DARWIN / SWIMMER / CAW

Project 14-017

TOOLKIT FOR THE MANAGEMENT OF GHANA'S RIVERINE BIODIVERSITY

CENTRE FOR AFRICAN WETLANDS,
UNIVERSITY OF GHANA

9TH - 13TH JANUARY, 2006

THE UNIVERSITY of LIVERPOOL

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WELCOME ADDRESS BY PROF W. A. ASOMANING

Good morning, Ladies and Gentlemen.

On behalf of the Chairperson of the Management Board of the Centre for African Wetlands (CAW), may I warmly welcome all of you to the Centre and to the Workshop.

The idea to establish a Wetland Centre of Excellence was conceived in the mid 1990s and this gave birth to the Centre for African Wetlands, which was inaugurated in July 2000. The mission of CAW is as follows and I quote:

(i)To promote the study of wetlands through high quality and internationally recognized research leading to a better understanding and qualification of the biophysical, socio-economic and policy interactions of wetland and wetland resources so as to enhance the ecological integrity of wetlands and hence improve the quality of human life.

(ii) To study through monitoring and modelling, the biophysical, socio- economic and policy changes using thematic areas so as to assess both past changes and current trends , and to predict future human impact on wetlands.

(iii) To secure, expand and provide relevant wetland data for further scientific research and to serve as the basis for advice on wetland conservation, management and sustainability utilization for the benefit of society as a whole.

(iv) To promote the use of the Centre's own research facilities and data and that of the CAW network, so as to provide research training of the highest quality, and to enhance the region's research base for biophysical socio-economic and policy concerns, and

(v) To promote through formal and informal agreements, collaborative research and information flow on all wetland issues to wetland stakeholders in the region.

The five-day workshop, which is an introductory but important activity of the project 'Toolkits for the Sustainable Management of Ghana's Riverine Biodiversity' clearly falls within the mission of the Centre and the Management Board, is happy that it is being hosted by CAW.

The Project, owned by the Institute for Sustainable Water, Integrated and Ecosystem Research of the University of Liverpool is being funded by the Darwin initiative. The project involves certain institutions in Ghana with CAW playing the role as the co-ordinating agency.

Participants for this workshop therefore are drawn from

The Departments of Botany and Zoology, Environmental Science Programme, the Volta Basin Research Project, all of University of Ghana, Ghana Wildlife Society and Water Research Institute of the Centre for Scientific and Industrial Research.

The results of the project arising from the ecosystem approach will be highly beneficial to Ghana in its quest to manage its riverine biodiversity. Ultimately the project will be beneficial to the entire West African sub region. May I take this opportunity to formally welcome the Resource Persons;

Professor Edward Maltby
Professor Brian Moss
Dr Richard Leah, from the University of Liverpool.

I wish participants and Resource Persons a successful workshop.

Thank you.

BACKGROUND TO PROJECT

"Tool-kits for the Sustainable Management of Riverine Biodiversity of Ghana, Burkina Faso, Nigeria, Côte d'lvoire, Togo, Benin" is a Darwin Initiative funded project. The Darwin Initiative is funded by the UK Department of the Environment, Food and Rural Affairs (DEFRA). This initiative enables UK experts to partner with developing countries with rich biodiversity but limited resources to develop and sustainably manage natural resources and ensure the equitable distribution of its benefits.

In the pursuance of work to be carried out in the project entitled "Tool-kits for the Sustainable Management of Riverine Biodiversity of Ghana, Burkina Faso, Nigeria, Côte d'lvoire, Togo, Benin", University of Liverpool acting through the Institute for Sustainable Water, Integrated Management and Ecosystem Research (SWIMMER) in partnership with the Centre for African Wetlands (CAW) submitted a proposal to the Department for Environment, Food and Rural Affairs (DEFRA) which was assent in 2005.

MAIN PROJECT OBJECTIVES

- Assess the current status of aquatic communities in some rivers in Ghana.
- Identify indicators for the various river systems in Ghana and develop a set of indicators of ecosystem health, which would be adapted for use within West Africa.
- To build capacity through training of local and regional staff by transferring knowledge.
- To produce policy document outlining the means of applying the Ecosystem approach in the management of West African rivers.
- The production of educational materials for users at various levels of expertise, for example students, policymakers and other stakeholders.
- To enhance environmental awareness throughout the Ghanaian society as well as increased engagement of local stakeholders in decision making about how they are managed.
- Publish information obtained on the World Wide Web for easy assess.

