CONSERVATION OF BIODIVERSITY OF LAKE BOSOMTWE

ENVIRONMENTAL EDUCATION SYLLABUS FOR STUDENTS AND TEACHERS AT BASIC SCHOOLS, WITH BIODIVERSITY AND WATER QUALITY MONITORING PLAN FOR SCHOOLCHILDREN

INTRODUCTION

Lake Bosomtwe is one of the many lakes in Ghana which is rich in biodiversity both flora and fauna. Aquatic and terrestrial biodiversity in the lake Bosomtwe is important from the local, national and global perspective. Friends of the Earth has been working with the local communities to conserve this biodiversity, but this and other efforts have been adversely impacted by a variety of factors. These include the lack of updated information, the weakening of traditional resource systems, (taboos, sacred groves regulations etc.), habitat degradation; and increased harvest of biodiversity resources, particularly in the fishing sector. Education, both in the formal and non-formal system, is one of the ways that could be used to conserve the biodiversity of the area and hence this syllabus.

The syllabus is designed to be integrated into the normal syllabus of the basic schools in the Lake Bosomtwe catchment area.

The syllabus has the following sessions:

1. Rationale
2. objectives
3. scope
4. how to use the syllabus
5. details of syllabus

1. RATIONALE

The environment is the sum total of everything that enables systems to operate. Every element or component of the environment has a part to play in the harmonious running of the system. This implies a balance in the interaction of the components of the environment. If this balance is however impaired environmental problems occur.

It has been observe that the environmental problems of any community are the interplay of behaviours and values of the members of the community. Therefore remedial and preventive strategies that have a wide impact are necessary to resolve the numerous environmental problems.

The environmental initiative to design an environmental education syllabus to conserve the biodiversity of the lake may be considered as the integrated study of the lake and its environment have at times negative impacts which threaten the biodiversity of the lake a comprehensive systematic and coherent activities integrated into the syllabus of Basic Schools in the catchment area of the lake is therefore of ut most importance.

2. OBJECTIVES

The general objective of the course is to help pupils to develop a sense of belonging and ownership of the lake so as to protect it.

Specifically the course is to:

a. Help pupils to identify environmental problems in their localities and how they adversely affect the bio-diversity of the lake.
b. Assist pupils to identify what they could do to help in the conservation of the biodiversity of the lake.
c. Develop in pupils' positive attitude in the management of the lake and its environment.
d. Prepare pupils' to teach their peers and their parents the need to conserve the biodiversity of the lake.
e. Develop in pupils' skills in identifying, observing, analyzing and collecting data.

3. SCOPE

The syllabus is designed for Basic Schools in Lake Bosomtwe catchment area and other schools in the lake environment area. The topics are to be integrated in subjects like Environmental Studies, Integrated Science and Agricultural Science. Environmental themes or topics have been included in these subjects. The teacher is expected to integrate these topics into the already existing ones. Where the topics are already in the syllabus the teacher should relate it to the conservation of the biodiversity of the lake. The teacher should study the lake environment of enhance learning. Teachers are therefore advised to use as much as possible, practical activities in handling the topics. Emphasis should be laid on group work and pupils contribution in class.

TEACHING/LEARNING STRATEGIES

The teaching/learning strategies to be adopted should include:

1. Observing
2. analyzing
3. investigating
4. experimenting
5. group discussion
6. describing
7. measuring
8. drawing

Before a lesson is planned, the teacher should read through the syllabus carefully noting carefully the rationale, the objectives and the teaching/learning strategies. The teacher can ask himself or herself these general questions:

- What teaching approach is the best suited to the group and the topic?
- What attitudes on my part as a teacher will encourage the pupils to learn?
- What teaching/learning aids can be used?
- How can class work be made more enjoyable?

Every topic has objective, teaching/learning strategies and notes. These are only suggestions to help the teacher. The teacher therefore is free to adopt these to enhance teaching/learning.

EVALUATION

This syllabus should not been seen as a isolated syllabus. It must be integrated into already existing syllabus. Therefore the evaluation should be part of the normal evaluation of the subject the topics are integrated into.

CLASS 1

TOPIC	OBJECTIVES	TEACHING/LEARNING ACTIVITY	NOTES
1. Source of Water	By the end of the lesson pupils should be able to:	• Take pupils to various sources of water in their locality	Source of water include rain, wells, ponds, streams, springs and

	• state the main sources of water • identify the main sources of water in their locality • say which of the sources they mostly depend on • identify a lake, river, stream	• Let pupils draw the sources of water they visited • Let pupils write the names of the sources on the sketches • Lead pupils to find out which sources they mostly depend on • Help pupils to identify from the sketches one major characteristic of the sources	lakes. Teacher to use posters/photographs to show sources not found in the area. Teacher to take note of pupils' interest
2. lake Bosomtwe and its surroundings	• Name of things that could be found around the lake	• Take pupils to the lakeside • Let them write down the names of the things they see	The things include the flora and fauna

CLASS 2

TOPIC	OBJECTIVES	TEACHING/LEARNING ACTIVITY	NOTES
1. Importance of Lake Bosomtwe	By the end of the lesson pupils should be able to: • state the uses of lakes • state the uses of Lake Bosomtwe • identify what they (pupils) benefit from Lake Bosomtwe	• Lead pupils to identify the importance of Lakes • Let pupils compile the names of lakes in the Ashanti Region and how they help the people around • Lead pupils to find out importance of Lake Bosomtwe	Help pupils to identify the negative effects of certain activities in lakes – washing of clothes, body, cars, pots etc. Pupils must note some bad practices around the lake e.g. dumping of refuse around the lake, farming very close to the lake
2. Physical features of Lake surroundings	• Described the type of the vegetable around the lake • Name some of the trees either in English or Local Language • Describe the landscape of the lake surroundings	• Take pupils to the lake • Let pupils draw the lake and the vegetation around • Let pupils categorize the vegetation as trees, shrubs and grass • Let pupils describe the landscape	

