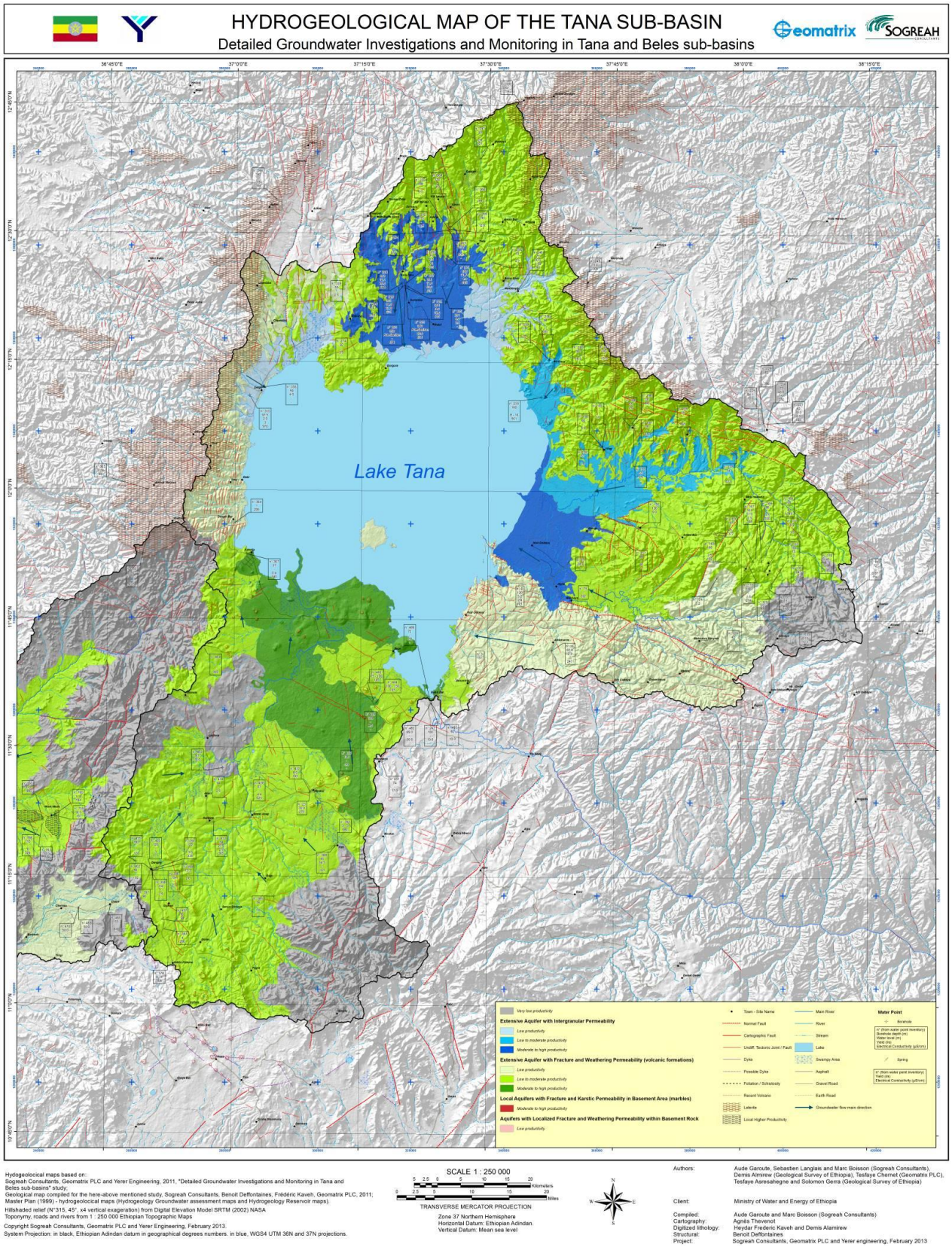

Figure 14: Hydrogeological Map of Lake Tana.

Table 9: Selected wetlands of Lake Tana.

Name Woreda	**Wetland name**
Bahir Dar *Zuria*	Latamba, lijome, Wenjeta, Sekelet, Ambo Bahir, Dek, Enfranz, Daki and Tomet
North Achefer	Legidiya, Estumit (inlet of Gilgel Abay), Chimba, Kunzila, Kunzila town, Wenberia eyesus area
Dembia	Megech river area, Achera, Seraba area, Gorgora, Dirma river area, Robit area
Gondar *Zuria*	Agid Kirigna, Arno Garno river area
Takusa	Asratie tokaw, Konso toka, Kechinit, Chegera toka, bergen toka, goja toka, achera area, sensay toka, ginza toka
Alefa	Beles mesk, Kentie jonka, Esey debir area, Azo bahir, Birr wuha area, Dengel ber area, Dengel shewa area.
Fogera	Wulela, Shesher, Kiristos Semmira area, Gumara river area, Woreta plain area.
Libo kemkem	Rib river area, Daga tokaw
Dera	Korata area, Tana kirkos, Geldaw river area, Gumara, Kiristos Semira area, Ahunweta area, from Fiseash to Lam Maderia, Bosit, Dengecha.
Bahir Dar	Gami Mesk, Debre Mariam area, Gedero, Selchen, Gudo bahir, Aba Gerima, Enfranz river, Bahir Dar University Abbay area, Chere chera Wier area, Wereb, Weramt area.

3. **Islands:** There are 37 islands in Lake Tana while the number fluctuates as a result of the increasing and decreasing water level during dry and rainy seasons. Among these islands, 19 have historical and religious monasteries and churches. Some islands are rocky and they serve as nesting places for birds while others are covered by trees.
4. **Churches and monasteries:** Around Lake Tana, there are more than 19 ancient and historical monasteries and churches most of which are found on islands while the others are situated at the shore of the lake. The monasteries are rich of private goods of former emperors, burial places of former kings, wall paintings, architectural features and writings on parchment (Birana). In addition, monastery life plays a pivotal role to preserve endemic trees, wildlife and other natural resources, e.g. for thousands of years they have protected the last remaining forests in the region and are promoting the protection of wildlife and nature.
5. **Biodiversity:** Lake Tana and its surroundings are home to a vast variety of different species. Some of them are endemic, others are migratory species only staying for some months every year - but all are in desperate need for

protection. There are more than 200 fish species in Ethiopia, 40 of which are endemic. In Lake Tana region, there are 28 fish species of which 19 are endemic in Ethiopia, mainly of the following categories:

Table 10: Most important fish species endemic in Lake Tana.

No.	Amharic	English
1	*Kereso*	Tilapia
2	*Ambaza*	Catfish
3.	*Nech asa*	Barbus
4	*Bezo*	Varicorhinus beso

While 1,454 tons of fish are annually produced in the Lake Tana region using traditional methods, it is possible to produce up to 15,000 tons a year by using modern methods.

In addition, 284 species of mammals are domiciled in Ethiopia, of which 29 are endemic. Many mammals can be found in and around Lake Tana, such as different monkey species, the hippopotamus and the common hyena. For more information please see annex 2. In Lake Tana, there are 201 species of reptiles and amphibians in Ethiopia including ten endemic ones. Reptiles that can be found in Lake Tana region are crocodiles, water snakes and pythons; toads and frogs are examples for amphibians domiciled in this area. Ethiopia is home to 861 different bird species, of which 18 are endemic. According to studies conducted in 2009 by the Ministry of Water Resource and other professionals, more than 300 types of birds inhibit the region around Lake Tana, of which 50 are ecologically crucial for preserving biodiversity, while they also attract international attention for their rarity. Migratory birds, such as the Eurasion or Common Crane are sheltered in this area during the winter in the northern hemisphere. These migratory birds come to Lake Tana from West Europe to escape from the snow and the cold during winter season and return to their home countries at the beginning of March every year. Also, there are over 6,000 species of big plants in Ethiopia, out of which 10 percent are endemic. As indicated in various studies, there are 181 species of trees and shrubs in and around Lake Tana.

6. **Local culture and annual celebrations:** There are many annual celebrations in Lake Tana and its surroundings such as Meskel (commemoration of the Finding of the True Cross), Epiphany and Eid-Al Fetir.

5.5.Importance of the natural and cultural resources of Lake Tana Biosphere Reserve

Lake Tana and its surrounding resources are of high value to the local communities. Among the major services are:

- Buffering service of wetlands from potential harmful substances;
- Home and reproduction area for birds, fish and other animals;

- Source for traditional medicine;
- Source for water for irrigation and human consumption;
- Providing local and modern transportation services for people and goods;
- Water and water-related attractions;
- Provision of food (fish production);
- Provision of income (selling of fish, papyrus etc.);
- Source of fuel wood, coffee, fruit and fodder;
- Agricultural utilization at Lake Tana;
- Electric power; and
- Climate change mitigation.

5.6. Challenges facing the natural and cultural resources at Lake Tana Biosphere Reserve

Even though Lake Tana and its surroundings are naturally endowed with various resources, nowadays, they are highly exposed to man-made and natural challenges.

1. **Uncontrolled agricultural expansion**: Due to the increasing population growth, most of the wetlands are used for agriculture which leads to a loss of wetlands in Lake Tana region. With the wetlands lost, the lake cannot fulfill its beneficial functions any longer.
2. **Deforestation:** Free cattle grazing and the increasing demand for fuel wood leads to a loss of natural forests. This deforestation has impacts on soil quality and leads to erosion, but also to a loss of biodiversity as their habitats are lost forever.
3. **Unregulated Overfishing**: Laws exist to protect the rich fish resources of Lake Tana from overfishing, e.g. during the spawning season, when the fish lay eggs, fishing is prohibited. Only if the fish can reproduce, a continuous supply of fresh fish from Lake Tana is possible.
4. **Increasing rate of overgrazing in and around Lake Tana:** As there is huge and increasing cattle traffic in the area, overgrazing has become a great challenge. The grass cannot grow fast enough, resulting in a degradation of the area.
5. **Environmental pollution due to rapid urbanization:** As there is no proper waste management, the waste is thrown into the river. The amount of waste increases because of the rapid urbanization. As plastic and chemicals cannot be absorbed by plants etc., they pollute the water.
6. **Expansion of various exotic/invasive weeds:** Among the exotic or so called invasive weeds, the water hyacinth has been noted as the type of alien weed posing the biggest challenge to the lake. As it forms a cover on the water surface, it prevents the oxygen intake of the lake, decreasing water quality resulting in fish loss. Without fish, e.g. mosquitoes can reproduce faster and spread diseases such as Malaria.

7. **Change of the land use system and loss of ecosystem services**.
8. **Siltation:** Due to farming activities in higher regions, soil ends up in tributaries that flow into the lake. As a result of this change of land use systems, the lake suffers from an increasing siltation.
9. **Degradation of cultural and historical resources:** Due to a lack of knowledge and awareness among local communities, cultural and historical places are being damaged and robbed.

5.7.Fulfilling the three functions of a Biosphere Reserve

The subject area comprises Lake Tana, the largest lake in Ethiopia. It is the main source of the Blue Nile which fulfils a significant role in the country's irrigation and hydropower industry. Lake Tana is an important hotspot for biodiversity, important fishery and agricultural resource, and harbours historic churches and monasteries dating back to the 13th century. Accordingly, the area is of global, national and transnational economic, political, ecological and cultural significance.

Due to its economic, natural and cultural attributes, Lake Tana is subject to increasing demands and development pressure which should be seen in context of global concerns over the world's ability to support its inhabitants under ever-increasing population and subsequent development pressure. It is accepted that, following present trends, Ethiopia will become more densely populated, more polluted, less ecologically stable and thus vulnerable to environmental hazards. Such trends inevitably lead to degradation of the natural environment and, subsequently, a reduction in the quality of human life.

A steady economic growth rate is said to be a prerequisite for ensuring an acceptable quality of life. Economic growth, however, implies increasing development pressure and additional burdens on the natural environment and its resources. Development can, therefore, only be sustainable if it is compatible with environmental requirements. It is of key importance that all development is planned and regulated in an integrated and holistic manner. This implies a substantial need for an integrated planning framework to guide development and land use. The intention is that the Lake Tana Biosphere Reserve *inter alia* fulfils this key function.

Article 43 of the Constitution of The Federal Democratic Republic of Ethiopia states that *communities have the right to improved living standards and sustainable development and that the State has the obligation to protect and ensure Ethiopia's right to sustainable development.* The Constitution furthermore requires that the basic aim of development activities *shall be to enhance the capacity of citizens to development and to meet their basic needs.*

Article 44 stipulates that *all persons have the right to a clean and healthy environment*. It is therefore imperative that an effective system is instituted that will enable all role-players, especially the affected communities, to constructively participate in promoting environmental sustainability and human well-being.

It is the intention of the Lake Tana Biosphere Reserve (also referred to in this document as the Biosphere Reserve), which is the subject of this application, to be a unique and innovative African water and land management entity that regulates and enhances the preservation and development of the Lake Tana area. In this regard, the Biosphere Reserve will be a site for excellence that explores and demonstrates approaches to conservation and sustainable development on a regional scale in

accordance with relevant legislation and policy such as the *Growth and Transformation Plan*, *Ethiopian Water Sector Strategy, Environmental Policy of Ethiopia*, *Conservation Strategy of Ethiopia*, *Agricultural and Rural Development Policies and Strategies*, and *Sustainable Development and Poverty Reduction Strategy Program*.

The Biosphere Reserve will aim to provide *'the ecological and social framework within which government, community, corporate and other private interests, share responsibility for co-ordinating land-use planning, for both public and private land and for defining and implementing development options that would ensure that human needs are met in a sustainable way'* (WRI, 1992).

5.7.1. Function 1: Conservation

The establishment of the Biosphere Reserve should play an important role in facilitating the conservation of the region's natural and cultural landscapes and heritage sites of international importance, as described in Chapter5.4, 5.5 and 5.6.