DAY ONE, JANUARY 9, 2006

Presentation on the Fundamentals of River Systems (Prof. Brian Moss)
Tropical and Temperate rivers and streams were compared by citing examples around the world including Nile, Amazon, Mississippi among others. The rivers and streams of tropical and temperate zones have similar basic characteristic. Analysis depended on undamaged river systems. Two main river models were identified. They are the catchment model and river continuum concept. The comparison was done along the following lines:

Drifts and histories
The role of forest in pristine river systems
The role of organisms
Stages of a river system e.g. Floodplain river characteristics
Interaction between living organisms and nonliving things in a river system
The effects of human activities on river systems.

Some negative perceptions of Wetlands were examined especially that for children. Among these were the fact that wetlands are considered as wastelands and habitat for vectors of water borne diseases e.g. Nematodes, numerous flukes, tapeworms, yellow fever and elephantiasis.

In spite of these perceptions, Wetlands resources are heavily utilized globally. Some products of wetland include medicinal leeches, rush seats, willow for cricket bats, aspirin and osier for basketry.

Discussion after Presentation
It was noted that the impact of the project on the local people should be looked at seriously. Thus the local people should be part of the decision making process. Some of the local people have useful ancient information concerning the river systems.

There seems to be lack of continuous date on freshwaters

Efforts should be made to seek the perceptions of children about wetlands in Ghana. There is the need to carry out a social survey as part of the project to capture the perception of children about wetlands

Incorporate local people in the understanding of biodiversity

It was observed that little or no sampling records of forest freshwater resources.

Brainstorming Session
Four key questions were used for this exercise. The main objective was to offer the group the basis to develop new approaches for the management of Ghana's water resources. Important points gained from the session are as follows:

1. What is the nature of Ghana's freshwater resources?
Ghana's freshwater resources are mainly rivers, a natural lake (Bosumtwi) and some artificial lakes (e.g. Volta Lake, which is one of the largest in the world). Ground water is also a common source of drinking for people in rural Ghana (about 80% of their drinking water). Freshwater resources in Ghana may be:

- Temporal – common in some small rivers in Ghana
- Permanent – most lakes and big river basins

There are three basin systems in Ghana, namely:

- The Volta Basin system comprising the main Volta, Red Volta, White Volta and the Black Volta. (The names White, Black and Red originate from the colour of the water)
- The South-western River Systems making up of the Bia river basin (international boundaries i.e. Cote d'Ivoire), Tano river basin, Ankobra river basin, Brim river and the Pra river basin.
- The Coastal river systems consisting of river Densu, river Ayensu etc.

Salt is not mined in any of the fresh waters in Ghana; however, there are inland saline deposits e.g. Daboya a town in Northern Ghana, which is basically rock salt.

Water Resources Management (WORM), 1998 was noted to have a great deal of information regarding the stress of water resources in Ghana. The figures indicate that the water resources of Ghana are under pressure and political priority is needed in the management of the water resources in Ghana.

The general assessment of water quality indicated that water is generally clean at headstream and deteriorates as it passes downstream. However, there are peculiarities in the different basin. For instance, River Ankobra is virtually polluted from headstream to downstream.

2. What are the actual uses of rivers and lakes?

The following were identified as the uses of lakes and rivers in Ghana:

- Drinking/Domestic use
- Agriculture – Irrigation, Aquaculture and livestock rearing
- Huge use in the industries, especially in the mining areas
- Generation of Hydro-electric Power
- Recreational – swimming
- Biodiversity
- Transportation
- Fish/crabs – food
- Minerals – Alluvial gold/sand/gravel
- Building and Construction – thatch materials

3. What are the impacts on freshwater ecosystems?

Pollution was seen as a major impact on freshwater ecosystem. Pollution can be categorized into diffuse and point source. Some of the sources of pollution in Ghana's freshwater included Agricultural activities, mining activities, agricultural chemicals, sewage, and town and industrial waste.

Another impact was siltation, which comes as a result of mining and farming activities. Siltation can lead to a reduction in the volume of water as well as changing the geomorphology of riverbeds thereby affecting the lives of plants and animals. De-silting the river channel seems the only plausible solution but this has economic implications.