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CLASS 3

TOPIC	OBJECTIVES	TEACHING/LEARNING ACTIVITY	NOTES
1. Lake Bosomtwe and its surroundings	By the end of the lesson pupils should be able to: • Tell the differences in soil types around the lake • Match the type of vegetation and the type soil • Name some animals, birds, insects commonly found around the lake • Name some common plants	• Let pupils collect soil from different areas of the lake and note the colour of each soil • Let pupil observe the type of vegetation of each soil type • Lead pupils to make a list of the birds and animals commonly found in the area • Lead pupils to name the plants species in the area	Teacher can give this exercise as a project. The local names of the plants and animals is acceptable
2. plant and animal life around the lake * Types of plants * Types of animals	• Describe how animals, insects, birds survive around the lake • Find how plants and animals depend on each other • Explain the importance of plants and animals around the lake	• Through discussion lead pupils to find out how the animals, insects and birds survive around the lake • Teacher to take one typical animal and lead pupils to find out how animals depend on each other • Through questions and answers lead pupils to find out the importance of plants and animals around the lake	Let pupils sketch a simple diagram to illustrate the dependence

		• Let pupils write a composition on "The importance of plants and animals in my community"	
3. Waste disposal practices around lake Bosomtwe	By the end of the lesson the child must be able to: • Identify the various types of wastes generated by people around the lake • Describe how waste is disposed off by people around the lake • Identify the best method of waste disposal around the lake	• Take pupils to a refuse dump closed to the school or in the community. Let them observe and record the types of refuse. Let them classify the refuse • Let pupils describe how waste is disposed off • Through questions and answers help pupils to find out the effect of each method on the lake. Let them tabulate the result of the discussion. Let them select the method that has least effect on the lake as the best method.	The classification could include: Organic and inorganic waste. Solid and liquid waste. Methods of disposal by the community should include: burying, burning and dumping along the lake and into the lake

CLASS 4

TOPIC	OBJECTIVES	TEACHING/LEARNING ACTIVITY	NOTES
1. The Environment	By the end of the lesson child must be able to: • Identify the components of the environment • Describe the natural and built environment • Name some animals and plants around them	• lead pupils through questions and answers to identify the components of the environment • Let pupils categorize the components into natural and artificial (built environment) • Ask pupils to observe and give the English and the local names of some plants and animals in around the community • Let pupils classify the plants into grasses herbs, shrubs and trees • Let pupils find out from farmers and hunters what animals are found in the forest around their community	Let pupils count the number of species in each category and draw a table Pupils should plot a bar chart from the data in the table
2. Human activities of communities around the lake	By the end of the lesson the child must be able to: • Describe what the people around the lake do to earn a living • Describe the social and other activities of the people around the lake • Identify which of them conserve the environment • Identify which of the activities degrade the surrounding of the lake	• Lead pupils to investigate which animals are currently easy to locate and which ones are no longer easy to locate • Let pupils make a list of the economic activities of the area • Help pupils to describe how each activity is carried out • Let pupils describe other activities that are not economic activities	The activities should include festivals and other social activities like funeral, football games etc.
3. Some environ-mental issues in the community	By the end of the lesson, the child must be able to: • Identify the main environmental issues in their community • Explain how they are involved in creating the main environmental issues in the community	• Lead pupils to find out which activities degrade the environment and which do not • Lead pupils to find out the effects of the activities that degrade the environment on wildlife • Let pupils list the environmental problems in their community • Through discussion let them identify the source of these problems	

		• Help pupils to find out how they are involved in creating the environmental problems of their communities	
4. Source of water in the lake	By the end of the lesson the child must be able to: • Describe the source of water in the lake • Explain how water is retained in the lake basin	• Take pupils to the lake. Help them to find out the source of water in the lake • Lead pupils to find out how water is retained in the lake	This must include the conservation of the vegetation around the lake
5. Water Pollution	By the end of the lesson the child should be able to: • Explain the term pollution • Identify sources of water pollution • Identify water pollutants • Describe how lake Bosomtwe is polluted	• Let pupils observe polluted and pure water • Help pupils to explain pollution. lead them to identify the sources of pollution of the lake	Pupils to use physical characteristic e.g. colour, sediments etc. to differentiate between polluted and unpolluted water.

CLASS 5

TOPIC	OBJECTIVES	TEACHING/LEARNING ACTIVITY	NOTES
1. The environ-ment	By the end of the lesson child must be able to: • Classify the components of the environment • Describe the physical environment • Described the bio-physical environment	• Ask pupils to list the components of the environment and classify them • Break the class into 2 groups. Let one group prepare a presentation on the physical environment and the other, bio-physical environment. Let the group choose their own leader. Give each group 20 minutes to do a presentation	This exercise must be given to pupils a week before presentation
2. Interaction of Elements in the Environment	By the end of the lesson the child must be able to: • Describe the importance of the elements in the environment • Describe how each element depend on each other • Draw a food chain • Explain a food chain • Explain what happens if one member of the food chain is not functioning	• Lead pupils to find out how the elements in the environment interact with each other • Through questions and answers lead them to identify the importance of each element. Let pupils role-play • Let pupils assume one element and talk about how it is important in the environment to the whole class • Let pupils draw a food chain and find out the implication, if a member of the chain falls out	The activities should include festivals and other social activities like funeral, football games etc.
3. Types of Lakes	By the end of the lesson, the child must be able to: • Describe how lakes are formed • Identify natural and manmade lakes • Describe how lake Bosomtwe was formed	Teacher to describe how lakes are formed. Show pictures of different types of lakes to pupils. Ask pupils about myths of the formation of lake Bosomtwe. Explain to pupils how the lake was formed	
4. Human activities and the Lake	By the end of the lesson the child must be able to: • Identify the human activities which affect the lake • Explain the activities of children that have a negative impact on the lake	• Let pupils describe the socio-economic activities of their communities • Let pupils describe how each activities impact on the environment • Lead pupils to identify how their own activities impact on the environment	Invite a hunter and a farmer to the school to explain to pupils how they carry

			out their activities
5. Water related diseases	By the end of the lesson the child should be able to: • Identify the various diseases at the area around the lake • Give his/her own understanding of these diseases • Relate the occurrence of certain disease to the lake • Find a relationship between the disease vectors and the disease-causing organism with the disease. • Identify water pollutants • Describe how lake Bosomtwe is polluted	• Posters of diseases and their vectors and mode of transmission should be shown • Through discussion help pupils to relate the occurrence of certain diseases to the lake	