The responsible Federal government body for establishing the Lake Tana Biosphere is the Ministry of Science and Technology (MoST). Furthermore, at the Federal level, the agencies tasked with the conservation of Ethiopia's natural resources are the Ministry of Environment and Forest (MoEF), the Ministry of Agriculture (MoA) and the Environmental Protection Council (EPC), together with the Institute of Biodiversity Conservation (IBC) which undertakes *ex situ* and *in situ* biodiversity conservation. Organisations, departments and stakeholders within the Lake Tana basin and Woreda Administrations are responsible for the administration of land and other natural resources in accordance with Federal Laws (Article 52[2] of the Constitution of The Federal Democratic Republic of Ethiopia). There are more than 3 000[14] registered Non-Governmental Organisations (NGOs), Civic Organisations (COs) and Community Based Organisations (CBOs) in Ethiopia of which a significant number primarily deals with natural resource management and biodiversity conservation and issues such as desertification, rehabilitation, water conservation etc.

The above functionaries, agencies and NGOs/CBOs are generally in need of financial and logistical support. There is also an urgent need for conservation activities to be co-ordinated and integrated. The Biosphere Reserve will strive to fulfil these functions.

The subject area is part of the Eastern Afromontane Biodiversity Hotspot and comprises four terrestrial and three freshwater 'Key Biodiversity Areas' (CEPF, 2012). Up to 67 different species of fish have been recorded in Lake Tana. Approximately 70% of these are endemic (e.g. *Labeobarbus* spp. which is the only known remaining species of large cyprinid fish). More than 217 bird species (Shimelis, 2013) have been observed at Lake Tana using the aquatic and wetland habitats both for breeding and wintering. The high abundances qualify areas around the lake as international renowned Important Bird Areas. The endemic *Coffea arabica* occurs naturally in some the remaining forests in the area (for example on the Zegie Peninsula). The

[14] http://allafrica.com/stories/201302220066.html - accessed on 16 July 2013.

numerous church forests around Lake Tana host an outstanding diversity of tree and shrub species and medicinal plants and provide habitat both for rare mammal and bird species. Notwithstanding this status, the area is subject to on-going degradation.

The Biosphere Reserve would contribute towards protecting a number of threatened vegetation types or biodiversity hotspots, namely (zur Heide, 2012 and Succow & Mundt, 2014):

a) Primary gene centre of several field crops which can be found in the Lake Tana region including Noug (*Guizotia abyssinica*), Tef or Teff (*Eragrostis tef*), Mashila (*Sorghum bicolor*) and Ethiopian mustard (*Brassica carinata*);

b) Indigenous medicinal plants such as Endod (*Phytolacca dodecandra*), Kosso (*Hagyinia abyssinica*), Gesho (*Rhamus prinoides*), Wanza (*Cordia africana*), and Girawa (*Vernonia amygdalina*) that are found in the Lake Tana watershed;

c) The church forests which are islands of biodiversity (refer, for example, to the Zegie peninsula that has 113 documented woody plant species and the Bahir Dar Blue Nile Millennium Park has about 140 woody plant species); and

d) Papyrus reed beds (*Cyperus papyrus*) which provide vital ecosystem functions and services for millions of people and form a habitat for unique forms of biodiversity.

A large number of wetlands occur, including some of the largest and ecologically important units in Ethiopia and in the Horn of Africa. The wetlands surround the lake and are flooded during the rainy season. Lake Tana and these wetlands are part of the Central Ethiopian Highland Wetland Complex. Some of these wetlands are dominated by *Papyrus* and *Typha* stands and some of them are still almost pristine. The ecologically important *Papyrus* populations have dramatically declined in distribution due to overexploitation and habitat fragmentation.

The Biosphere Reserve would contribute to the rehabilitation and appropriate management of modified, but extremely conservation-worthy, river systems, streams and wetlands on Dembia (or Dembiya), Fogera and Kunzila plains. The floodplains around Lake Tana provide important habitats for waterfowls and seasonally migrating fish stocks for spawning. The adequate conservation and management of four major rivers flowing into Lake Tana, namely the Megech, Ribb, Gumara and Gilgel Abbay Rivers is important for the proper functioning of the lake and its different and various ecosystems.

In addition, the Biosphere Reserve would also support the conservation of avifaunal biodiversity, providing habitats for a wealth of bird species. Lake Tana is internationally known as an Important Bird Area (IBA). The lake and the surrounding wetlands host a wide variety of birds both resident and migratory. Many Palaearctic migrant water birds depend on the lake as feeding and resting grounds, including the Common Crane (*Grus grus*), Northern Shoveller (*Anas acuta*), Black-tailed Godwit (*Limosa limosa*) and Ruff (*Philomachus pugnax*). Furthermore, it provides habitats for several endangered and endemic species, such as the Wattled Crane (*Grus carunculatus*), Wattled Ibis (*Bosstrychia carunculata*), White-collared Pigeon (*Columbia albitorques*), Black-winged Lovebird (*Agapornis taranta*) and White-cheeked Turaco (*Tauraco leucotis*), Pallid Harrier (*Circus macrourus*) and Black-crowned Crane (*Balearica pavonina*).

Moreover, the Biosphere Reserve would serve the preservation of the decreasing habitat of large mammals that are native to the area, *inter alia* the Hippopotamus (*Hippopotamus amphibious*), Black and White Colobus Monkey (*Colobus guereza*), and Leopard (*Panthera pardus*) that occur in the area.

Finally, the Biosphere Reserve would contribute to the protection of the unique cultural, historical, geological and aesthetic qualities of the Lake Tana basin. Lake Tana has 37 islands and 16 peninsulas[15] with 21 churches and monasteries dating back to the 13th century. They are important cultural and religious heritage sites for the Ethiopian Orthodox Christians as well as important tourist destinations. In this regard, it is noted that the culture-historic landscapes are characterised by a fusion of different cultures and their history. The subject area is also the distribution area of the endemic *Fogera* cattle[16] breed which has been a key element of the history of the local pastoralist people.

5.7.2. Function 2: Development

A primary over-arching function of the Biosphere Reserve is to facilitate the sustainable development and management of the Lake Tana area. The Biosphere Reserve is premised on the principle that sustainable development can serve as a primary economic driver that unlocks funds to support, in a meaningful and sustainable manner, economic growth, social development and environmental rehabilitation.

Reducing poverty and inequality, whilst also undertaking effective environmental rehabilitation and conservation, requires that the economy grows and that the efficiency of state spending and the efficiency of the use of resources increases. Such efficiency can be considerably enhanced through focused and much needed partnerships. The Amhara National Regional State has an obligation to execute economic, social and development policies, strategies and plans, and to administer land and other natural resources in accordance with Federal laws (Article 52 of the Constitution of The Federal Democratic Republic of Ethiopia).

In order to fulfil the obligation of the State and to foster local economic and human development, which is socio-culturally and ecologically sustainable, the Biosphere Reserve will provide a framework to promote, support and guide public-private-community based programs and partnerships that address key issues.

The Biosphere Reserve will furthermore provide a coherent framework for the sustainable use of natural resources in order to enhance the key economic sectors of the area and, consequently, contribute to the eradication of poverty and inequality as a core obstacle to a stable and prosperous future. The enhancement of production and marketing of local products from the Biosphere Reserve through cooperatives and small scale businesses will be intensified in close cooperation with the local tourism service and hotel sector. A logo for local products from Lake Tana area has been developed.

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[15] Is a piece of land that is bordered by water on three sides but connected to the mainland.

[16] One the best native Ethiopian milk cow breeds which is at risk of genetic dilution.

The Biosphere Reserve will also support 'Tourism and Community-based Ecotourism (CBET)' initiatives in the area which promote the following:

a) Creating awareness and appreciation for the value of nature and biodiversity of both tourists and locals (educational aspect);

b) Creating job opportunities not only in hotels, for tour operators and guides, but also for local communities (employment aspect);

c) Creating economic incentives for the conservation of natural (and cultural) assets by monetary valorisation (conservation aspect); and

d) Reducing land degradation through taking people off the land (conservation aspect).

In this regard, *inter alia*, in selected sites, community based tourism initiatives were started following the *Ecotourism Concept* that has been developed in 2014 by NABU and international and national experts. Intense training, awareness creation and infrastructure development for the promotion of ecotourism in pilot sites in the proposed Lake Tana Biosphere Reserve are underway (EWNHS) and a tour guide association is being set up (BoCTPD).

The promotion (through the dissemination of knowledge and provision of expertise as well as sharing of traditional knowledge) of economic activities that are environmentally sustainable (e.g. local irrigation methods as opposed to intensive irrigation methods using modern methods, correct ploughing practices to combat erosion, protection of church forests, water management, wetland usage by different communities, diversification of farming practices etc.), would help to restore and protect the integrity of the ecosystems. In addition, the deriving of income from the sustainable use of natural resources would promote an interest in the conservation of these resources. For the indigenous communities, the Biosphere Reserve would aim to rekindle an appreciation of their traditional cultures, knowledge and skills of sustainable living within the environment. The restoration of land (e.g. the eradication of alien plant infestations, sustainable fishing practices, the compacting of erosion trenches, restoration of degraded wetlands and marshes etc.) could create job opportunities for local communities and generate income.

The Biosphere Reserve would promote sustainable urban and rural development, with the focus on providing much-needed bulk service infrastructure in terms of the relevant Federal and State policy, the spatial designation principles of the Biosphere Reserve, and detailed standards and guidelines for development, land management and resource utilisation stipulated in the Biosphere Reserve Management Plan. In 2013 an action plan for the city of Bahir Dar as green model city has been successfully developed and presented to stakeholders and the public.

5.7.3. Function 3: Logistic support

The Biosphere Reserve will have an important function in coordinating and facilitating existing and future programs pertaining to the above. The Biosphere Reserve will create synergies with various partners to provide a coordination framework and support for *inter alia*:

a) Tana and Beles Integrated Water Resources Development Project (World Bank);

b) Community-Based Integrated Natural Resources Management Project in Lake Tana Watershed (IFAD);

c) Sustainable Land Management Program (GIZ);

d) Conservation, environmental education and development programs (NABU);

e) Sustainable Resource Management Program in North Gondar (SRMP-NG);

f) SIDA-Amhara Rural Development Programme (completed);

g) NESTown (New Ethiopian Sustainable Town, NESTown Group);

h) Bahir Dar Abbay (Blue Nile) River Millennium Park;

i) Bahir Dar Integrated Development Plan (RUPI, Bahir Dar Municipality); and

j) Flood Preparedness and Early Warning – Phases I and II (ENTRO).

In addition, the Biosphere Reserve will provide an important platform to coordinate future initiatives and programs such as:

- Agricultural research that is based on agro-ecological diversity;
- Pilot introduction of Conservation Agriculture;
- Community dynamics for example on multi-species interactions, predator-prey interactions, and parasite-host relations;
- Comparison studies of the structure and functioning of Lake Tana with regards to other great lakes in Africa;
- Effects of sediment-load and siltation on the abiotic and biotic factors, its rate and possible measures to combat this problem;
- Land-use dynamics and land evaluation studies;
- Natural resource management, soil and water conservation, and forestry;
- Population genetics of fish stocks;
- Rural technology and the fishing sector;
- Significance of biodiversity and its resilience (adaptability) and productivity of the various ecosystems which include molecular and genetic approaches;
- Water resource management studies; and
- Wetland ecosystems functioning (for example the energy flow in the ecosystem through lower trophic levels (i.e. phytoplankton dynamics, detritus, bacterio-plankton etc.), and the sustainable management and conservation of these wetland areas.

The Biosphere Reserve will support the ‘Participatory Forest Management (PFM)’ system which shares the management responsibilities and benefits with the communities living adjacent to the forests such as Zegie, Tara Gedam, etc. and the church forests located in the subject area.

Due to its unique biological, cultural and historical values, the Lake Tana area has been a focal point for research for many years and a good knowledge-base is available. A number of government departments, NGOs, research institutions and agencies have made and continue to make significant contributions to this knowledge base (see Table 10).

Table 11: NGOs and their work in Lake Tana region (Source: zur Heide and BoFED, 2012 updated 2014).

NGO	WOREDA	FIELD OF ACTIVITY
Action for Sustainable Natural Resource Management.	Fogera	Combating land degradation for improved livelihoods and poverty reduction (terminated).
Afro Ethiopia Integrated Development Association.	Northern Achefer	Ground rural water, sanitation, hygiene.
Amhara Agricultural Research Institute (ARARI).	Lake Tana area	Develop, adopt, and disseminate agro-ecological sound improved agricultural technologies based on appropriate management and utilization of the biodiversity and natural resources for the better living standard of the society.
Bahir Dar University (BDU).	Lake Tana area	Fisheries management, livestock, agriculture, agroforestry, climate change, development, water.
Care Ethiopia, FFTH, World Vision.	Dembia	Joint emergency flood mitigation action.
Ethiopian Wildlife and Natural History Society (EWNHS)	Lake Tana area	Avifaunistic studies and monitoring, environmental education, fisheries management.
Ethio-Wetland Natural Resource Association.	Fogera	Wetland restoration and alternative.
Frankfurt Zoological Society.	Debark	Afroalpine Ecosystem Conservation project.
LEM Ethiopia	Bahir Dar Zuria	Participatory and integrated waste management project.
ORDA.	Fogera	Biodiversity programme in Amhara (all Woredas).
Organisation for the Rehabilitation Development in Amhara (ORDA).	Northern Achefer	Water, sanitation and hygiene.
SOS Sahel.	Dembia	Insuring smallholder producers in Ethiopia.
The Nature and Biodiversity Conservation Union (NABU) in cooperation with Michael Succow Foundation.	Lake Tana area	Natural resource management, restoration of habitats, regional development, environmental education, structural and technical support for biosphere reserve set up, feasibility study for Lake Tana Biosphere Reserve.
University of Natural Resources and Life Sciences, Vienna (BOKU), Institute of Hydrobiology and Aquatic Ecosystem Management.	Lake Tana	Sustainable development of the fisheries value chain and fish processing capacity for economic livelihoods, food security and job creation
World Vision.	Libokemkem	Area development programme (multi-sectoral).
World Vision.	Gondar Zuria & Dembia	Area development programme (multi-sectoral).