Water over abstracting
Bush burning for farming along river banks
Urbanization or population growth which may put pressure on the resources
Water borne diseases
Climatic changes
Deforestation

4. What is the policy framework for the management of Ghana's rivers and lakes?

Several agencies and ministries were noted to be associated with the management of environmental resources, and water resources are no exception. For instance, Water Resource Commission under the Ministry of Water Resources, Works and Housing, the Environmental Protection Agency under the Ministry of Environment, Ramsar Convention under the Ministry of Land and Forestry, Ministry of Fisheries and Ministry of Food and Agriculture are all stakeholders in the management of water resources in Ghana. Aside the role of public agencies, the contribution of traditional society and NGOs in the management of water resources is highly recognized.

In conclusion, some policies exit from the local assemblies to the national level for the management of freshwater resources. For instance permits are required for the abstraction of water, especially for commercial purposes. However, there is still the need to develop better tools to improve the management of water resources in the country.

Progress in Ghanaian studies – Reporting back

The studies have been focused on the Akyem Abuakwa traditional area (Okyeman), which has a total population of about 2 million representing 10% of Ghana's population. The three rivers Densu, Birim and Ayensu provide water for a greater chunk of the population. The people of the area are predominantly farmers and educational level is about 4%.
Two main field visits have been made to the area aside the reconnaissance. The first visit was towards the end of the rainy season (August, 2005) and the other the supposed dry season (December, 2005).
The rivers were sampled at different sites for physicochemical parameters and macroinvertebrates. Water samples were also taken to the Water Research Institute for further analysis. Two sampling methods used were the pond net sweeps and core sampling. To have fair representative samples some of the sites were sampled at both the upstream and downstream to assess impact of various landuse activities.

The physico-chemistry of the three basins was within normal ranges but the three rivers had different conductivity values, which could easily be distinguished. A positive correlation was observed between Shannon diversity and species richness. The results show that the three rivers support a low diversity of macro invertebrates as the total of 435 organisms were collected from all the sites sampled with three of them having no fauna at all. The predominant organisms found were Mollusc, Crustaceans and Chironomids.

Answering to the question of standardizing the sampling method, Mr. Ankrah noted that the benthic characteristics and habitats conditions at the site informed the kind of method used. Further difficulty is anticipated when the water rises. As to why fishes were not considered, Prof. Gordon answered that the fishes were not readily sampled with the methods used. It was recommended that subsequent sampling should involve fish because the local people related easily to fish than the macroinvertebrates. There was the need to combine a lot of methods to get the best results.

PLEASE INSERT GRAPH

DAY TWO, 10TH JANUARY 2006

Field Trip to Akyem Abukwa Traditional Area

A field trip was undertaken by participants to have first hand information and feeling of some of the sampling sites. 7 sites were earmarked for the visit. However 4 sites were visited due to time constraints. The sites included D4 upstream (at Koforidua water works), D4 downstream (near Koforidua water works), D2 (off Kukorantumi) and B1 (near Bunsu Cocoa College).

The physico-chemical parameters were measured and benthic samples were taken at each of the sites visited. Photographs were also taken at all sites visited. The table below shows the physico-chemical data taken from the sites visited. Samples taken from sites were to be sorted and identified later.

Site	Time/ GMT	Tem °C	D.O	pH	Salinity %	Conduc. mS/cm	Trans / cm	Depth/ cm
D4 up	9:57	27.3	1.2	6.44	0.1	0.276	CTB	62
D4 down	10:28	26.6	2.20	6.49	0.1	0.254	CTB	33
D2	12:03	24.7	5.37	6.94	0	0.225	20	31
B1	13:00	24.7	6.09	6.95	0	0.140	50	60

DAY THREE (11TH JANUARY 2006)

The third day began at 9.00GMT, with a presentation, By Prof Edward Maltby. The Ecosystem Approach and the principles associated with it were the main focus of the presentation.

What is Ecosystem Approach?

Participants understanding of ecosystem based approach included the following:

The totality of the environment
A specific ecosystem analysis
A holistic view of social interaction with the environment
How to manage the ecosystem
Integrated management of the environment

The Convention on Biological Diversity (CBD) sees the Ecosystem Approach as a strategy for the integrated management of land, water and living resources that promotes conservation and sustainable use in an equitable way. It is the application of appropriate scientific methodologies focused on levels of biological organisation, which encompass the essential structure, process, functions and interactions among organisms and their environment. It also recognises that humans, with their cultural diversity, are an integral component of many ecosystems.