CLASS 6

TOPIC	OBJECTIVES	TEACHING/LEARNING ACTIVITY	NOTES
1. The Environment	By the end of the lesson child must be able to: • Differentiate between physical environment and bio-physical environment • Identify the socio-cultural aspect of the environment	• Let pupils compare and contrast the physical and bio-physical environment • Through questions and answers lead pupils to identify the interaction of the people with the environment	The interaction must focus on the culture of the people- taboos, proverbs, festivals etc.
2. The Ecosystem	By the end of the lesson the child must be able to: • Explain eco-system • Explain how the ecosystem is maintained • Name some members of the eco-system • Identify the importance of the eco-system • Explain the food chain	• Explain the term eco-system to pupils and help them to identify some members of the eco-system • Explain to pupils how the members in the eco-system depend on each other • Lead pupils to deduce the importance of eco-system • Let pupils draw a food chain and label it	
3. Life in Lake Bosomtwe	By the end of the lesson, the child must be able to: • Identify some common aquatic plants • Give the common and scientific names of the identified plants • State the importance of some aquatic plants	Take pupils to the lakeside. • Let them observe and record the plants in the lake • Let pupils give the local names of the plants • Let pupils record the local and scientific names of the plants in their note books • Identify some common aquatic fauna • Give their common local names • State the importance of aquatic fauna	Teacher to tell pupils scientific names of the plants Teacher to give scientific names to the animals
4. Farming Activities around Lake Bosomtwe	By the end of the lesson the child must be able to: • Identify what type of farming is practiced around the lake • Describe how each type of farming is practiced • Identify the impact of farming activities on the aquatic life and the life around the lake	• Take pupils to the farm. Let them interact with the farmers. Request the farmers to tell pupils the type of farming practices in the area and their advantages and disadvantages • Let pupils deduce what impacts the farming activities have on the lake and its surroundings	

	• Recommend a method of farming that will not degrade the lake environment		
5. Fishing around Lake Bosomtwe	By the end of the lesson the child should be able to: • List the various fishing methods and the type of fishes caught • Identify sources of water pollution • Identify water pollutants • Describe how lake Bosomtwe is polluted	• Pupils go on a field trip to the lake site to observe the fishermen land their catch • Let pupils interact with fishermen to find out the fishing methods employed in the lake • Let pupils find out which type of fish they catch with each method	

J.S.S.1

TOPIC	OBJECTIVES	TEACHING/LEARNING ACTIVITY	NOTES
1. The Environment	By the end of the lesson the child should be able to: • Explain the concept of the environment • Identify the various components of the environment • Explain the socio-cultural aspect of the environment	• Let pupils to list what they find around them. Let them categorize this into living and non-living things. Let them further categorize the non-living things into natural and man-made • Help pupils to describe how human beings interact with the environment • Let pupils deduce the socio-cultural element of the environment	Mention how festivals, funerals, football games, relate to the environment
2. Environmental Degradation	By the end of the lesson the child should be able to: • Identify some common environmental problems in their locality • Identify the causes of the degradation of the lake environment • Explain the effect of human activities on the lake	• Take pupils out to observe some environmental problems in their locality. Let them record their observations in their books. Lead pupils to describe the causes of the environmental problems. Let them categorize the causes into human activities and natural causes • Through questions and answers lead pupils to find out the effect of human activities on the lake	
3. The Eco-system of the World	By the end of the lesson, the child should be able to: • Identify the main eco-systems of the world • Describe each main ecosystems • Describe how living things survive in the ecosystem	Through discussion help pupils to identify the main eco-systems of the world Through discussion lead pupils to discover how living things depend on each other for survival	Show pupils a video documentary of the main eco-systems
4. Farming Activities around Lake Bosomtwe	By the end of the lesson the child must be able to: • Identify what type of farming is practiced around the lake • Describe how each type of farming is practiced • Identify the impact of farming activities on the aquatic life and the life around the lake • Recommend a method of farming that will not degrade the lake environment	• Take pupils to the farm. Let them interact with the farmers. Request the farmers to tell pupils the type of farming practices in the area and their advantages and disadvantages • Let pupils deduce what impacts the farming activities have on the lake and its surroundings	
5. Water Quality	By the end of the lesson the child should be able to:	• Lead pupils through discussions to find out the qualities of good water	Use simple water

	• Differentiate between polluted and non-polluted water • Identify methods of finding out water quality • Explain the effect of water pollution on aquatic life and wildlife around the lake	• Take pupils to the lakeside. Take pupils to the polluted and unpolluted areas of the lake • Let pupils write down the differences • Let pupils carry out in groups simple experiments to determine the quality of water • Through discussion lead pupils to explain the effect of pollution on aquatic life and wildlife	experiment apparatus e.g. filter paper, p^h paper etc.
6. Pollution	By the end of the lesson the child should be able to: • Explain the term pollution • Identify types of pollution • Identify the pollutants of the lake • Explain the sources of pollution of the lake	• Through discussion lead pupils to explain the term pollution and identify the types • Let pupils explain the source of pollution of the lake • Let them list 5 pollutants • Let pupils build a matrix of pollutants and their source	
7. Life coping skills *Communication Skills *Assertiveness *Decision-making	By the end of the lesson the child should be able to: • identify some life coping skills • identify who he/she is • say No to activities that can destroy the biodiversity of the lake • demonstrate skills in coping with life	Invite the School Guidance and Counselling Co-odinator or the District Guidance Co-ordinator to have sessions with pupils and organize activities that will help pupils develop life coping skills	Guidance co-ordinator can use value clarification role-play, group-guidance etc.