5.8. NABU's mission and project work at Lake Tana Biosphere Reserve

For over a hundred years, The Nature and Biodiversity Conservation Union (NABU) has been promoting the interests of people and nature, drawing on its unwavering commitment, specialized know-how and the backing of 620,000 members and supporters. Africa, Asia and Caucasus form the geographical focus of NABU's international commitment. In respect of content, NABU's work connects ecologic and social aspects ranging from climate protection, conservation of habitat and species diversity, ecotourism and environmental education to capacity building, support to protected areas and biosphere reserves, poverty alleviation and strengthening of civil society.

The Nature and Biodiversity Conservation Union (NABU) was registered as an international non-government organization in Ethiopia in 2010 and since 2010, NABU was supporting the establishment of Kafa and Lake BRs and also has follow up projects in both sites to support various conservation and development related activities in Kafa and Lake Tana Biosphere Reserve. In addition, NABU has started a new 4-year project in the forest biosphere reserves Yayu and Sheka together with it's main consortium partner UNIQUE, on behalf of the GIZ, or BMZ respectively. The aim is to build capacities for an effective biosphere reserve management and to promote income-generating activities.

To assess the potential of the Lake Tana region as a biosphere reserve, a feasibility study was undertaken in 2011 by the Michael Soccow Foundation in collaboration with NABU. According to the study, Lake Tana and its surroundings had a very high potential to fulfill the criteria of UNESCO and to get recognized as a biosphere reserve. In 2012, the first NABU office opened in Bahir Dar. The organization signed a four-year contract (2012 to 2015) with various offices of the Federal and Amhara National Regional Governments. The project '*Community based Climate Adaptation and Biodiversity Conservation in the model area of Lake Tana Biosphere Reserve in Ethiopia*'received financial support from the German Bundesministerium für wirtschaftliche Zusammenarbeit und Entwicklung (BMZ), which is the German federal ministry for economic cooperation and development.

5.9. Main objectives of Lake Tana Biosphere Reserve

In summary, the three main objectives of the Lake Tana Biosphere Reserve are as follows:

1. Conservation

The main aims under this function are as follows:

1. Ensuring the ecological integrity of Lake Tana and thereby its continued ability to provide ecosystem services to the region through the preservation and restoration of its surrounding landscapes, ecosystems and genetic diversity; and

2. Protecting the area's biodiversity, landscape and cultural heritage which are of international importance.

2. Development

The main aims under this function are as follows:

1. Promoting the lake and its resources (i.e. social, economical, heritage, cultural etc.) and surroundings for sustainable economic development, including eco-tourism development;

2. Establishing a model region for sustainable development based on the ecosystem approach which incorporate a showcase for sustainable rural-urban linkages and urban areas; and

3. Developing and continually improving environmentally friendly agricultural management regimes to increase productivity of agricultural crops through suitable location-specific technologies.

3. Logistical Support

The main aims under this function are as follows:

1. Ensuring information exchange on environmental research, monitoring and education in relation to nature protection and regional development in the designated area;

2. Promoting understanding with regards to environmental processes and protection and sustainable development in the Biosphere Reserve;

3. Improving economic and 'image-building role' of tourism combined with environmental conservation as a lesson and as an example to other areas in Ethiopia;

4. Enabling local communities to participate in the management of their own environment through, e.g. local initiatives, associations, the use of indigenous knowledge and by-laws. Thereby, reducing the burden of government institutions in local enforcement of proclamations, strategies and international conventions related to biodiversity conservation, climate change and sustainable resource management; and

5. Creating better opportunities for education. The Biosphere Reserve would be a platform for education, investigation, and environmental monitoring which would provide access for the local communities to technical and advanced training through the existing tertiary institutions and by means of courses and on-going educational programmes presented under the auspices of the Biosphere Reserve.

5.9.1. Primary beneficiaries of Lake Tana Biosphere Reserve

The beneficiaries of the Lake Tana Biosphere Reserve are categorised as follows:

a) **Local communities:** The local community includes local residents (i.e. farmers, small and micro enterprises or associations), private sectors, public sectors, and academic institutions. Potential benefits to local residents in

the Biosphere Reserve include: protection of basic land and water resources, a more stable and diverse economic base, creating additional employment opportunities, more influence in land-use decision-making, getting access to training, getting access to demonstration projects on alternative land-uses and management strategies, reduced conflict with protected area administrations and interest groups, and an opportunity to maintain existing traditions and lifestyles. Getting additional income/job opportunities will be achieved through crafts-making (such as mats), wood carvings, farming (i.e. fruits, vegetables, cereals), fishing, providing food and drink services to visitors, fodder production, beekeeping, etc.

b) **Ethiopian communities:** Preserving and restoring the wetlands and last church forests will secure the maintenance of one of Ethiopia's important carbon sinks. The Biosphere Reserve also contributes to conserve *in situ* gen pools of endangered flora and fauna (e.g. wild coffee). Moreover, important regulatory functions of water supply ('Water tower of Africa') and micro-climate will be maintained, and the Biosphere Reserve aims to expand the country's tourism by creating an attractive travel destination for national and international tourists.

c) **Global community:** The preservation of valuable habitats like lake sides, wetlands and church forests will aid the global community to avoid further greenhouse gas emissions caused by habitat destruction and deforestation. The area is also part of one of the world's hotspots of biodiversity and is therefore of global significance for conservation.

5.9.2. Sustainable development objectives of Lake Tana Biosphere Reserve

Sustainable development has three global imperatives, namely *human well-being, environmental integrity* and *economic efficiency* (International Institute for Sustainable Development {IISD}, 1995). The Rio Declaration, which forms the preamble to Agenda 21, states that *'human beings are at the centre of concern for sustainable development'* (CSIR, 2002). The Biosphere Reserve builds on the following understanding of the three global imperatives for sustainable development:

a) **Human Well-Being:** This refers to both *material* and *spiritual* well-being. Material well-being refers to the absence of poverty. Spiritual well-being, among others, refers to the absence of inequality and being in a position to obtain new powers, emotionally, intellectually and physically and to be able to play a meaningful role at all spheres of society.

b) **Environmental Integrity:** This imperative refers to the relative '*wholeness'* of the environment Environmental integrity is determined by the *value* of the environment or place (natural or human-made), with specific reference to its intrinsic, systemic, and/or instrumental value. The Biosphere Reserve builds on the recognition that the human-made environment is located within and 'contained' by the natural environment. The manner in which human settlements are developed, therefore, has an immense impact on the quality and integrity of the environment as a totality. It is therefore imperative that the human-made environment is planned, designed and developed in a

manner that will ensure the maintenance of the values of the environment. Ecological integrity is a key factor in the sustainable development equation. Ecological integrity, among others, requires that biodiversity is protected and essential ecological processes and services (e.g. water yield and quality, soil conservation, decomposition, etc.) are maintained.

c) **Economic Efficiency:** This is understood as *the optimisation of benefit at the lowest cost*. It includes the innovative and efficient use of available resources. Adequate funds and the appropriate allocation of such funds in terms of agreed-to priorities are of fundamental importance.

As stated before, sustainable development in the Biosphere Reserve constitutes a pro-active and systems approach focussed on the enhancement of human well-being and environmental integrity through the efficient use of the inherent resources (i.e. capital) of the area. Sustainable development objectives for the Lake Tana Biosphere Reserve *inter alia* include:

1. Ensuring the sustainable use of the area's natural resources is essential to its conservation;
2. Together with the local communities, the Biosphere Reserve will assist with the implementation of conservation, restoration and development of land-use plans for wetlands and church forests;
3. Soil-friendly agricultural methods and e.g. energy-saving stoves are being introduced to reduce the communities' impact on the environment while ensuring yields and household energy supply;
4. The production and marketing of natural products through the establishment of micro-enterprises with communities; and
5. Promote ecotourism in the region in order to direct the current tourism to one that focuses on nature and to benefit local communities caring for their environment.

5.9.3. Main stakeholders involved in the management and planning of Lake Tana Biosphere Reserve

Stakeholder identification/analysis was done during the project appraisal and formulation period. Stakeholders ranged from the public and private sector, government, NGOs to civil society and local communities spanning across diverse sectors. The institutions and stakeholders that are playing an important role in the management and planning of the Biosphere Reserve are listed in Table 12.

Table 12: Role and mandate of institutions and stakeholders in the management and implementation of the Biosphere Reserve (zur Heide, 2012).

INSTITUTION/STAKEHOLDER	ROLE AND MANDATE WITHIN THE BIOSPHERE RESERVE CONTEXT
NATIONAL LEVEL	
Ministry of Science and Technology (MoST)	• Coordinating the Ethiopian MaB Programme and MaB Committee. • Overseeing Biosphere Reserves and Biosphere Reserve initiatives. • Setting National MaB Strategy and Biosphere Reserve guidelines. • Conducting stakeholder workshops.
Environmental Protection Authority (EPA)	• Focal points for the Convention on Biological Diversity (CDB) and the National Biodiversity Strategy and Action Plan (NBSAP). • Coordination of ministries and agencies on environmental issues.
Institute of Biodiversity Conservation (IBC)	• Implementation of the CBD. • Upgraded status by the Government of Ethiopia.
Ministry of Agriculture (MoA)	• Conservation and utilisation of forest and wildlife resources. • Food Security Plan. • Water harvesting and small-scale irrigation. • Monitoring effects on agricultural development and operation of early warning systems. • Market-orientated agricultural development. • Guidelines and procedures for agriculture. • Distribution of agricultural inputs. • Establishment of training centres for agriculture and rural technology. • Implementation of the Convention on International Trade in Endangered Species of fauna and flora (CITES).
Ethiopian Road Authority (ERA)	• Planning, construction, administration and maintenance of road constructions.
Ethiopian Electric Power Corporation (EEPCO)	• Energy generation and distribution. • Environmental Monitoring Unit since 2002 to manage environmental impacts of hydropower and energy transmission projects.
Ministry of Water and Energy (MoWE)	• Planning and management of water resources for irrigation and drinking purposes. • Taken reforms on challenges and opportunities in the water sector. • Principles: Irrigation, participatory approach, decentralised management, and comprehensiveness.
Ministry of Finance and Economic Development (MoFED)	• Approval of all development programs in Ethiopia. • Environmental Planning Unit ensures clean and health environmental aspects of programs.
Higher Learning Institutions (HLI)	• Post-graduate study programs in Environmental Sciences at Addis Ababa Universities. • Bahir Dar and Gondar Universities.
REGIONAL LEVEL	
Amhara National Regional State's Bureau of Culture, Tourism and Parks Development (BoCTPD)	• Designated authority for Biosphere Reserve administration and management (Biosphere Reserve Management Unit). • Coordination and implementation of Biosphere Reserve activities, management plan, business plan, zonation, advisory

	boards and steering committees, monitoring and evaluation, establishment of a management team. • Integration and consultation with other regional, local and national institutions. • Promotion of community-based eco-tourism. • Wildlife conservation and protected area management.
Amhara National Regional State's Bureau of Environmental Protection, Land Administration and Use (BoEPLAU)	• Ensure that development activities protect the livelihoods of communities and the natural resources. • Focal institution for the implementation of environmental conventions. • Branch offices in each Woreda and Zone. • Setting the legal status for Biosphere Reserve zones and developing legally binding land-use plans. • Formalising informal land-use in the wetlands. • Developing community-based land-use regimes for the communal lands.
Amhara National Regional State's Bureau of Agriculture (BoA)	• Supervising programmes and projects related to agriculture, forestry, livestock, and fisheries. • Implementation of Sustainable Land Management projects, agricultural growth projects, irrigation schemes, and export orientation projects. • Controlling agricultural extension up to Kebele level, which includes community participation. • Forest rehabilitation which *inter alia* includes nurseries, area closures, etc.) and erosion control measures.
Amhara National Regional State's Bureau of Water Resources Development (BoWRD)	• Planning and implementation of water-related intervention of water-related interventions (i.e. small and large-scale irrigation, and water infrastructure). • Safeguarding the sustainable utilisation of the water resources (i.e. Lake Tana, important rivers and their tributaries, wetlands and floodplains).
Amhara National Regional State's Bureau of Finance and Economic Development (BoFED)	• Mobilisation of internal and external resources for community-based integrated resource management. • Facilitate the engagement of NGOs in the Biosphere Reserve.
Bahir Dar University (BDU)	• Education and teaching: Institute of Land Administration and the Maritime Academy, College of Agricultural and Environmental Science, and Biology Department). • Research: Initiate and conduct research projects in the Biosphere Reserve. • Community services and projects.
Amhara Regional Urban Planning Institute (RUPI)	• Provide advice and help on planning-related issues and land-use management aspects. • Provide help and advice on sustainable development and sustainable planning.
Amhara National Regional State Agricultural Research Institute (ARARI)	• Conduct applied research on crops, soil, water, forests and livestock. • Provide solutions on existing land-use problems.
Ethio-Wetlands and Natural Resources Association (EWNRA)	• Dissemination of information, create awareness on aspects relating to wetlands. • Provide capacity-building, technical material, research, testing sustainable wetland management practices.

LOCAL LEVEL	
Zonal and Woreda Administrations	• Offices for Agriculture, Environmental Protection, Culture and Tourism.
Kebele offices: Leader and Development Agents.	• Provides information on agriculture, forestry, afforestation, marketing, sustainable land management measures.
Elders and Heads of local communities	• Enforcement of values and education (i.e. for the wise use of resources).
Religious leaders from Orthodox and Muslim communities	• Enforcement and conservation/spiritual values and education for the wise use of resources. • Provide guidance on traditional values and sustainable practices.
Community-based organisations (i.e. tour guides, water use associations, wetland user groups, producer associations [coffee, honey, fruit, etc.])	• Representation of interests. • Development of grassroots initiatives. • Participation in zonation and implementation of management plan. • Development of by-laws.
Bahir Dar City Administration	• Planning of urban processes, promotion of green economy and green model city (i.e. waterfront), tourism development, culture and heritage development, etc. • Coordinate urbanisation processes and align with the Bahir Dar Blue Nile River Millennium Park, and other environmental-related aspects.
Bahir Dar Blue Nile (Abbay) River Millennium Park	• Management of the Bahir Dar Blue Nile Millennium Park. • Showcase for conservation and environmental education and awareness.