The Ecosystem Approach is the balance of conservation/biodiversity, sustainable use and equitable sharing of benefits. It was mentioned, however, that these three pillars should not be recognised with equal importance in all context. The application of the Approach should therefore be flexible and this will vary from country to country. For example, the Ecosystem Approach will differ depending on the needs or questions raised the culture as well as the economic reality.

A distinction was made between Ecosystem management and Ecosystem based management. Ecosystem management is doing something deliberately to an ecosystem structure (introducing plants or control of nutrients) whilst Ecosystem based management is the result of unintended actions by management to an ecosystem. A number of interpretations of the ecosystem -based approach have been developed, but all these aim to ensure that resource management decisions taken do not affect the ecosystem function and productivity.

Why adopt an Ecosystem Approach?

It is necessary to opt for the Ecosystem Approach because the classical nature conservation approaches have several limitations, such as;

Lack recognition of the importance of ecosystem function
Ignore site inter-linkages e.g. migratory birds and fish
Ignore inter-linkages between nature and culture
Focus on single species (usually game fish), the most degraded stream segments or on the chemical aspects of water quality.
Lack of stakeholders participation in management of ecosystem
Inappropriate division of costs and benefits
Sectoral interest not integrated

The Ecosystem-based management is currently a highly topical issue and is being widely discussed in the context of biodiversity management. The World Summit on Sustainable and Development (WSSD) as well as the European Approach to River basin coordination has advocated the need for more integrated approaches. For example WSSD recognises the need to integrate into global, regional and national sectoral and cross-sectoral programmes and policies, especially economic and financial institutions as well as recognising the rights on local people.

The 12 Principles of the Ecosystem Approach

1. The objectives of management of land, water and living resources are a matter of societal choice. Societal choice in now in this principle instead social change because it gives much larger implication. How can this principle be applied in Ghana? A participatory approach can be used. The following are the comments of participants regarding this principle:

Local people have the general belief that exploiting resource in their area will be of benefit to them without considering the effects on the environment e.g. mining. On the contrary, people outside these circles see the impact of such activities on the environment to be enormous.

Local people also have some beliefs about the exploitation of some water resources e.g. it is taboo to fish in some rivers in Ghana either entirely or particular times in a year, month or week.

2. Management should be decentralised to the lowest appropriate level.

In Ghana management can be looked at in two ways: The decision making process and the implementation process. Local authority plays an important role in the regulation of river systems in Ghana. For example, the demarcations of Ramsar sites have traditional characteristics. The district assemblies also have responsibility for issuing permits for diverse operations. It must also be noted that in principle Water Resource Commission is technically responsible for the management of water resources but in practice they seems not to be doing so.

It was noted that there is the need for a wide range of management levels for the effective management of water resources. Key among these was the surrounding community because the economic needs of the fringe communities often are the deciding factors when land management decisions are made. The need for dialogue was emphasized.

3. Ecosystem management should consider the effects (actual or potential) of their activities on adjacent and other ecosystems. In Ghana, the Environmental protection Agency (EPA) through the Environmental Impact Assessment (EIA) manages the effects of actual or potential activities on adjacent or other ecosystems. It was recommended that efforts should be made to show the impact of some environmental issues using both the electronic media and the print media. For examples, articles can be written on each of the 12 principles.

4. Recognising potential gains from management, there is usually a need to understand and manage the ecosystem in an economic context. Any such ecosystem-management programme should:

a) Reduce those market distortions that adversely affect biological diversity;
b) Align incentives to promote biodiversity conservation and sustainable use;
c) Internalise costs and benefits in the given ecosystem to the extent feasible.

There was the need to identify ways in which economic instruments can make sustainable development of the ecosystem difficult to achieve. An example was cited in the cocoa industry where the introduction of a hybrid variety led to the complete felling of trees in cocoa farms because the variety does not need shade.

5. Conservation of ecosystem structure and functioning, in order to maintain ecosystem services, should be a priority target of the ecosystem approach. This principle is considered to be the most important worldwide and is said to have strong bearing on the project. With this principle there is the need to identify (clarify) the ecosystem services that are delivered in the study area.