J.S.S.2

TOPIC	OBJECTIVES	TEACHING/LEARNING ACTIVITY	NOTES
1. The Formation of Lake Bosomtwe	By the end of the lesson the child should be able to: • explain how the lake was formed • explain the link between the lake and the physical features surrounding the lake	Let pupils find out myth surrounding the formation of the lake • Take pupils to the lake side • Let pupils observe the physical features of the lake • Discussion with class, how the lake was formed	
2. Flora and Fauna of the Bosomtwe Lake Basin	By the end of the lesson the child should be able to: • Describe various physical features of the basin • Describe how human activities affect the flora and fauna of the basin and the lake • Suggest ways of protecting the flora and fauna of the lake basin	• General class discussion on the physical environment of the lake • Drawing and modeling (in groups) of relief or landscapes. Perform simple experiments to show water retention properties of different soil types	Use test tubes, funnels, filter, papers etc.
3. socio-economic activities of the Bosomtwe catchment area	By the end of the lesson, the child should be able to: • Describe the major economic activities of the communities around the lake basin • Suggest ways of protecting the biodiversity of the lake		
4. Tourism	By the end of the lesson the child should be able to: • Explain the importance of the lake in the tourism industry	Invite officers from the Ghana Tourist Board to talk to pupils on the importance of the lake in the tourism	The importance of the lake should include

	• Identify the effect of tourism on the lake	industry and the effect of the industry on the lake	the bio-diversity of the lake

J.S.S.3

TOPIC	OBJECTIVES	TEACHING/LEARNING ACTIVITY	NOTES
Conservation of bio-diversity of Lake Bosomtwe - Legislation - Environmental Education - Environmental Impact Assessment	By the end of the lesson the child should be able to: • explain the term biodiversity • identify the causes of degradation of biodiversity of the lake • explain the effect of human activities on the biodiversity of the lake • identify strategies of conserving the bio-diversity of the lake • explain how legislation can be used to conserve the biodiversity of the lake • explain how education can help in the conservation of biodiversity of the lake • explain how EIA can help to conserve the bio-diversity of the lake • identify traditional methods of conservation of the biodiversity of the lake	• let pupils watch a film on wildlife • through discussion lead pupils to infer from the film what bio-diversity is • help them to explain the term • through discussion lead pupils to find out the biodiversity of the lake • let pupils in groups suggest how the bio-diversity of the lake could be conserve • let pupils explain how laws could be made to conserve the bio-diversity of the area • let them find out if bye-laws exist in the area to protect bio-diversity • lead pupils in group discussion how education and legislation can be used to conserve bio-diversity • let one group talk on education and the other on legislation/invite EPA officer to talk to pupils on EIA • invite an elder to talk to pupils about traditional conservation methods	
Tourism	By the end of the lesson the child should be able to: • explain the importance of the lake in tourism • explain the effects of tourism on the lake • explain how tourism affects the biodiversity of the lake	Invite officers from the Ghana Tourist Board to give a talk to pupils on the importance of the lake to the tourism industry and how the industry affects the bio-diversity of the area around the lake	Restaurants and Hotels discharging their liquid wastes into the lake consider also the disposal of solid waste.

HANDBOOK FOR TEACHERS

WHAT IS THE ENVIRONMENT?

The Environment can be said to be the area that one finds oneself in at a particular point in time. For example, the classroom, the school compound, the home or even the whole village, town and settlement can be ones environment. It is made up of natural resources and human-created things.

The natural resources consist of land, water bodies, plants of all types, animals and air. The human-created or artificial things are the results of human's social, cultural and economic efforts to use the natural re sources in an area for living and development to make life comfortable. The living elements of the environment live and interact with non-living elements in an ecosystem.

ECOSYSTEM

An ecosystem is an environment where plants and animals live together and interact with non-living thins. The non-living things include soil, water and air. All the plants and animals that live in a particular area make a community. In a particular community the plants and animals interact with one another for food and shelter.

For example a bird make a next in the trunk of a tree. The members of the community also interact with the non-living component of the environment. For example crabs living in holes and plants using water sun's energy and carbon dioxide component of the air of making food.

TYPES OF ECOSYSTEM

There are two major ecosystems. These are terrestrial and aquatic. The terrestrial ecosystems are forest, grasslands, deserts and tundra. The aquatic ecosystems are fresh water, estuarine and marine.

The ecosystems function by the flow of energy and nutrients passing through them. There is an energy flow from solar radiation through plants to herbivores, then to carnivores, omnivores and micro-organisms in food chains. A simple food chain on land might by represented by Grass-rabbit-snake.

1

For example, in the simple food chain on land, if insects are removed, toads cannot feed directly on grass. A simple food chain in water might be represented by phytoplankton – insect larvae – small fish – large fish. There can be complex food chains were consumers feed on several different organisms. This is called a food web. In a food chain if one link is removed there is a gab, which can disturb the chain. In the next section we shall look at one ecosystem-water.

IMPORTANCE OF WATER

Water is important all over the world. Without water living things cannot survive. 70 percent of the human body weight is water, and 99 percent of some plants are water. When we breathe, the air is dissolved in water before it moves into the blood. The blood can only carry things that dissolve in water. Plants that live on the land also need water. Water in plants helps to carry nutrient s form the soil, reduces the temperature of plants when the weather is hot, and keeps the plants up right in the preparation of food for the plant in a process called photosynthesis.

Many plants and animals need water for breeding. Some of these plants and animals are: liverworts, mosses, ferns, flatworms, roundworms, sponges, mollusks, starfish, fish amphibian, reptiles, birds and mammals.

Water covers 2/3 of the earth surface. Some are salty, brackish or fresh. While some move others are still. Some move very fast, some move in one direction while others wash to and fro as on shoreline. Some waters are shallow and others are deep. Some are opened while others are filled with vegetation.

Some plants and animals live in water. A small number of them have special features, which help them to move between different environments. However most plants and animals are less tolerant. Whenever there is a small change in conditions which can upset the balance in their habitat they move away or become extinct.

The habitats of aquatic plants and animals are ponds, streams, rivers, lakes, sea etc. Plants and animals are adopted to live in water. Many floating or submerged plants rely on the buoyancy of water for support and to spread their leaves to catch maximum sunlight. Some animals have adaptations for moving on or through water. Fishe s are streamline to move through water. The pond skater has large feet. Some animals, which live in fast flowing streams have claws to cling to stones and are flattened to reduce the drag of water flowing over them. Some insects have external gills and need a constant flow of oxygenated water to enable them to breathe e.g. fresh water shrimps. Some have their legs having to trap air from the water surface. Example is the water boatmen.