5.9.4. Consultation procedure that followed in the designation process of Lake Tana Biosphere Reserve

The idea to make Lake Tana region a Biosphere Reserve was already born in 2005, when a group of national experts from various disciplines (environmental protection, land management, fisheries, tourism) have concluded that a Biosphere Reserve would be the best tool to address the already then existing severe environmental threats (zur Heide, 2012).

The idea was revived when the Ministry of Science and Technology, UNESCO and NABU signed a trilateral Memorandum of Understanding (MoU) aiming to work towards the protection of biodiversity and, more specifically, towards the establishment of a national network of biosphere reserves in Ethiopia. In 2010, a field trip by several national and international experts identified the Lake Tana watershed as a region of high priority for the development of a biosphere reserve, given the diversity of landscapes, the international significance of the Lakes' ecosystems and the acuteness due to various threats.

Since the feasibility study, numerous meetings were conducted with regional institutions and experts regarding the awareness of environmental problems facing Lake Tana and its surroundings. Furthermore, two stakeholder workshops on a

potential Lake Tana Biosphere Reserve were conducted in Bahir Dar on 10 March and 14 November 2011, which signalled the high commitment for addressing the environmental challenges in the Lake Tana basin through a biosphere reserve.

As an expression of commitment of the regional institutions, *Biosphere Reserve Focal Persons (BRFP)* were assigned from the Bureau of Culture, Tourism and Parks Development (BoCTPD), Bureau of Agriculture (BoA), Bureau of Environmental Protection, Land Administration and Use (BoEPLAU), Bureau of Water Resources Development (BoWRD), Bahir Dar University and the Regional Council of the Amhara Government that are mandated to follow and conduct Biosphere Reserve related activities and guarantee a constant personnel representation of their organisation. In order to improve scientific cooperation on Biosphere Reserve related subjects a *Memorandum of Understanding* has been signed between Bahir Dar University, Ethiopian Institute of Architecture, Building Construction and City Development (EIABC) at Addis Ababa University, the BoCTPD, Michael Succow Foundation and the University of Greifswald, Germany. The MoU has been the basis for joint research between Ethiopian and German Master and PhD students.

Since 2012, institutions for the management and administration of the Lake Tana Biosphere Reserve have already been established. This includes a *Biosphere Reserve Management Unit*, *Focal Persons* that from a link between the Biosphere Reserve institutions and the respective administration level representing Zonal, Woreda and Kebele levels, a *Steering Committee*, *Technical Committee*, and a *Biosphere Reserve Council* which is the core management and decision-taking entity for the planning of the Biosphere Reserve.

Proposals for a zonation of a future biosphere reserve around Lake Tana were outlined in 2006 during the 2006 National Consultative Workshop in Bahir Dar. Since 2012, further consultations among regional and local stakeholders, workshops and zonation trainings have resulted in the determination of the outer boundary and the definition of a number of core and buffer zones.

In 2013, Goesys and Kreft (2013) on behalf of NABU's project in cooperation with Michael Succow Foundation conducted numerous interviews, workshops, and field studies around Lake Tana with local leaders (e.g. chair people of trading cooperatives for agricultural products), Kebele and Woreda heads, local communities and other stakeholders to assess specific goals:

1. Allow local, sub-regional leaders in land-use and other related key persons to share local/sub-regional knowledge on land-use related biodiversity issues (participation);
2. Help workshop participants to view land-use from a biodiversity (conservation) perspective (identification with the establishment of the Biosphere Reserve); and
3. Provide a systematised and spatialised data retrieval process during the workshops and field visits.

5.9.5. Stakeholder involvement in the Lake Tana Biosphere Reserve

The Biosphere Reserve will not be an additional and optional entity that will be liable for the relevant stakeholders. It will be an integral part of the relevant Woredas and will be incorporated as part of the on-going management of such Woredas and

Kebeles. As such, the various functions of the biosphere reserve would form part of the responsibilities of the relevant Woreda management portfolios.

Stakeholder involvement in the Biosphere Reserve is a continuous process and actions such as the following will be promoted (zur Heide, 2012):

- Facilitate the establishment and capacitation of community-based organisations;
- Actively involve religious leaders in advocating the value of nature through environmental education programmes drawing on indigenous knowledge and in the conservation of church forests;
- Develop business models to make better use of economic incentives that also provide benefits to the environment and local communities;
- Use the agricultural extension systems with the Development Agents for community participation; and
- Incorporate participatory processes into planning and implementing interventions to improve community participation, e.g. Community Conserved Areas (CCAs) and by-laws.

Examples of previous and ongoing projects, accounting community participation are (zur Heide, 2012 updated):

- Community-Based Integrated Natural Resources Management Project (IFAD);
- Organisation for the Rehabilitation of the Amhara Region (ORDA) has long-standing experiences with Area Closures and development of by-laws;
- Participatory Forest Management (PFM) systems, in which local people have adequate duties and rights in managing forest resources (e.g. in Zegie, Tara Gedam, Alem Saga, Kulkual Ber, etc.);
- The cascaded agricultural extension system with the development agents as a link to local communities (used for agricultural-related projects and the GIZ Sustainable Land Management Programme);
- Participatory methods such as PRA (Participatory Rural Appraisal) are applied for wetland management and awareness creation by the Ethio-Wetlands Natural Resources Association and were part of the Feasibility study for a potential biosphere at Lake Tana prepared by zur Heide, 2012.; and
- For People and Nature – Establishment of a UNESCO biosphere reserve at Lake Tana in Ethiopia. Project implemented by NABU in cooperation with Michael Succow Foundation. Supported by BMZ.

5.9.6. Partners to implement the objectives of Lake Tana Biosphere Reserve

The Ethiopian MaB Programme could be supported by a number of institutions financially and/or logistically and thus support the Biosphere Reserve, including the following:

- Biodiversity International (BI);
- Centre for Development Research (ZEF);

- Conservation International (CI);
- Earthwatch Institute;
- FARM-Africa/SOS Sahel;
- Food and Agriculture Organisation (FAO);
- German Technical Co-operation (GTZ);
- Global Environmental Facility (GEF);
- Global Environmental Monitoring System (GEMS);
- International Council for Science (ICSU);
- International Fund administered by the World Bank;
- International Plant Genetic Resources Institute (IPGRI);
- International Social Science Council (ISSC);
- International Union for Conservation of Nature (IUCN);
- Medical Plants Project;
- Nature and Biodiversity Conservation Union (NABU);
- Ramsar Convention of Wetlands;
- Smithsonian Institute (SI);
- The Nature Conservancy;
- Third World Academy of Sciences (TWAS);
- UN World Heritage Convention;
- United Nations Children's Fund (UNICEF);
- United Nations Development Programme (UDEP);
- United Nations Environment Programme (UNEP);
- United Nations HABITAT;
- United Nations University (UNU);
- United States Agency for International Development (USAID);
- World Health Organisation (WHO); and
- World Resources Institute (WRI).

A number of funding options are feasible for the Lake Tana Biosphere Reserve and has to be researched during interviews with relevant stakeholders in the area. Furthemore, for the Kafa Biosphere Reserve a 'fundraising strategy' has been prepared that can provide a framework for potential fundraising activities for the Lake Tana Biosphere Reserve. Pascall (2013) lists the following potential sources or options of finance for the Lake Tana Biosphere Reserve:

a) **Governmental Contributions (i.e. Federal, Regional and Zonal):** This will constitute an important source for covering the regular biosphere reserve management costs.

b) **Conservation Trust Fund:** If this is an option or any other kind such as an endowment, sinking or revolving fund then it should be evaluated in the near future. However, a reliable structure for receiving, managing and spending funds has to be built up first.

c) **International governmental and non-governmental donors:** In the case of the Kafa Biosphere Reserve approximately 97% of its funding derives from NABU. Currently, NABU provides funding for the establishment of the Lake Tana Biosphere Reserve but for the long-term security a variety of these funding donors are necessary.

d) **Private Donations:** Private donations can be sought nationally as well as internationally with certain pre-conditions to attract donors such as intended use of donations or incentives for potential donors (i.e. ways of involvement, a certificate, sponsorships, etc.).

e) **Corporate funds:** Companies could become involved in the Lake Tana Biosphere Reserve through their Corporate Social Responsibility (CSR) actions. To attain and attract corporate funds requires significant up-front effort, researching different companies' past CSR activities, and providing interest for companies to be involved in the Lake Tana Biosphere Reserve. Corporate engagement can be stopped by the company at any time, on the other hand, if relations develop well, long-term partnerships can evolve.

5.10. The recognition of Lake Tana as UNESCO Biosphere Reserve

Following all these endeavors aiming at sustainable development and conservation of resources in the area, the regional and federal government with the support from NABU applied to have the area registered by UNESCO as a Biosphere Reserve.

After three years of preparation by NABU and its partners, the application was filed in September 2014, registration formalities were met and ultimately the Lake Tana Biosphere Reserve was recognized as a UNESCO Biosphere Reserve on the 27th UNESCO meeting held in Paris on the 9th of June 2015.

Figure 15: Impressions from the Inauguration Celebration for Lake Tana Biosphere Reserve in 2015.

Overall, 695,885.056hectares of land were registered and included as biosphere reserve in the 3 administrative zones (South Gondar, North Gondar and West Gojjam). Next to the Bahir Dar City Administration, 9 Woredas namely: Bahir Dar Zuria, Dera, Fogera, Libokekem, Gondar Zuria, Dembia, Alefa, Takusa and North Achefer are included in the biosphere reserve. The Lake Tana Biosphere Reserve includes 137 kebeles with the usual zonation comprising three land use zones: core, buffer and development zones. The Core Zone comprises of 3.3 % of the total Biosphere Reserve area. It shall be totally free from reach of humans for its value for conservation of biodiversity. (For detailed zonation of core zone, please refer annex 1). Only restricted activities, pertaining research and scientific studies, are allowed.

The buffer zones are mostly found around the core zone while sometimes they can be delineated independently. Buffer zones comprise 27% of the total area of the Lake Tana Biosphere Reserve. Activities, such as ecotourism, agricultural activities and fishery are practiced.

The development or transition zone is the largest zone that comprises 69.7 % of the total area. In this zone activities are possible that do not have any negative impact neither on the natural resources development nor on the sustainable use of them.

Table 13: Lake Tana Biosphere Reserve Zones.

Lake Tana Biosphere Reserve Zones	Dry Land in hectare	Water Body in hectare	Total area in hectare
Core zone	7,699,619	15,141,965	22,841
Buffer zone	30,968,976	156,597,689	187,566,66
Transition zone	353,297,400	131,179,400	485, 476,806
Total area in Hectare			**695,885,056**

A biosphere reserve differs from other protected areas in the sense that it is owned and conserved by the community. Many national parks are keeping people outside with fences and guards, while the biosphere reserve is protected by the community itself and their behaviour. As the community is aware of the benefits of the biosphere reserve, they are accepting the necessary infringements, e.g. non-disturbance of core zones.

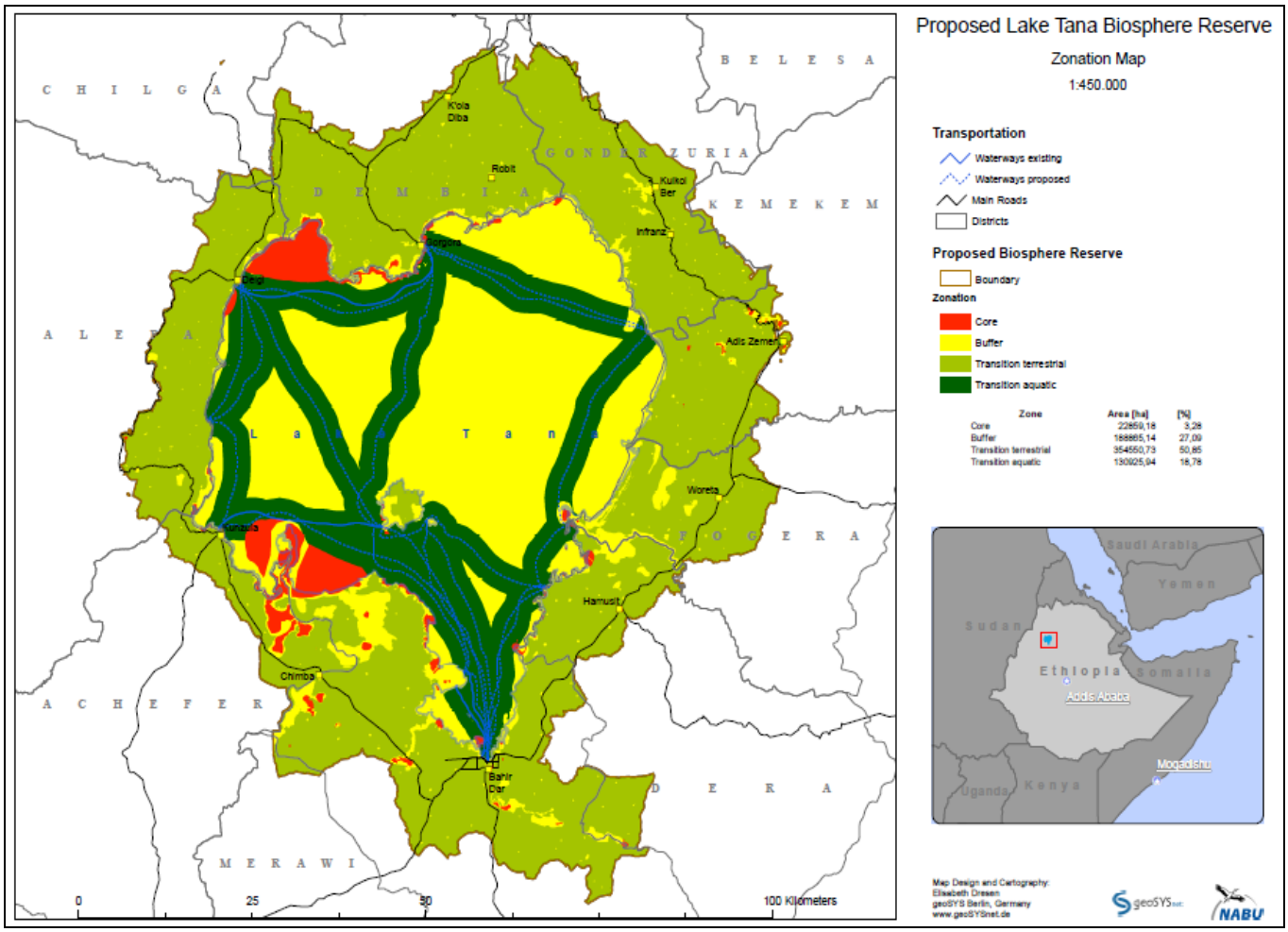

Figure 16: Map of the Lake Tana Biosphere Reserve boundaries.