6. Ecosystem must be managed within the limits of their functioning. Are we maintaining sustainable uses of our water resources? Most rivers in Ghana are under pressure as a result of waste disposition and over abstracting of water in some cases.

7. The ecosystem approach should be undertaken at the appropriate spatial and temporal scales. A major limitation noted with this principle was that the catchments of some rivers have international boundaries.

8. Recognising the varying temporal scales and lag-effects that characterise ecosystem processes*, objectives for ecosystem management should be set for the long term.* It was imperative that there should be long term set objectives for ecosystem management in Ghana, which could easily be passed from generation to generation.

9. Management must recognise that change is inevitable. Policies, which promote the management of freshwater resources, may suffer due to change in governments. Natural happenings like climate changes and earthquakes may also affect biodiversity. Population growth can put pressure on resources.

10. The ecosystem approach should seek the appropriate balance between, and the integration of, conservation and use of biological diversity.

11. The ecosystem approach should consider all forms of relevant information, including scientific and indigenous and local knowledge, innovations and practices. Some examples of local knowledge were cited: "when the top of mushroom is hit before uprooting it enables spores (seeds) to drop to the ground to produce more mushrooms" "people should not step in water with their footwear" "fishing is not allowed in some river" etc

12. The ecosystem approach should involve all relevant sectors of the society and scientific disciplines.

Salient features
Features to be borne in mind in the application of the principles of the Ecosystem Approach are:

- There is no single or unique ecosystem approach
- The final goals of the approaches acknowledge human participation and interest
- Emphasis is on maintaining the interaction within and functioning of natural systems
- The approach may be applied over a wide range of scales
- There may be instances of applying an ecosystem approach without it being referred to as such.

Although the principles should be considered in its entirety, some of them cannot be applied in certain situations for one reason or another.

Convention on Biological Diversity Ecosystem Approach
Convention on Biological Diversity Ecosystem Approach is basically a strategy for the integrated management of land, water and living resources that promotes conservation and sustainable use in an equitable way. The aim is to use a wider (ecosystem catchment related) set of variables to assess the quality of a river habitat and create a way of comparing the quality with a reference (baseline) data. The following points were noteworthy:

- ❖ The river ecosystem is more than just the dry season channel. It involves the riparian zone and the wider catchments.
- ❖ Three basic characteristics of all ecosystems that are undisturbed are: available nutrients scarcity; characteristic structure (including food web): high connectivity with systems (catchment, upstream/downstream).
- ❖ A scheme (system, tool) is needed that is inexpensive, measures basic characteristics and can be used widely to give a measure of the amount of change
- ❖ When the amount of change is known suggestions can be made for improvement, if desired or required towards the baseline state.
- ❖ Major changes to river ecosystems in Ghana and West Africa in general are: deforestation, wash-off of nutrients and soil from catchment; loss of riparian zone; alteration of hydrology (barrages, diversion).

Suggested scheme
The general suggested scheme highlighted included:

- ❖ A range of variables is measured at one or more reference sites (National Parks) or the values are compiled from literature and other information
  The same variables (or as many as possible) are measured at the sites under study, preferably at least once.

- ❖ The amount of change (as a percentage) from the reference state is calculated and judgement is applied to each variable, based on local experience, to decide if the river site is excellent (close to reference), good (changed but still has a lot of biodiversity), fair (greatly changed, still has moderate biodiversity), or poor (very low biodiversity). The scale is decided for each variable. For each variable, judgement is used to allocate particular percentage threshold

- The profile in then described in terms of the profile of excellent/good/fair/poor features. This profile is then used to assess possibilities for improvement, if required or desired. Biodiversity is assumed to increase as the reference state is approached.