HUMAN ACTIVITIES AND WATER BODIES

Human activities close to water bodies influence the quality of water. The nutrients from fertilizers dissolve in the water bodies along where farming activities take place. The nutrient enrichment from the fertilizers causes the bacteria and plankton to reproduce and multiply. These serve as food supply to the other animals. If these animals become too many they can use up all the oxygen dissolved in the water. This can kill life in water. Therefore the amount of oxygen demanded by life in the water can indicate if the water is poll uted or not.

Pesticides also accumulate in the food chain and can be passed on from one animal to the other. As rivers enter cities and town they are polluted by wastes of all types. Solid and liquid. Solid waste result from human excreta, domestic wastes, industrial waste, sewage that is waste that comes out of our houses and factories, contents of toilets, baths, washing tubs and factory waste pipes. Rivers can be so polluted by sewage that almost nothing lives in them. Such rivers become almost useless to people.

Other indicators of pollution in rivers/lakes are:

1. The presence of algae in the lake or river
2. The presence of dead fishes
3. Dumping solid waste into the lake – broken fish traps boats, empty cans etc.
4. Defecation along the bank of the lake.
5. Washing of fertilizer down the lake which causes many plants to grow in the lake.
6. The presence of many water snails and mosquito larvae in the water.
7. Few animals living in around the lake.

Do you have some of these factors around Lake Bosomtwe?

Human activities along the lake also involve fishing. There are two difference ways we can fish. We have sustainable fishing and unsustainable fishing. Sustainable fishing is carefully done so that some of the fishes are left in the lake to breed. We need to catch only some of the fish, but not too many. If we use nets with small holes it can catch all sizes of fish, which is not good. Sometimes people use poison to catch fish. They pour the poison in the lake and the fishes die. They then pick them. When poison is used to fish, it kills all the fishes in the lake and sooner or later all the fishes will die in the lake. It will no more be useful to human beings. Fishing with chemicals is a criminal activity. Anybody found doing that must be reported to the police.

Over fishing is also sustainable fishing method. This means catching to may fishes, and catching young fishes. In our country, fishermen do not go fishing on Tuesday. This is to give time to the fish to rejuvenate. This means that fish is a renewable natural resource. In the next section we shall look at one of Ghana's historical lake – Lake Bosomtwe.

Why do you think some people use chemicals to fish or will like to catch many fish?

LAKE BOSOMTWE

A lake can be defined as a hollow reservoir in the earth's surface in which water collects. There are many types of lakes and they are classified according to their origin. Majority of them have been formed by the action of glaciers and ice sheets. Other source of formation include rivers, marine and wind action, by earth movements and vulcanicity and by man and other natural means. Lake Bosomtwe is one of the major lakes in Ghana.

It is a sacred lake of the Ashantis. The origin of the lake has been a source of argument. There are four schools of thought that have explained the origin of the lake. Some people think that the lake has a volcanic origin. That is a volcano occurred in the spot and when it became extinct the crater got filled with both rain and river. This explanation of the origin of the lake has come out because the lake appears to be so formed. The lake is almost a perfect bowl with hills all round it. The second school of thought believes that a huge meteorite might have hit the area and made a large crate with was later filled with water. The third explanation attributes the origin of the lake to two parallel faults in the earth, creating a resultant hole. The fourth theory explains the origin of the lake in terms of the volcanic theory and the faulting theory. It states that an explosive volcanic activity was accompanied by faulting and shattering of rocks in the area.

PHYSICAL FEATURES

The lake is 90 meters deep and has a diameter of 10.5km. two rivers and ground water keeps the water volume of the lake constant. The lake has several features.

- Because of its special formation there is decomposition on vegetation aerobically producing hydrogen sulphide which usually evolved at night to burn out with oxygen giving off light.

- Many sacred groves could be found around the lake. These roves together with the vegetation around the lake contain unique flora and fauna.

The lake is surrounded by steep hills, which rise from the surrounding area to about 213.4 meters in places. There are some streams around the lake at Abonu, Obo, Kakoma, Duasi and Apenu. The surrounding hills come within the middle course of the streams. Consequently the latter's middle sections have rapids and falls while the upper and the lower parts of their courses are characterized by low gradients.

Villages are dotted around the lake. A historic village located along the lake is Abrodwum village. The village has been submerged and resettled several times. History has it that Akorobompi the hunter of Asaman first passed through Abrodwum to discover the lake in the nineteenth century. Even though the village has been resettled several times; the path Akrorobompi the hunter used is the one still used the enter the lake from that side. Along this path could be found the stone of Abrodwum (Abrodwum Bo).

HUMAN ACTIVITIES AROUND THE LAKE

The major activities by the people around the lake is farming and fishing and until recently tourism activities. There are 24 communities around the lake, and the inhabitants depend mostly on fish from the lake for their livelihood. The other source of livelihood is farming.

Farming has resulted in the felling of trees along the banks of the lake. This has resulted in deforestation. Fishing is carried out all year round with no close season. Usually fishing is done with inappropriate nets. The local people also wash their clothing's bodies in the lake. Domestic wastes are also dumped along the bank of the lake. The lake offers opportunities for tourists' activities. They litter the bank with butts of cigarettes, empty mineral cans. The farming and the fishing activities coupled with the other human activities have put the ecosystem of the lake to serious threat.

AQUATIC BIODIVERSITY OF THE LAKE

The lake is rich in fish species. The most important fish species is the Tilapia. Generally eight different types – species of tilapia have been identified. However all cannot be found in Lake Bosomtwe. All the eight species bear a common name in English as the Managofish. In Akan they are either called "Otidie", "Apatre", Mpatowe" and sometimes "Kwakye". In Ewe they are called Akpa. The two most important kind of tilapia, in the lake and other lakes in Ghana as far as size and abundance is concerned are what is scientifically known as Tilapia nilotica and Tilap ia galilaea. The other known fish of importance is the cat fish of genus claria.