5.11. Benefits of Lake Tana as a UNESCO Biosphere Reserve

The recognition of the Lake Tana Biosphere Reserve as UNESCO biosphere reserve in 2015 offered the area special status - it is one of 668 biosphere reserves in the world.

Preliminary studies of the project indicated that the recognition of Lake Tana biosphere reserve helps to ensure a sustainable development of the surrounding using the natural, social and economic values enshrined in the locality. Lake Tana and its vicinity accommodate various rivers, wetlands, residence areas, monasteries, churches, forests, historical and cultural antiquities as well as other natural resources. The establishment of the biosphere reserve is crucial to bring about sustainable development in the area and to conserve the natural resources for future generations.

The recognition helps to bring about economic development in the Lake Tana catchment, foster a more effective conservation of natural resources and biodiversity, as well as integrates conservation endeavors in the area. The establishment of the Lake Tana Biosphere Reserve will have the following detailed significances:

- Sustainable conservation of the ecosystems of Lake Tana and its surroundings;
- Minimizing threats to biodiversity and ecosystems of the Lake Tana region as well as natural and cultural antiquities;
- Enabling the community to benefit lastingly from the natural and cultural resources;
- Creating various new job opportunities for the local community using the great potentials of natural resources in the area, such as ecotourism, fishery and the manufacturing of agricultural products, thereby helping the society to enhance its quality of life;
- Coordinating stakeholders to create a better future for the area;
- Undertaking awareness creation activities in local communities for nature conservation, sustainable development and on various technical topics;
- Facilitating an immediate benefit for local communities from micro and small enterprises through cooperative systems;
- Attracting domestic and foreign donors and researchers to address solutions for various local problems;
- Sharing information and attracting research;
- Working on the basis of a good administrative structure and a coordinated development plan;
- Contributing to the realization of a governmental strategic plan on green economy, (i.e: ecotourism, fish production on ponds, wetland management and agro-processing among other).

Lake Tana is our life – let us do our part and protect it!

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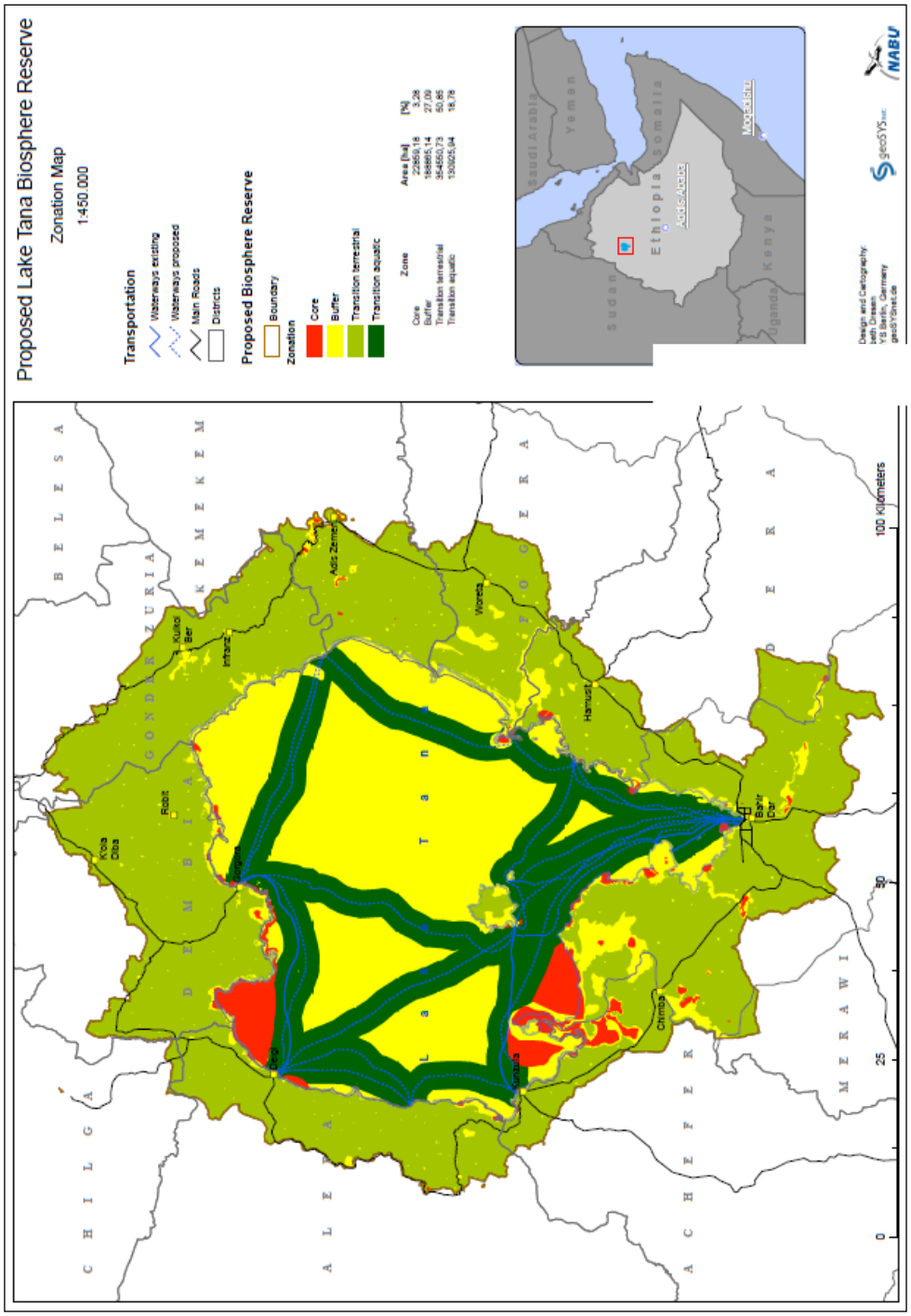
7. Annex

7.1.Annex 1. Map of Lake Tana Biosphere Reserve



7.2.Annex 2. The areal coverage of core zones and their respective kebeles

No.	*Core Zone/ Reserves*	*Area/ha*	*Woreda*	*Kwbele*
1	Aba Gerima Island	155.9987	Bahir Dar City	Shimibit
2	Millennium park Abay River Island	6.050541	“ ”	Shum Abo
3	Beles mesk	8.436828	Alefa	Dengel Ber
4	Warkawesen Kuante Jankaw	10.65739	Alefa	“
5	Menekuse Dinday	54.99657	Alefa	“
6	Ahcha mangur, Wenbera Eyesus	98.50416	Alefa	Dengel Ber & Ahcha Mangur
7	Yigoma Huletu	16.581229	Bahir Dar Zuria	Yigoma huletu
8	Daki Sanctuary	62.557336	“ ”	Dahana Mesenta
9	Tomit Sanctuary	13.13578	“ ”	“ ”
10	Millennium park, Sebatamit	65.919193	“ ”	Sebatamit
11	Lijome drekuna wuhaw	6,155.483693	“ ”	Lijome
12	Lata Amba 1	101.323895	“ ”	Lata Amba
13	Deq-Goza	27.821685	“ ”	Deq
14	Deq-Gurer	5.459437	“ ”	“
15	Deq -Leketa	25.90507	“ ”	“
16	Deq menast Tetiy	19,00631	“ ”	“
17	Gorgora sanctuary	82.442525	Dembia	Gorgora
18	Gurgara to Chemera-Derekuna wuha	8,133.635193	Dembia nad Takusa	Chemera, Tezeba, Genbara, Aberjiha, Dahina wawa, Mange, Fantayu Narchacha, GurandiWenbaba
19	Jarjer sarye 1	122.212001	Denbia	Jarjer Abanova
20	Megech River enterance	122.637254	“ ”	Tana woyina and Adisge
21	Bebirbira-Tana woyna	25.708146	“ ”	Tana woyina
22	Jarjer Sarye 2	1.719992	“ ”	Jarjer Abanova
23	Nedadit- Achera	65.797928	“ ”	Seraba dablo and Achera
24	Dirma River Mouth	143.4816	“ ”	Seraba Dablo and Abrhajira Dahna wawa
25	Abalay-Achera	43.960121	“ ”	Achera
26	Kuli Forest	20.299139	Alefa	Amchaho
27	Aba Bailo Forest	27.09179	Libo kemkem	Agid Kirgna
28	Jinjero Mountain	4.757619	“ ”	Kab
29	Kolelat-Sendo Forest	55.965623	“ ”	Wusha Tirs

30	Gimajer Forest	1.983771	“ ”	Yifag
31	Silkesa	3.293764	“ ”	Ginaza Silkisa
32	Aba Mata Kala Yohannes	18.720962	“ ”	Tara Gedam
33	Awstatiwos	4.638048	“ ”	“ ”
34	Ezkias	1.480897	“ ”	“ ”
35	Wenbera	36.079119	“ ”	“ ”
36	Ararat	25.948095	Bahir Dar city	Urra
37	Gami Mesk	19.939237	“ ”	“ ”
38	Lumami	104.1482	“ ”	Weramit
39	Enfranz sanctuary	165.23392	“ ”	Weramit, wegelsa and Yibab
40	Millennium Park- Addis Alem	31.748162	“ ”	Addis Alem
41	Legidiya 1	431.504696	North Achefer	Legidia
42	Legidiya 2	266.824997	“ ”	“ ”
43	Bête Menzo Island	3.048614	Dera	Korata
44	Mitsli Fasiledes	8.370984	“ ”	Tana Metsli
45	Tinshu Ginjaba Deset	2.394509	“ ”	Mirafit
46	Abay River Mouth sanctuary	12,23373	Bahir dar city	Shum Abo
47	Lata Amba 2	158.920325	Bahir Dar Zuria	Lelata Amba andDahina Mesenta
48	Yiganda sanctuary 2	167.899839	Bahir Dar city	Yiganda
49	Debranta-Wenjeta sanctuary	25.667337	Bahi Dar Zuia	Debranta and Wenjeta
50	Debranta sanctuary	268.491057	“ ”	Debranta
51	Sekelet lijome bushy area	54.189176	“ ”	Sekelet and lijome
52	Sekelet sanctuary, including water body	143.877767	“ ”	Sekelet
53	Astumit sanctuary2	69.187862	North Achefer	Astumit
54	Sekelet sanctuary and water body 2	52.734601	Bahir Dar zuria	Sekelt
55	Astumit sanctuary	1,674.517395	North Achefer	Astumit
56	Yitem Forest	21.592869	Dera	Mirafit
57	Tana Kirkos sanctuary	2.776852	Dera	Tana mitsli
58	Goy	19.9131	Takusa	Goy
59	Mendeaba Forest	85.773241	Libo kemkem	Aaaaaberjeha
60	From Dengecha fisash to Lam maderia	14.313936	Dera	Mirafit
61	Mirafit-kurt	3.618555	Dera	“ ”

62	Lata Amba 3	129.969913	Bahr Dar Zuria	Lata Amba
63	Astumit water body	2,315.254144	North Achefer	Astumit
64	Abebayehu Forest	21.931482	Libo kemkem	Angot
65	Amba Mountain	50.87497	Libo kemkem	Agela
66	Millennium Park-Dasera	61.723427	Bahir Dar city	Dasera
67	Enfranz-Yibab	1.811684	“ ”	Yibab
68	Dana Mesenta	4.726501	Bahr Dar Zuria	Dahina Mesenta
69	Yiganda sanctuary	29.615655	Bahr Dar City	Yiganda
70	Gelda river mouth and Bosit	149.08903	Dera	Korata
71	Gubgube Forest and Water Boy	251.61717	“ ”	Tana Mitsli
72	Ahun Weta	143.935625	Dera and Fogera	Wagetera and Tana Mitsli
73	Tana kirkos Water body	37.20811	Dera	Tana mitsli
74	MirafitAbara	23.523606	“ ”	Mirafit
75	Kunzila zuria sankta	3.487723	North Achfer	Kunzila zuria
76	Kunzila zuria St. George Church Area	10.308146	North Achefer	Kunzila zuia
77	Kunzila zuria, mouth of the hydroelectric power dam	16.911221	“ ”	“ ”
78	Korata sanctuary	11.129201	Dera	Korata
	Lumpsum Totol	**22,841.58**		