This commonly known in Akan as Adwene or Opitri. There are also shell fishes e.g. crabs and what is commonly known in Akan as "sesew" and water snails also commonly called "abebew".

TERRESTIAL BIODIVERSITY

The forests in the catchment areas of lake Bosomtwe harbour a variety of fauna. These species include palm squirrel (Expixerus ebii), giant pangolin (manis phataginus gigantean), tree pangolin (M. tricuspids), long-tailed pangolin (M. tetradactyla), bosman's potto (perodicticus potto), dwarf galago (galagoides demidoff), Diana monkey (Cercopithecus Diana), black and white colobus.

LIFE COPING SKILLS

To protect the bio-diversity of the lake pupils need to develop certain life coping skills. This will help them take rightful decisions to conserve and protect the lake and its biodiversity. In this section we shall look at steps in decision making and how to say No and assertiveness.

DECISION-MAKING SKILLS

We are everyday faced with situation that calls for decisions. Some decisions are more crucial than others and we must learn how to take decision. Use the formula below:

PLANS

P - Pose the question. Define what it is to be decided on or what are the choices clearly and explicitly.

L - List alternatives: What are the options available? To do this effectively, gather all relevant information on the subject of the question.

A - Assess values – clarify values: Realistically assess potential strength and weakness especially if it is a career question.

N - Narrow down alternatives systematically: Having gone through the first three stages one will be in a position to eliminate options that are inconsistent with ones values, strengths and weaknesses and will be left with responsible option. Then formulate an action plan.

S - Set goals and start: It is only when one has been able to go through all the stages that one will feel empowered and committed to make responsible choices.

There are 3 steps for saying No:

STEP 1 Ask questions so you can know that you are getting into. Decide if the situation could lead to trouble.

STEP 2 Say No if it is wrong or will get you into trouble and give a reason.

STEP 3 Know some positive alternatives; suggest one of them. If the person doesn't accept it leave. You can still be friends.

ASSERTIVENESS

Expressing one's feelings honestly and directly, while still respecting the other persons feelings. One has the right to say what one believes. This includes disagreeing and saying "no" when one does not want to do something. However, ignoring one's own feeling rather than disagreeing may avoid an argument but it means the person is not being true to himself or herself. This may make one to feel angry or manipulated thus interfering with one's relationship with the other person and reducing the person's effectiveness. An assertive person is happier more effective and dependable. We therefore need to be assertive.

TRAINING PROGRAMME

CONTENTS

TOPIC	OBJECTIVES	ACTIVITES
i. The Environment	Participants to reveal their own concept of the environment. Participants to identify their relationship with the environment	Divide group into smaller groups. Let each group write down the conception of the environment of the members of the group. Group then discuss to reach a consensus. Let participants in their groups identify their relationship with the environment. The groups then present their report to the whole group
ii. The Origin of Lake Bosomtwe	To give opportunity to local people to share what they know about the lake and its environment To explain to local people how the lake was formed	Let participants in turn share their ideas about the formation of the lake Explain to them how lake was formed. Show them pictures of other lakes and their surroundings
iii. Flora and Fauna around Lake Bosomtwe	Participants should be able to name the flora and fauna around the lake, identify the importance of the flora and fauna, explain how flora and fauna of the lake is being destroyed	Let participants in turn mention the flora and fauna around the lake. Get participants into groups. Let them discuss the importance of the lake and its surroundings. Participants in their previous groups discuss how the flora and fauna around the lake is being destroyed
iv. Strategies of conservation of Biodiversity of lake Bosomtwe	Participants to identify what could be done to conserve the biodiversity of the lake	Participants in groups discuss strategies of Conservation of Biodiversity of the lake. Participants present Local Action Plan to the whole group
v. Communication Skills	Participants to recognize and enhance their own communicative skills and to develop new ones	Take participants through communication exercises

MONITORING OF LAKE BOSOMTWE BY SCHOOL CHILDREN

1.0 INTRODUCTION

Freshwater is a vital resource. Lakes, ponds, rivers and streams provide habitats for many types of organisms and they provide drinking water, food, recreation and aesthetic experiences for people. Rivers and streams carry nutrients mostly vital to life in the oceans, and throughout history they have been important in transportation.

Many human activities are disturbing the delicate ecological balance in freshwater. They threaten the survival or organisms that live there as well as human health. Each freshwater species is adapted to a range of conditions; temperature, dissolved oxygen and pH being the most important. While some organisms can survive within a wide range of environmental conditions others can only survive within a narrow range of environmental conditions. Key organisms, adapted to different conditions, can be used as indicators of

water quality when organisms that require pH range of 7 to 8 are not found it may indicate that the water is more acid or more basic.

About two-thirds of water pollution results from agriculture, followed by human and industrial wastes. Removal of trees, by deforestation of fire, increases run off and brings more organic materials to the waters. When a body of water becomes overloaded with organic matter the oxygen level of the water decreases. Fertilisers and other materials rich in phosphates can result in excessive algae growth and low oxygen levels. As the oxygen becomes scares, organism die adding a further burden of organic material to the water.

Lake Bosomtwe in the Ashanti region of Ghana is one of such freshwater that has suffered degradation over the years. Friends of the Earth, Ghana is implementing an intervention to protect the Lake. Community-based Biodiversity Assessment and Monitoring is one of the components of that intervention. The targets included twenty-two primary and secondary schools. The schools will carry out Hydrology Investigation of the lake. The schools will meet every three months to disseminate information to their communities and other stakeholders.

The present document is a guide adapted from the Global Learning and Observations to Benefit the Environment (GLOBE) project to the Hydrology Investigation of the Lake.

2.0 HYDROLOGY INVESTIGATION OF LAKE BOSOMTWE BY SCHOOL CHILDREN

Hydrology is the study of water. In this case we will carry out Hydrology Investigation of Lake Bosomtwe which is essential to all of us. You and your friends will take some measurements of the water quality of the Lake. You and your friends will meet once in three months to compare and discuss your results. You will then make the results known to members in your communities. You will explain the implications of the results to them. The measurements we shall take are called **Protocols.** The protocols are:

- Transparency
- Temperatures
- Dissolved Oxygen
- pH
- Electrical Conductivity / Sedimentation

Others which we will not investigate are:

- Salinity
- Alkalinity
- Nitrate

3.0 WHY TAKE THESE MEASUREMENTS

These measurements will help us to answer the following questions:

- What is the condition of Lake Bosomtwe?
- How do these conditions vary over the year?
- Are the conditions changing from year to year?
- What are the probable causes of these conditions?