7.3. Annex 3: List of Trees and Shrubs, Birds, Mammals and Reptiles of Lake Tana Biosphere Reserve

A. List of Common Tree and Shrub Species of Lake Tana Biosphere Reserve

#	Species Name	Family name	Category	Endemics
1	Acacia abyssinica Hochst. ex Benth.	Fabaceae	Tree	NE
2	Acacia albida Delile	Fabaceae	Tree	NE
3	Acacia brevispica Harms	Fabaceae	Scrambler	NE
4	Acacia hockii De Willd.	Fabaceae	Shrub	NE
5	Acacia seyal Del. var. Seyal Delile	Fabaceae	Tree	NE
6	Acanthus arboreus Forssk. var. ruber Engl.	Acanthaceae	Shrub	NE
7	Acanthus polystachyus Delile	Acanthaceae	Shrub	NE
8	Acanthus senni Chiov.	Acanthaceae	Shrub	NE
9	Acokanthera schimperi (A. DC.) Schweinf	Apocynaceae	Shrub	NE
10	Albizia gummifera (J.F. Gmel.) C.A.Sm.	Fabaceae	Tree	NE
11	Albizia malacophylla (A. Rich.) Walp.	Fabaceae	Tree	NE
12	Albizia schimperiana Oliv.	Fabaceae	Tree	NE
13	Alisma plantago-aquatica L.	Alismataceae	Herb	NE
14	Allophylus abyssinicus (Hochst.)	Sapindaceae	Tree	NE
15	Apodytes dimidiata Arn.	Icacinaceae	Tree	NE
16	Bersama abyssinica Fresen.	Melinthaceae	Tree	NE
17	Bridelia micrantha (Hochst.) Baill.	Euphorbiaceae	Tree	NE
18	Buddleja polystachya Fresen.	Loganiaceae	Tree	NE
19	Calpurnea aurea (Ait.) Benth.	Fabaceae	Shrub	NE
20	Carex peregrine Link	Cyperaceae	Herb	NE
21	*Carissa edulis*	Apocynaceae	Tree	NE
22	Carissa spinarum L.	Apocynaceae	Shrub	NE
23	Cassia petersiana Bolle in Peters	Fabaceae	Shrub	NE
24	Celtis africana Burm. f	Ulmaceae	Tree	NE
25	Centella asiatica (Linn.) Urb.	Apiaceae	Herb	NE
26	Chionanthus mildbraedii	Oleaceae	Tree	NE
27	Citrus auranteus L.	Rutaceae	Shrub	NE

28	Clausena anisata (Willd.) Benth.	Rutaceae	Shrub	NE
29	Clerodendrum myricoides (Hochst.)	Lamiaceae	Shrub	NE
30	Clutia abyssinica Jaub. and Spach.	Euphorbiaceae	Shrub	NE
31	Coffea arabica L.	Rubiaceae	Tree	NE
32	Croton macrostachyus Del	Euphorbiaceae	Tree	NE
33	Dichrostachys cinerea L.	Fabaceae	Shrub	NE
34	Diospyros abyssinica (Hiern) P. White	Ebenaceae	Tree	NE
35	Diospyros mespiliformis A. DC.	Ebenaceae	Tree	NE
36	Dodonaea angustifolia L.f.	Sapindaceae	Shrub	NE
37	Dombeya torrida (J.F. Gmel.) Bamps	Sterculaceae	Tree	NE
38	Dovyalis abyssinica (A. Rich.) Warb.	Flacourtiaceae	Shrub	NE
39	Ehretia cymosa Thonn	Boraginaceae	Tree	NE
40	Embelia schimpri Vatke	Myrsinaceae	Shrub	NE
41	Erythrina abyssinica Lam. ex DC.	Fabaceae	Tree	NE
42	Erythrina brucei Schweinf	Fabaceae	Tree	E
43	Eucalvptus camaldulensis Dehnh	Myrtaceae	Tree	NE
44	Eucalyptus globulus Labill.	Myrtaceae	Tree	NE
45	Euclea racemosa subsp. schimperi (A. DC.) P. White	Ebenaceae	Shrub	NE
46	Euphorbia ampliphylla Pax	Euphorbiaceae	Tree	NE
47	Euphorbia tirucalli L.	Euphorbiaceae	Tree	NE
48	Ficus ovata Vahl	Moraceae	Tree	NE
49	Ficus sur Forssk.	Moraceae	Tree	NE
50	Ficus sycomorus L.	Moraceae	Tree	NE
51	Ficus thonningii Blume	Moraceae	Tree	NE
52	Ficus vasta Forssk.	Moraceae	Tree	NE
53	Flacourtia indica (Burm. f) Merrill	Flacourtiaeae	Shrub	NE
54	Fluggea virosa (Willd.) Voigt.	Euphorbiaceae	Shrub	NE
55	Galiniera saxifraga (Hochst.) Bridson	Rubiaceae	Shrub	NE
56	Gardenia volkensii K. Schum	Rubiaceae	Shrub	NE
57	Grewia bicolor Juss.	Tiliaceae	Shrub	NE
58	Grewia vilosa Willd.	Tiliaceae	Shrub	NE
59	Guineense	Piperaceae	Tree	NE
60	Hagenia abyssinica (Bruce) J.F. Gmel.	Rosaceae	Tree	NE

61	Heteromorpha trifoliata (Wendl.)	Apiaceae	Shrub	NE
62	Hypericum revolutum Vahl	Hypericaceae	Shrub	NE
63	Juniperus procera Hochst. ex Endl.	Cupressaceae	Tree	NE
64	Justicia flava (Forssk.) Vahl	Acanthaceae	Herb	NE
65	Justicia ladanoides Lam.	Acanthaceae	Shrub	NE
66	Lantana camara L.	Verbenaceae	Shrub	NE
67	Lepidotrochilia volkensii (Guerke)	Meliaceae	Tree	NE
68	Maesa lanceolata Forssk.	Anacardiaceae	Tree	NE
69	Maytenus arbutifolia (A. Rich.) Wilczek	Celastraceae	Shrub	NE
70	Maytenus obscura (A. Rich.) Cufod.	Celastraceae	Shrub	NE
71	Maytenus serrata (Thunb.)	Celastraceae	Shrub	NE
72	Microchloa kunthii Desv.	Poaceae	Tree	NE
73	Millettia ferruginea (Hochst.) Bak	Fabaceae	Tree	NE
74	Mimusops kummel A. DC.	Sapotaceae	Tree	NE
75	Myrsine africana L.	Myrsinaceae	Shrub	NE
76	Nuxia congesta R. Br. ex Fresen.	Loganiaceae	Tree	NE
77	Olea europaea (Wall. ex. DC) Cifferri	Oleaceae	Tree	NE
78	Olinia rochetiana Juss.	Olinaceae	Tree	NE
79	Osyris quadripartita Salzm. ex Decne.	Santalaceae	Shrub	NE
80	Otostegia integriflia Benth.	Lamiaceae	Shrub	NE
81	Oxyanthus speciosus DC.	Rubiaceae	Shrub	NE
82	Pavetta. Abyssinica Fresen.	Rubiaceae	Shrub	NE
83	Phoenix reclinata Jacq.	Palmaceae	Tree	NE
84	Phytolacca dodecandra L' Herit	Phytolaccaceae	Shrub	NE
85	Pittosporum viridiflorum Sims	pittosporaceae	Tree	NE
86	Podocarpus falcatus Thunb. R. Br. ex Mirb.	Podocarpaceae	Tree	NE
87	Premna schimperi Engl.	Lamiaceae	Shrub	NE
88	Procera	Apocynaceae	Tree	NE
89	Prunus africana Hook. f. Kalkm.	Rosaceae	Tree	NE
90	Rhamnus staddo A. Rich.	Rhamnaceae	Shrub	NE
91	Rhus glutinosa A. Rich.	Anacardiaceae	Shrub	NE
92	Rhus retinorrhea Steud ex Oliv.	Anacardiaceae	Shrub	NE
93	Ricinus communis L.	Euphorbiaceae	Tree	NE

94	Rosa abyssinica R. Br. ex Lindl	Rosaceae	Shrub	NE
95	Rothmannia urcelliformis (Hiern) Robyns	Rubiaceae	Tree	NE
96	Rumex nervosus Vahl.	Polygonaceae	Shrub	NE
97	Ruttya speciosa (Hochst.) Engl.	Acanthaceae	Shrub	NE
98	Salix subserrata Willd.	Salicaceae	Tree	NE
99	Sapium ellipticum (Hochst.) Pax (Schellenb.)	Euphorbiaceae	Tree	NE
100	Schefflera abyssinica A. Rich.	Araliaceae	Tree	NE
101	Scolopia theifolia Gilg,	Flacourtiaceae	Shrub	NE
102	Senna didymobotrya Fresen.	Fabaceae	Shrub	NE
103	Senna occidentalis (L.) Link	Fabaceae	Shrub	NE
104	Senna petersiana (Bolle) Lock	Fabaceae	Shrub	NE
105	Senna singueana (Del.) Lock	Fabaceae	Shrub	NE
106	Sesbania sesban (L.) Merr.	Fabaceae	Shrub	NE
107	Setaria atrata Hack.	Poaceae	Shrub	NE
108	Sideroxylon oxanthus Hutch.and Bruce	Sapotaceae	Shrub	E
109	Solanum giganteum Jacq.	Solanaceae	Shrub	
110	Stereospermum kunthianum Cham.	Bignoniaceae	Tree	
111	Syzygium guineense (Willd.) DC.	Myrtaceae	Tree	
112	Teclea nobilis Del.	Rutaceae	Tree	
113	Terminalia brownii Fresen.	Combretaceae	Tree	
114	Turraea holstii Guerke	Meliaceae	Tree	
115	Vepris dainellii (Pich. -Serm.) kokwaro	Rutaceae	Tree	E
116	Verbena officinalis L.	Verbenaceae	Shrub	
117	Vernonia amygdalina Del.	Asteraceae	Tree	
118	Vernonia leopoldii Sch.Bip	Asteraceae	Shrub	E
119	Vernonia auriculifolia Hiern.V. sp.	Asteraceae	Shrub	
120	Ximenia americana L.	Olacaceae	Shrub	

B. List of Common Botanical Species of Lake Tana Biosphere Reserve

No.	Amharic name	English name	Botanical Species	Family
1	ግራር	*Acacia*	*Acacia spp.*	Fabaceae
2	ከሸሸሌ		*Acanthus senni*	Acanthaceae
3	ሰሳ		*Albizia spp.*	Fabaceae
4	ሽንኩርት	*Onion*	*Allium cepa*	Liliaceae/Alliaceae
5	አሉማ		*Amaranthus spinosus*	Amaramthaceae
6	ለውዝ	*Ground nut*	*Arachis hypogaea*	Fabaceae
7	አርከቶትስ		*Arctotis stoechadifolia*	Asteraceae
8	ነ ጨእሸህ		*Argemone mexicana*	Papaveraceae
9	ኒም	*Nym*	*Azadirachta indica*	Meliaceae
10	ዳያሲ		*Bellis perennis*	Asteraceae
11	ጥቅልነ መነ	*Cabbage*	*Brassica oleracea*	Brassicaceae
12	ገ ሚሮ		*Capparis tomentosa*	Capparidaceae
13	በርበሬ	*Pepper*	*Capsicum annum*	Solanaceae
14	ፓፓያ	*Papaya*	*Carica papaya*	Caricaceae
15	አጋም		*Carissa spp.*	Apocynaceae
16	ያበሻሱፍ		*Carthamus tinctorius*	Asteraceae
17	አርዘሊባኖስ		*Casuarina equisetifolia*	Casuarinaceae
18	ጫት	*Khat*	*Catha edulis*	Celastraceae
19	ሽምበራ	*Chickpea*	*Cicer arietinum*	Fabaceae
20	ያህያእሾህ		*Cirsium vulgare*	Asteraceae
21	ሎሚ	*Lemmon*	*Citris limon*	Rutaceae
22	ትርንጎ		*Citrus medica*	Rutaceae
23	ብርቱካን	*Ornage*	*Citrus sinensis*	Rutaceae
24	ልምጭ		*Clausena anisata*	Rutaceae
25	ቡና	*Coffee*	*Coffee spp.*	Rubiaceae
26	ጥንጅት		*Combretum collinum*	Comberetaceae
27	አቫሎ		*Combretum molle*	Comberetaceae
28	የ ወሃአንጉር		*Commelina benghalensis*	Commelinaceae
29	ዋንዛ		*Cordia africana*	Boraginaceae
30			*Coreopsis spp.*	Asteraceae
31	ምኳና		*Croton macrostachyus*	Euphorbiaceae

32	የፈረንጅጥድ	*Junipres*	*Cupress lustinica*	Cyperaceae
33	ደንገል	*Papayrus*	*Cyperus papyrus*	Cyperaceae
34	እፀፋሪስ		*Datura stramonium*	Solanaceae
35	የድሬደዋዛፍ		*Delonix regia*	Fabaceae
36	ክትክታ		*Dodonaea angustifolia*	Sapindaceae
37	ለንቋጣ		*Dombeya torrida*	Sterculiaceae
38	ቀይባህርዛፍ	*Eucalyptus*	*E. Camaldulensis*	Myrtaceae
39	የሽቶባህርዛፍ	*Red Eucalyptus*	*E. Citriodora*	Myrtaceae
40	ቀንጥፍጥፋ		*Entada abyssinica*	
41	ቁልቋል	*Cactus*	*Euphorbia abyssinica*	Euphorbiaceae
42	ቅንጭብ		*Euphorbia tirucalli*	Euphorbiaceae
43	በለስ		*Ficus carica*	Moraceae
45	የጎማዛፍ	*Rubber Tree*	*Ficus elastica*	Moraceae
46	ሾላ	*Fig tree*	*Ficus sur*	Moraceae
47	ባንባ		*Ficus sycomorus*	Moraceae
48	ዋርካ		*Ficus vasta*	Moraceae
49	ግራቪሊያ		*Gravilla robusta*	Proteaceae
50	ኑግ	*Lean seed*	*Guizotia abyssinica*	Asteraceae
51	ኩርባ/አሜኬለ		*Hygropahila schulli*	Acanthaceae
52			*Indigofera sp.*	Fabaceae
53			*Ipomoea purpurea*	Convolvulaceae
54	የጠበንጃዛፍ		*Jacaranda mimosifolia*	Bignoniaceae
55	ጃትሮፋ	*Jatrofa*	*Jatropha curcas*	Euphorbiaceae
56	ጥድ	*Junipres*	*Juniperus procera*	Cupressaceae
57	ስሚዝ		*Justitia schimperana*	Acanthaceae
58	ጓያ		*Lathyrus sativus*	Leguminosae
59	ምስር	*Lentill*	*Lens culinaris*	Fabaceae
60	ሉኪና		*Leucaena leucocephala*	Fabaceae
61	ማንጎ	*Mangoe*	*Magnifera indica*	Rubiaceae
62	አጣጥ		*Maytenus gracilipes*	Celasteraceae
63	ሚሊያ		*Melia azedarach*	Meliaceae
64	ብርብራ		*Milletia ferruginea*	Fabaceae
65	እሸህ		*Mimusops kummel*	Sapotaceae

66	እንጆሪ	*Strawberry*	*Morus alba*	Moraceae
67	ሙዝ	*Bannana*	*Musa sapientum*	Musaceae
68	አደስ		*Mytenus communis*	
69	ጥቁርአዝሙድ	*Black Cummon*	*Nigella sativa*	Ranunculaceaec
70			*Nymphaea caerulea*	Nymphaeaceae
71			*Nymphoides indica*	Poaceae
72	ዳማክሲን		*Ocimum lamiifolium*	Lamiaceae
73	ዌራ	*Olive*	*Olea spp.*	Oleaceae
74	በለስቁልቋል		*Opuntia cylindrica*	Cactaceae
75	ሩዝ	*Rice*	*Oryza glaberrima*	Poaceae
76	አቮካዶ	*Avoccado*	*Persea americana*	Lauraceae
77	ዘንባባ/ሰሌን	*Palm Tree*	*Phoenix reclinata*	Arecaceae
78	ዝግባ	*Zigba*	*Podocarpus falcatus*	Podocarpaceae
79	ጥቁርእንጨት		*Prunus africana*	Rosaceae
80	ዘይቱን	*Guava*	*Psidium guajava*	Myrtaceae
81	ጌሾ	*Hobbs Tree*	*Rhamnus prinoides*	Rhamnaceae
82	ቀጋ		*Rosa abyssinica*	Rosaceae
83	ፅጌረዳ		*Rosa spp.*	Rosaceae
84	ሳስባንያ		*Sasbania sesban*	Leguminaseae
85	ጠፍአዳም		*Satereja paradoxa*	Lamiaceae
86	ቁንዶበርበሬ		*Schinus molle*	Anacardiaceae
87	ሰርክ አበባ		*Senna didymbotrya*	Fabaceae
88			*Sesbania sesban*	Fabaceae
89	እንቧይ		*Solanum indicum*	Solanaceae
90	ድንች	*Potatoes*	*Solanum tuberosum*	Solanaceae
91	ዶክማ		*Syzygium spp.*	Myrtaceae
92			*Trifolium acaule*	Fabaceae
93	አብሽ		*Trigonella foenum*	Fabaceae
94	አቱች		*Verbena officinalis*	Verbenaceae
95	ግራዋ		*Vernonia amygdalina*	Asteraceae
96	የሴት ምላስ		*Xanthium spinosum*	Asteraceae

97	እንኮይ		*Ximenia americana*	Tiliaceae

C. List of Common Mammals and Reptiles of Lake Tana Biosphere Reserve

S/N	Local Name	Scientific Name	Common Name
1	Nebir	*Panthera pardus*	Leopard
2	Midako	*Silvicopra grimmer*	Antelope
3	Kebero	*Canis aureus*	Common jackal
4	Tera Jib	*Hyaena hyaena*	Striped hyaena
5	Tinchel	*Lopus starkii*	Rabbit
6	Zinjero	*Papio Anubis*	Anubis baboon
7	Sesa	*Oreothragus oreothragus*	Klippspringer
8	Faro	Ichneumia albicauda	White-Tailed Mongoose
9	Silemetimat	*Genetta Sp*	Genet
10	Jart	*Hystrix cristata*	Crested porcupine
11	Aner	*Felis serval*	serval cat
12	Awuchi	*Orycteropus afer*	Aardvark
13	Dikula	*Sylvicapra Sp*	Bushbuck
14	Asama	*Potamochoerus larvatus*	Bushpig
15	Bihor	*Redunka redunka*	Bohr reedbuck
16	Tera Tota	Cercopithecus aethiops	Vervet monkey
17	Gureza	*Colobus polykomos*	Colobus monkey
18	Shikoko	*Procavia capensis*	Rock hyrax
19	Ebab		Snakes
20	Zendo		Python
21	Arjano	*Veranus niloticus*	Nile monitor
22	Gumare	*Hypopotamus amphibies*	Hyppopotamus
23	Tirgn	*Civetictis civetta*	African Civet
24	Muchekay	*Orycteropus afer*	Ardvark
25	Kerkero/Riya	*Phacochoerus africanus*	Warthog
26	Filfel	*Trachytocytes spelender*	Mole
27	Ayt		Rat
28	Enkurarit		Frog
29	Gurt		Toad
30	Kemer Jib	Proteles cristatus	Aardwolf
31	Azo	Crocodilus niloticus	Crocodil

D. List of Common Bird Species of Lake Tana Biosphere Reserve

Species or group name	#	Common name of birds	Amharic/ local Name	Remark
Avocet	1	Pied Avocet	አፈ ቁልምም አቮሴት	
Babbler	2	White rumped babbler	ነጭ ላእላይ ጅራተ ከድን መዘምር	
Barbet	3	Banded Barbet	ሽልምልም ጋርዴም	Endemic
	4	Blackbilled Barbet	ጥቁር አንገት ጋርዴም	
	5	Double toothed Barbet	ድርብ ጥርስ ጋርዴም	
Bateleur	6	Bateleur	መጦሎኒ	
Batis	7	Black headed	ራስ ጥቁር ባቲስ	
Bee eater	8	Blue breasted	ሰማይ ደረት ንበበል	
	9	Little	ትንሽ ንበበል	
	10	Northern Carmine	ኮክማ ንበበል	
Bishop	11	Black winged	እራስ ብርቱካን ጨረባ	
	12	Northern red	ቀይ ጀርባ ጨረባ	
	13	Yellow crowned	ቢጫ ዘውድ ጨረባ	
Blackcap	14	Blackcap	ጥቁር ቆብ ዋብለር	
Boubou	15	Tropical (Ethiopian)	የኢትዮጵያ ወፈ-ያሬድ	
Brubru	16	Brubru	ብርቡር	
Bulbul	17	Common	ተራ ጉትያ ወፍ	
Bunting	18	Ortolan	ስንዴሽት በንቲንግ	
	19	Cinnamon-breasted (rock)	የአለት በንቲንግ	
Bustard	20	Black bellid	ጥቁር ሁድ ኩርኩሜ	
Buzzard	21	Augur	ገዴ	
Camaroptera	22	Gray backed	ጅራቴ በጀርባ	
Canary	23	Yellow fronted	ግንባረ ቢጫ ካነሪ	
Chat	24	Mockin gcliff	ክንፈ ነጭ የቋጥኝ ወፍ	
Chiffchaff	25	Common	ችፍችፍ	
Custicola	26	Stout	የደጋ ሲሰቲኮላ	
Citril	27	Africn	ጥላሽት አይን ሲትሪል	
Coot	28	Red knobbed	ቀይ አንፖል ግንባር የውሃ ደሮ	
Coucal	29	Blue headed	አንፀባራቅ ሰማያዊ ራስ ኩኩል	
Cordonbleu	30	Red checked	ጉንጨ ቀይ ድንቢጥ	
Cormorant	31	Reed	ጅራተ ረጅም አሳ ወጊ	
	32	White breasted	ደረተ ነጭ አሳ ወጊ	
Crake	33	Black	የሰይጣን ዶሮ	
Crane	34	Black crown	ሎንጋ ሽመላ	
	35	Common (Eurasian)	የደንቢያ ሽመላ	
	36	Wattled	ባለ እንጥል ሽመላ (አባኪሾ	
Crombec	37	Northern	ጅራተ ጎማዲት ከሮምቤክ	
Crow	38	Cape crow	ጥቁር ቁራ	

	39	Pied	ቡሬ ቁራ	
Cuckoo	40	African cuckoo	ግራጫ ኩኩ	
Klaa’s cuckoo	41	Klaa’s cuckoo	አንፀባራቂ አረንጓዴ ኩኩ	
Curlew	42	Eurasian	የአውሮፓ ረጅም አፈድፋት መንቁር	
Darter	43	African	ለመሚት	
Dove	44	African morning	የቆላ ዋኔ	
	45	Blue spotted wood	ሰማያዊ ነጠብጣብ ክንፍ ዋኔ	
	46	Dusy Turtle	የደጋ ዋኔ	
	47	Laughing	ትንሻ ዋኔ	
	48	Lemon	የጫካ ወለል ዋኔ	
	49	Namaqua	ጥቁር ፊት ዋኔ	
	50	Red eyed	ኩኩ መለኮቴ ዋኔ	
	51	Vinaceous	ወይንማ ዋኔ	
Drongo	52	Fork-tailed	ሹካ ጅራት ድሮንጎ	
Duck	53	African black	ጥቁር ዳክዬ	
	54	Comb duck	እንቡጥ መንቁር ዝይ	
	56	Ferruginous	የፈርጎሰን ዳክዬ	
	57	Fulous	ሸክላማ ዳክዬ	
	58	White backed	ጀርባ ነጭ ዳክዬ	
	59	White faced	ቦቃ ፊት ዳክዬ	
	60	Yellow billed	ቢጫ መንቁር ዳክዬ	
Eagle	61	African fish	አሳ አውጪ ንስር	
	62	Long crested	ቁንጫሙ ንስር	
Egret	63	Cattle	የከብት ሳቢሳ	
	64	Great white	የወንዜው ሳቢሳ	
	65	Little	ትንሹ ሳቢሳ	
	66	Yellow billed	ቢጫ መንቁር ሳቢሳ	
Eremomela	67	Green-backed	አረንጋዴ ጀርማ ኤር ሞሜላ	
Falcon	68	Lanner	ቡና ጉ ን ጨመስ መር ሲላ	
Finch,	69	cut-throat	ቁ ር ጥ አ ን ገ ት ድ ን ቢ ጥ	
finfoot	70	African	ቀ ይ እ ግ ር ለ መ ሚ ት	
Firefinch	71	Red –billed	ቀ ይ መ ን ቁ ር የ ጋ ሮ ድ ን ቢ ጥ	
Fiscal	72	Common	ተ ራ ሽ ሻ ይ	
	73	Gray backed	ግ ራ ጫ ጀ ር ባ ሽ ሻ ይ	
Flamingo	74	Greater	ቆ ል ማ ሚ ት	
Flycatcher	75	Abyssinian slaty	የ አ ቢ ሲ ን ያ ዝ ን ቦ ቦ ል	
	76	African Paradise	የ ገ ነ ት ወ ፍ	
	77	Northern black	ጥ ቁ ር ዝ ን ቦ ቦ ል	
	78	Pale	ቡ ላ ዝ ን ቦ ቦ ል	
	79	Spotted	ነ ጠ ብ ጣ ብ ዝ ን ቦ ቦ ል	
Francolin	80	Clapperton’s	ፊ ተ ቀ ይ ቆ ቅ	

Gallinule	81	Allen’s (lesser)	ሰማያዊ ግንባር የረግረግ ዶሮ	
Garganey	82	Garganey	ጋርጋኒ	
Godwit	83	Black tailed	ጫፈ ጥቁር ጅራትምጉዲት	
Goose	84	African pygmy	ድንክዬ ዝይ	
	85	Blue winged	ክንፈ ሰማያዊ ዝይ	Endemic
	86	Egypian	ይብራ (የ ግብጽ ዝይ)	
	87	Spur winged	ቡሬ ዝይ (ዚብራ)	
Goshawk	88	Dark Chanting	አይጠሙነ ጥላ ቃሚጭላት	
	89	Gabar	ፊተ ብር ቱካና ማጭላት	
Grebe	90	Greater crested	ትልቁ ባለ ቁንጮ ገ ር ብ	
	91	Little	የ ውሃ ጫጩት	
Greenshank	92	Common	ተራ የ ወንዝ ፏፌ	
Guineafowl	93	Hemeted	ጅግራ	
Gull	94	Black headed	ራስ ጥቁር ገ ል	
	95	Great black headed	ትልቁ ጅር ባ ጥቁር ገ ል	
	96	Lesser black headed	ትንሹ ጀ ር ባ ጥቁር ገ ል	
Hamerkop	97	Hamerkop	የ ወንዝ አ ሙቴ	
Harrier	98	Eurasian Marsh	የ ደ ን ገ ል ጨሊሌ	
	99	Montagu’s	ጥቁር መስ መር ክ ን ፈ ጨሊሌ	
	100	Pallid	ግ ራ ጫጨሊሌ	
Herrier hawk	101	African	እ ን ቁ ላ ል ለ ቃ ሚ ጭላ ት	
Herons	102	Black headed	ጥቁር እ ራ ስ ሳ ቢ ሳ	
	103	Black crowned night	የ ለ ሊ ት ሳ ቢ ሳ	
	104	Goliath	ጉ ሊ ያ ድ ሳ ቢ ሳ	
	105	Green-backed	የ ቀ ጥ ር ሳ ቢ ሳ	
	106	Grey	ግ ራ ጫ ሳ ቢ ሳ	
	107	Purple	አ ን ገ ተ ሰ ጎ ግ ቡ ና ማ ሳ ቢ ሳ	
	108	Squacco	የ ረ ግ ረ ግ ሳ ቢ ሳ	
Hoopoe	109	Eurasian	የ አ ውሮ ፓ እ ማሆ ይ ወ ፍ ጥ	
Hornbill	110	Abyssinian Ground	የ አ ቢ ሲ ኒ ያ እ ር ኩ ም	
	111	African gray	ቅ ራ ጫ ውአ ፈ ቀ ን ድ	
	112	Hemprich’s	የ ወ ን ዜ ውአ ፈ ቀ ን ድ	
	113	Silvery –cheeked	ጉ ን ጨ ብ ራ ማ አ ፈ ቀ ን ድ	
Ibis	114	African sacred	ነ ጨ ጋ ጋ ኖ	
	115	Glossy	ወ ይ ና /ብ ር ቅ ር ቅ ጋ ጋ ኖ	
	116	Hadeda	አ ደ ን ቁ ር ጋ ጋ ኖ	
	117	Wattled	የ ደ ጋ ባ ለ እ ን ጥ ል ጋ ጋ ኖ	Endemic
Ingigobird	118	Village	ድ ን ቢ ጥ የ መ ስ ቀ ል ወ ፍ	
Jacana	119	African	ት ል ቁ ስ ን ዝ ሪ ት	
	120	Lesser	ት ን ሹ ስ ን ዝ ሪ ት	
Kestrel	121	Common	ጉ ን ጨ መ ስ መ ር ሲ ላ	