The measurement will help us to develop a better understanding of the Lake which is a source of our livelihood. The result of the measurement can help us make more intelligent decisions about how we use, manage and enjoy Lake Bosomtwe. The results of the measurements can help us assess the extent to which human activities are affecting the quality of the Lake and thus affecting how we will be able to use it in the future. Finally you will learn how to take certain measurements, record and discuss data analyze and tale decisions based on data. Through this investigation you can develop the following skills:

- Observations
- Applications

- Calibration
- Following directions
- Recording
- Reading
- Communicating
- Questioning
- Forming and Testing
- Designing
- Using water quantity measurements
- Using tools
- Creating and recording graphs
- Calculating
- Making Comparisons
- Analyzing Data

4.0 A FEW THINGS YOU NEED TO BEAR IN MIND

- Frequency: Collect all water chemistry measurements at roughly the same time each day on a weekly basis.
- Reliability is achieved by
  ◊ Collecting the water sample as directed
  ◊ Performing tests immediately after the water sample
  ◊ Careful calibration, use and maintenance of testing equipment
  ◊ Following the specific directions of a protocol exactly as described
  ◊ Check that accuracy and to understand any resources of error
  ◊ Minimising contaminations of stock chemicals and testing equipments.

6.0 PROTOCOLS

6.1 Water transparency

6.1.1 Aim

To determine water transparency using a Secchi disk (still, deep water) or turbidity tube (flowing or shallow waters)

6.1.2 Overview

The Secchi disk transparency depends on the amounts of suspended and coloured material in the water, material that comes from either sediment washed into a water body or biological activity in the water body. Turbidity is used to measure transparency of flowing waters or where use of a Secchi disk is impractical.

6.1.3 Materials and Tools

SECCHI DISK

- 5m length of rope (or longer or shorter, depending on depth of the water site)
- Latex enamel spray paint: black and white
- 2.5-3 cm diameter by 15 cm long steel and pipe drill
- Circular piece of wood 2.5 cm thick and 20 cm diameter
- 2 hook screws
- 15 cm length of sting
- Small bottle of wood glue or super glue
- Waterproof makers (red, blue and black)
- Meter stick

TURBIDITY TUBE

- Clear plastic tube, approx. 1 cm long (depending on transparency of water at your site) and 4.5 cm diameter (e.g. clear plastic fluorescent light casting. White cap that fits securely on bottom of the tube (a cap to a PVC pipe fits nicely)
- Black permanent maker
- Meter stick

6.1.4 How to measure transparency

- Make sure that Secchi disk and turbidity tube measurements are made in the shade with the sun to your back to make an accurate and reproducible reading. If there is no shade available, use an umbrella or a large piece of cardboard to shade the particular area where the measurements is being made. For the turbidity the shadow of the observer should be adequate.
- Different individuals may see the Secchi disk or the bottom of the turbidity tube disappear at different water depths. For this reason whenever possible the transparency observation should be made by three different students and each of their observations recorded.
- Lower the disk slowly into the water until it just disappears. If possible, grab the rope at the surface of the water and mark this point on the rope (e.g. use a clothes pin). If it is not possible to mark the rope at the water surface, mark the rope a known distance above the water.
- Then raise the Sechhi disk until it just reappears into view. Grab the line at the surface of the water when the Secchi disk reappears and mark this point (or some known distance above the water). The rope should now be a few centimeters difference between these points.
- Record both depths on your Hydrology Investigation Data Work Sheet to the nearest 1 cm.
- If the two depths differ by more than 10 cm, repeat the measurement, recording the new depths on your Hydrology Investigation Data Work Sheet.

Note: If the Secchi Disk reaches the bottom of your study site and you can still see it, simply record the depths to the bottom by referring to the point where the rope is at the water surface and put a greater than symbol in front of the measurement on your data work sheet.

Turbidity tube

- Pour sample water into the tube until the image at the bottom of the tube is no longer visible when looking directly through the water column at the image.
- Rotate the tube while looking down at the image to see if the black and white areas of the decal are distinguished.
- Record this depth of water on your Hydrology Investigation Data Sheet.

Note: If you can still see the image on the bottom of the tube after filling it, simply record the depth as greater than the depth of the tube.

6.1.5 Implication

Light essential for growth of green plants, travels further in clear water than in either turbid water that contains suspended solids or coloured water. Sunlight provides the energy for photosynthesis, the process by which plants grow by taking up carbon, nitrogen, phosphorus and other nutrients and give off oxygen. Thus penetration of sunlight into water body determines the depth to which algae and other plants can grow and the relative amount of growth Transparency decreases as colour, suspended sediments or algal abundance increase. Suspended sediments often come from sources such as agriculture, construction, storm runoff and re-suspension of bottom sediments.

Most natural waters have transparency ranging from 1 meter to a few meters. A low value, less than 1 meter, would be expected in a highly productive body of water. A low value can be due to as well to a high concentration of suspended solids.

6.2 Water Temperature

6.2.1 Aim

To measure the temperature of the water sample

6.2.2 Overview

The temperature of the water sample is needed for the dissolved oxygen and pH measurements.

6.2.3 Materials and Tools

- Alcohol –filled thermometer
- A clock or watch
- Enough string to lower the thermometer into the water
- Rubber band Data sheets

6.2.4 How to measure water temperature

- Tie one end of a piece string securely to the end of thermometer and other end to a rubber band. Slip the rubber band around the wrist so that the thermometer is not lost if it is accidentally dropped in the water.
- Hold the end of the thermometer and shake it several times to remove any air in the enclosed liquid. Note the temperature reading.
- Immerse the thermometer to a depth of 10 cm in the sample water for three to five minutes.
- Raise the thermometer only as much as is necessary to read the temperature. Quickly note the temperature reading. If the air temperature is significantly different from the water temperature or it is a windy day, the thermometer reading may change rapidly after it is removed from the water; try to take the reading while the bulb of the thermometer is till in the water. Lower the thermometer for another minute or until it stabilizers. Read it again. If the temperature is unchanged, proceed to step 3.
- Record this temperature along with date and time on the Hydrology Investigation Data Sheet.
- Take the average of the temperatures measured.