	122	Gray	ግራጫሲላ	
Kingfisher	123	African pygmy	ድንክዬ አሳ አሙቴ	
	124	Giant	ግዙፉ አሳ ዓሙቴ	
	125	Gray headed	ራስ ግራጫአሳ ዓሙቴ	
	126	Malachite	ዲንቢጥ አሳ ዓሙቴ	
	127	Pied	ቡሬ አሳ ዓሙቴ	
	128	Striped	ንቅሴ አሳ ዓሙቴ	
	129	Woodland	የ ወንዜ አሳ ዓሙቴ	
Kite	130	Black	ጥቁር መንቁር ጭልፊት	
	131	Black shoulder	ጥክሻ ጥቁር ጭልፊት	
	132	Yellow billed	ቢጫመንቁር ጭልፊት	
Lark	133	Thekla	ቹን ጫሚት ላርክ	
Lovebird	134	Black winged	ጥቁር ክንፍ ብርቅዬ በቀቀን	Endemic
Maninkin	135	Bronze	ነ ሀ ስ ማን ኪን	
Martin	136	Brown throated	ቡና ማአንገ ት ወን ጨፊ ት	
	137	Common house	ተራ ወን ጨፊ ት	
	138	Rock	የ ቋጥኝ ወን ጨፊ ት	
	139	Sand	የ ወን ዜ አሸዋ ወን ጨፊ ት	
Moorhen	140	Common	ቀይ ግን ባ ር የ ውሃ ዶሮ	
	141	Lesser	ትን ሻ የ ረ ግ ረ ግ የ ውሃ ዶሮ	
Mouthbird	142	Specked	ን ቅ ሴ ሙ ጎ ጥ ወ ፍ	
Oriole	143	Abyssinian	የ አ ቢ ሲ ኒ ያ አ ሪ ኦ ሌ	
Ospery	144	Ospery	እ ስ ፕ ረ ይ	
Owl	145	Abyssinaian long eared	የ አ ቢ ሲ ኒ ያ ጉ ጉ ት	
Oxpecker	146	Red billed	አ ፈ ቀ ይ አ ረ ጭ	
Parrot	147	Yellow fronted	ቢ ጫ ራ ስ ብ ር ቅ ዬ በ ቀ ቀ ን	Endemic
Pelican	148	Great white	ት ል ቁ ነ ጭ ሻ ላ	
	149	Pink-back	ት ን ሹ ሮ ዛ ሻ ላ	
Petronia	150	Bush petronia	ቁ ጥ ቋ ጦ ጨ ረ ባ	
Pigeon	151	Bruce’s green pigeon	ቢ ጫ ሆ ድ እ ር ግ ብ	
	152	Spechled	የ ጣ ራ እ ር ግ ብ	
	153	White collared	ባ ለ ነ ጭ ኳ ሌ ታ እ ር ግ ብ	
Pintail	154	Northern	መ ር ፌ ጅ ራ ት ዳ ክ ዩ	
Pipite African	156	Pipite African	የ ሳ ር ምድ ር የ ሰ ን ደ ዶ ወ ፍ	
	157	Plain –backed	ጀ ር ባ ለ ጥ የ ሰ ን ደ ዶ ወ ፍ	
	158	Red –throated	ቀ ይ አ ን ገ ት የ ሰ ን ደ ዶ ወ ፍ	
Plantain eater	159	Easter	ቢ ጫ መ ን ቁ ር ግ ራ ጫ ስ ኮ ር	
Plover	160	African wattled	ባ ለ እ ን ጥ ል ኩ ል ሊ ት	
	161	Black headed	ራ ስ ጥ ቁ ር ኩ ል ሊ ት	
	162	Black winged	ክ ን ፈ ጥ ቁ ር ኩ ል ሊ ት	
	163	Common ringed	ጥ ቁ ር አ ግ ድ ም ደ ረ ት ኩ ል ሊ ት	

	164	Kittlitz's	ሽሮ ቀለ ምደረት ኩልሊት	
	165	Little ringed	ትንሽ ኩልሊት	
	166	Spur winged	ነ ጭጀሮግንድ ኩልሊት	
	167	Three banded	ድርብ ጥቁር ደረት ኩልሊት	
Pratincole	168	Collared	ባለ ከራባት ፕራቲንኮል	
prinia	169	Tawny flanked	የ ጓሮ ፕሪኒያ	
Puffback	170	Nothern	ኤነ ቀይ ኘፍባክ	
Pytilla	171	Red billed	ቀይ መንቁር ፒቲሊያ	
Quails	172	Harliguine	ኩልሌ	
Rail African	173	Rail African	ቡና ማየ ወፃ ዶሮ	
	174	Rouget's	ቂጠነ ጭየ ረግረግ ዶሮ	
Raven	175	Fan tailed	ጅራተ መሸረፊት ቁራ	
Redhank	176	Spotted	ጠቃጠቆ ረጅምእግር ፋፉዬ	
Redstar	177	Common	ተራ ሬድስታርት	
Robin-chat Rueppell's	178	Robin-chat Rueppell's	የ ቁጥቋጦ ስር ሮቢን ቻት	
Roller	179	Abyssinian	የ አቢሲንያ ምዝግዝግ ሮልር	
Ruff	180	Ruff	ግር የ ወንዝ ፋፉዬ	
Sandgrouse	181	Four banded	ድርብር ብ መስ ምር የ አሸዋ ድር ጭት	
Sandpiper	182	Common	ትንሻ የ ወንዝ ፏፉዬ	
	183	Curlew	አፈ ደፋታ የ ወንዝ ፏፉዬ	
	184	Green	ጥቁር ማጀርባ የ ወንዝ ፏፉዬ	
	185	Marsh	ረግረግ የ ወንዝ ፏፉዬ	
	186	Wood	ጠቃጠቆ የ ወንዝ ፏፉዬ	
Seedeater	187	Streaky	ገ ብስ ማዘር በል	
Shikra	188	Little banded	አይነ ቀይ የ ጨረባ ጭላት	
Shoveler	189	Northern	አ ካፎ	
Shirke	190	Lesser grey	ግራጭሸሻይ	
	191	Red backed	ቀይ ጀርባ ሸሻይ	
	192	Red tailed	ጅራተ ቀይ ሸሻይ	
	193	Wood chat	እራሰ ቸኮሌት ሸሻይ	
Snake –eagle	194	Western banded	እባበ በል ንስር	
Snipe	195	African	የ ኢትዮጵያ ረጅም መንቁር ስናይፕ	
	196	Common	ተራ ስናይፕ	
Sparrow	197	Swainsons's	ደቡሽ ጨረባ	
Sparrowhawk	198	Little	ትንሽ የ ጨረባ ጭላት	
Sparrowlark	199	Chestnut-backed	ጀርባ ቡና ማ ጨረባ ላርክ	
Spoonbill,	200	African	ማንኪያ አፍ	
Starling	201	Greater blue –eared	ጆሮ ሰ ማያ ዊ ወማይ	
	202	Red winged	ክንፈ ቀይ ወማይ	
	203	Violet backed	ጀርባ ሀ ምራዊ ወማይ	

Stilt	204	Back winged	ጥቁር ክንፍ ረዥሜስቲልት	
Stint	205	Little	ትንሻ አጭሬ ስቲልት	
	206	Termminck's	ሰታታ ጀርባ ነ ጭስቲልት	
Stonechat	207	Common	ተራ ስቶን ቻት	
Storks	208	Abdim's	ሀምራዊ ራዛ	
	209	African open billed	አይገ ጥሜማን ቁር ራዛ	
	210	Black	ጥቁር ራዛ	
	211	Marabou	አባኮዳ/አባኪሾ	
	212	Saddled billed	ሽልምራዛ	
	213	White	ነ ጭራዛ	
	214	Wooly –necked	ሸሸ አንግት ራዛ	
	215	Yellow billed	ቢጫመን ቁር ራዛ	
Sunbird	216	Copper	መዳብ አበባ ቀሳሚ	
	217	Scarlet –chested	ደማቅ ቀይ ደረት አበባ ቀሳሚ	
	218	Tacazze	ተከዜ አበባ ቀሳሚ	
	219	Variable	እስስተ ቀለምአበባ ቀሳሚ	
Swallow	220	Barn	የ ትምነ ሽ ወን ጬሌ ት	
	221	Lesser striped	ደረተ ጭረ ት ወን ጬሌ ት	
	222	Mosque	ሞስ ክ ወን ጬሌ ት	
	223	Wire-tiailed	ቀይ ራስ ወን ጬሌ ት	
Swift	224	Nyanza	ቡና ማ ወን ጬሌ ት	
Tcharge	225	Black crowned	ጥቁር ዘ ውድ ቻ ግ ራ	
Teal	226	Common	ተራ የ አ ውሮ ፓ ቲ ል	
Tern	227	Caspain	ቀ ይ መን ቁ ር ነ ጭ ገ ል	
	228	Gull billed tern	አ መዳ ማ ነ ጭ ገ ል	
	229	Whiskered	ግ ራ ጫ ማ ነ ጭ ገ ል	
	230	White winged	ክ ን ፍ ነ ጭ ገ ል	
Thick knee,	231	Sengel	የ ሴ ኔ ጋ ል ደ ጓ ሳ እ ግ ር	
Thrush	232	African	የ ቆ ላ ጭ ሪ	
	233	Groundscraper	የ መ ሬ ት ጭ ሪ	
	234	Olive	የ ዛ ፍ ጭ ሪ	
Tinkerbird	235	Yellow fronted	ቢ ጫ ግ ን ባ ር ቲ ን ከ ር በ ር ድ	
Tit	236	White backed	ጀ ር ባ ነ ጭ ቲ ት	Endemic
Trongon	237	Narina	ና ት ሪ ና ት ሮ ጎ ን	
Turaco	238	White cheeked	ነ ጭ ከ ን ፈ ነ በ ል ባ ል ዞ ሪ ት	
Vulture	239	Egyptian	ነ ጭ ጆ ፊ አ ሞ ራ	
	240	Hooded	ቡ ና ማ ራ ስ ጆ ፊ አ ሞ ራ	
	241	Ruppell griffon	የ ገ ደ ል ጆ ፊ አ ሞ ራ	
	242	White backed	ጀ ር ባ ነ ጭ ጆ ፊ አ ሞ ራ	
Wagtail	243	African pied	የ አ ፍ ረ ካ ቡ ሬ ጠ ል ጠ ሌ	
	244	Citrine	ት ን ጎ ጠ ል ጠ ሌ	

	245	Gray	ግራጫጠልጠሌ	
	246	Mountain	የ ወን ዝ ጠልጠሌ	
	247	White	ነ ጭጠልጠሌ	
	248	Yellow	ቢጫጠልጠሌ	
Warbler	249	Buff-bellied	የ ግራር ዋብለ ር	
	250	Eurasian reed	የ አ ውሮ ፓ የ ደ ን ገ ል ዋ ብለ ር	
	251	Olivaceous	ወይራማዋ ብለ ር	
	252	Sedge	የ ግ ጭዋ ብለ ር	
Wattle eye	253	Brown throated	ቡና ማአ ን ገ ት አ ይነ እ ር ግ ብ	
Weaver	254	Baglafecht	አ ይነ ነ ጭ ጨ ፈ ባ	
	255	Spectacled	ባ ለ መነ ፀ ር ጨ ፈ ባ	
	256	Village	ጥ ቁ ር እ ራ ስ ጨ ፈ ባ	
Wheatear	257	Black eared	ጆ ሮ ጥ ቁ ር ዊ ቴ ር	
	258	Red breasted	ደ ረ ተ ቀ ይ ዊ ቴ ር	
	259	Northern	ተ ራ ዊ ቴ ር	
	260	Pied	ቡ ሬ ዊ ቴ ር	
Whinchat	261	Whinchat	ዊ ን ቻ ት	
White eye	262	African yellow	የ አ ፍ ሪ ካ ቢ ጫ ነ ጭ አ ይ ን	
	263	Abysinian	የ አ ቢ ሲ ኒ ያ ን ነ ጭ አ ይ ን	
	264	Montane	የ ደ ጋ ነ ጭ አ ይ ን	
whydah	265	Pin tailed	መ ር ፌ ጅ ራ ት ዎ ይ ድ	
	266	Exlamtory paradise	ድ ን ቅ የ ገ ነ ት እ መ ቤ ት	
widgeon	267	Eurasian	አ ውሮ ፓ ዊ ገ ን	
Widowbird	268	Fan tailed	ጅ ራ ተ መ ሸ ረ ፊ ት ዊ ዶ በ ር ድ	
	269	Yellow mantled	ጥ ቁ ር ት ከ ሻ ዊ ዶ በ ረ ድ	
Wood-hoope	270	Black billed	ጥ ቁ ር መ ን ቁ ር ጨ ፉ ሪ ወ ፎ ች	
Woodpecher	271	Bearded	ቤ ር ድ ድ ግ ን ደ ቆ ር ቁ ር	
	272	Cardinal	ጉ ን ጨ ን ቅ ሴ ግ ን ደ ቆ ር ቁ ር	
	273	Gray	ግራጫ ግንደ ቆርቁር	
	274	Gray –headed	ግራጫ ራስ ግንደ ቆርቁር	
	275	Nubian	ኑ ቢ ያ ን ግ ን ደ ቆ ር ቁ ር	
Wryneck	276	Eurasian	የአውሮፓ ራይኔኮ	

NABU, The Nature and Biodiversity Conservation Union, has promoted the interests of people and nature for more than 100 years drawing on its unwavering commitment, specialised expertise and the backing of its 625,000 members and supporters. The NGO is the largest of its kind in Germany.

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