6.2.5 Implications

Water temperature is largely determined by the amount of solar energy absorbed by the water and the surrounding soil and air. More solar heating leads to higher water temperatures. Water evaporating from the surface can lower the temperature of the water but only for a very thin layer at the surface. We need to understand the patterns of a change over the year because the temperatu re of the amount and diversity of its aquatic life.

6.3 DISSOLVED OXYGEN

6.3.1 Aim

6.3.2 Overview

Dissolved oxygen is closely related to survival of plant and animal life in all bodies of water. It is affected by natural processes and by human activities.

6.3.3 Materials and Tools

- Dissolved Oxygen Kit
- Distilled water
- 250-ml polythene bottle with top

- Thermometer
- Data Work Sheets Latex gloves/safety goggles

6.3.4 How to measure Dissolved Oxygen

Sampling Procedure

- Rinse the sampling bottle and hands with sample water three times. Rinse via three times in distilled water.
- Replace the cap on the bottle
- Submerge the bottle in sample water and remove the cap. Allow the container to fill.
- Tap the bottle to release air bubbles.
- While the bottle is submerged, replace the cap. Remove the capped bottle from the water.
- Check to ensure that no bubbles are present in the bottle. If bubbles are found, repeat the sampling procedure.

Sampling Preservation and Testing Procedure

- Use a dissolved oxygen test kit that meets the specifications in the Toolkit of the GLOBE Program Teacher's Guide. Follow the instructions carefully. If a scoop is used to measure powdered chemicals, do not allow the scoop to come in contact with the liquid.
- Record the values from the student groups on the Hydrology Investigation Data Work Sheet. Take the average of the DO values measured by the student groups.

6.3.5 Implication

Aquatic animals such as fish and the zooplankton they feed on do not breathe the oxygen dissolved in water. Without sufficient levels of dissolved oxygen in the water aquatic life suffocates. Dissolved oxygen levels below 3 mg/L are stressful to most aquatic organisms. Vigorous mixing of air and water such as in turbulent at reams, increases the amount of oxygen dissolved in water. So does photosynthesis by aquatic plants. Oxygen is consumed by fish zoo plantation and the bacteria that decompose organism materials.

6.4 pH

6.4.1 Aim

To measure pH

6.4.2 Overview

The pH or acidity of the water sample is a key factor in determining what can live in the water.

6.4.3 Materials and Tools

For Method 1

pH indicator paper
50 or 100 ml beakers

For Method 2

- pH pen
- One jewellery screwdriver (for calibration)
- Three 50 or 100 ml beakers
- 50 ml polythene bottle with top or clean baby food jar with lid
- pH buffer solution for pH 7 or
- pH meter
- Five 50 or 100 ml beakers
- Three 50 ml, polyethylene bottles with tops or clean baby food jars with lid

- Three pH solutions for pH 4, 7 and 10

And for both pen and meter techniques:
- 100 ml graduated cylinder
- Paper towels
- Soft tissues
- Distilled water in a squeeze bottle
- Stirring rod or spoon
- Masking tape
- Permanent marker
- Latex gloves and safety goggles

6.4.4 How to measure 'pH'

Method 1: pH indicator paper
- Rinse a 50ml or 100ml beaker at least twice with sample water.
- Fill the beaker about halfway with water to be tested
- Dip one strip of indicator paper into the sample water for at least a minute. Make sure all four segments of the paper are immersed in sample water.
- Remove the paper from the water and compare the resultant four colour segments with the chart on the back of the back of the pH indicator paper box.
- Read the corresponding pH and record his value of your Hydrology Investigation Data Work Sheet.

Method 2: pH pen or pH meter

In order to measure the pH of your water buffer solutions the pH meter you need to –

(i) prepare buffer solutions
(ii) calibrate the instruments
(iii) recheck your instrument by measuring the buffers in the field and
(iv) measure the pH of your sample in the filed

Procedure
- Rinse the electrode and the surrounding area with distilled water using the squeeze bottle. Blot the area dry with a soft tissue.
- Fill a clean, dry 100 ml beaker to the 50 ml line with the water to be tested.
- Immerse the electrode in the water. Be sure that the entire electrode is immersed, but avoid immersing it any further than necessary.
- Stir once and then let the display value stabilize
- Once the display value is table, read the pH value and record it on your Hydrology Investigation Data Work sheet.
- Repeat steps 1 through 5 for another sample as a quality control check. The two pH values should agree to within 0.2 which is the accuracy of this technique.
- Rinse the probe with distilled water, blot it dry with soft tissue, replace the cap on the probe and turn the instrument off.
- Take the average of pH values measure by the student groups and record on your Hydrology Investigation Data Sheet.

NOTE: Meter or pH readings may not be accurate if your water sample has conductivity below 100 micro Siemens/cm (pH pens and meters do not function properly below this level)

6.4.5 Implication

pH is a measure of the acid content of water. The pH of water influences most of its chemical processes. Pure water with no impurities (and not in content with air) has a pH of 7. Water with impurities will have a pH of 7 when its acid and base consent are exactly equal and balance each other out. At pH values below 7 we have excess acid, and at pH levels above 7 we have excess base in the water.

The pH of a water body has a strong influence on what can live in it. Salamanders, frogs and other amphibian life are particularly sensitive to low pH. Most insects, amphibians, and fish are absent in water bodies with pH below 4.

6.5 ELECTRICAL CONDUCTIVITY

6.5.1 Aim

To measure the conductivity of the water

6.5.2 Overview

Conductivity is a measure of the amount of total dissolved solids in the water.

6.5.3 Materials and Tools

Total dissolved solids tester (or conductivity tester)
Standard solution
Distilled water
Squeeze bottle
Soft tissue
Three 50 ml or 100 ml beakers
Jewellery screwdriver (for calibration)