Suggested Variables Based on Field Visit

1. Percentage of catchment still covered in natural/semi-natural vegetation (determined from aerial photographs, maps, GIS or hilltop survey)

2. Change in hydrology (measured as run-off per km^2 of catchment, corrected for regional variation in rainfall (data from Water Resource Commission)

3. Number of dams upstream of site (determined from maps)

4. Percentage of bank length (100m section) on both sides still occupied by natural/semi-natural vegetation (determined by visual estimate)

5. Concentration of available phosphate - P (analysis)

6. Concentration of available nitrate – NH_3(analysis)

7. Concentration of available ammonium - NH_4 (analysis)

8. Concentration of total suspended solids (or Secchi disc depth) (measurement of site)
9. Number of species of submerged native plants (podostemonads, bryophytes) (counted at site)
10. Number of species of introduced plants (e.g Pistia, Azolla) (counted a site)

11. Percentage of benthic fauna that are that are other deposit feeders (based, as in other benthic estimates) on combined samples of all major habits done in a systematic way (measured on sorted samples)

12. Percentage of benthic fauna (numbers, families) that are Ephemeroptera and Trichoptera (measured on sorted samples)

13. Percentage of benthic fauna (numbers, families) that are predators (measured on sorted samples)

14. Numbers of crabs per standard sampling (traps, perhaps using local people)

15. Mean size of crabs (measured by local people)

16. Number of fish species (test fishing at site or compiled by local people)

17. Number of bird species recorded in standard time over 100m length of the river (assessed at site).

Participants were expected to reflect on the 17 variables for discussion later.

DAY FOUR (12TH JANUARY 2006)

Developing a project protocol

Participants were divided into three groups, namely, A, B and C. The objective was for participants to have a detailed discussion of the 17 suggested variables based on the field visited. Basically, the groups considered:

The feasibility of the suggested variables
Difficulties or problems that are likely to be encountered using those variables
The incorporation of new variables if any.

The table below shows the results from the group discussions.

Variables	Group A (comments)	Group B (comments)	Group C (comments)
1. Percentage of catchment still…	It is feasible because aerial photographs, maps are available and can easily be obtained	Feasible – satellites can even be used	It is feasible but can be expensive. Visual assessment of vegetation can also be used.
2. Change in hydrology…	Feasible because a great deal of information can be obtained from the hydrological service. Data can also be generated.	Hydrological services are available and data can be acquired easily.	Data from water resources commission would be useful.
3. Number of dams…	Feasible – information can be acquired form the local people as well.	Feasible	Some dams are not mapped and supplementary data can be added e.g. human knowledge.
4. Percentage of bank length…	Feasible	Feasible	Feasible
5. Concentration of…	Feasible	Feasible	Feasible
6. Concentration of…	Feasible	Feasible	Feasible
7. Concentration of…	Feasible	Feasible	Feasible
8. Concentration of…	Feasible – criticised however that the Secchi disc is subjective and rather recommended TSS.	Secchi disc depth is subjective. The use of silicate, diatoms, phytoplankton and zooplankton could be considered.	Conductivity, D O, Temperature, BOD, and pH should also be measured.

9. Number of species…	Experts would be required. Diatoms and bryophytes can be included	Feasible	Expertise will be needed for this exercise.
10. Number of species…	Feasible	Feasible	There is the need to consider other species.
11. Percentage of benthic…	Feasible	Feasible	Feasible
12. Percentage of benthic…	Feasible	Feasible	Feasible
13. Percentage of benthic	Feasible	Feasible	Feasible
14. Numbers of crabs…	Crabs might not be available in some acidic stream.	Why crabs? There are limited numbers of crabs in most of our river systems.	Why crabs? There is no need for standardisation in this case.
15. Mean size of crabs…	Local people involvement in the collection of crabs may compromise the data. If crabs are used then their internal organs could be analysed.	Measuring crabs would be difficult for the local people.	This can only be possible when people are trained.
16. Number of fish…	The types of species should be included as well as the number of species.	Feasible	Feasible
17. Number of bird…	It should be decided how far away from the bank the sampling should be done.	1500 m standard time over should be used. Mammals and reptiles could also be used. E.g. food prints of mammals can be used.	Feasible

Group A recommended the inclusion of inorganic analysis of substances like metals. Also there should be sediments and plants analysis.

Build up Discussion I

After the group presentations, participants deliberated on some of the 17 variables further. This is shown in the table below.

Variables	Comments
1	Distinction should be made between primary and secondary forest. Our forest is said to be secondary.
2	
3	Any major dam should be on the maps. It only very small dams that are not shown on maps
4	The bank length should be up to flood plain
5	
6	
7	
8	pH if measured should be carefully interpreted. There is correlation between pH and conductivity. The measure of BOD and silicate was dropped completely because they expensive to measure.
9	It was argued that experts are not needed for this exercise as raised by Group A and C.
10	It was agreed that diatoms would be too cumbersome and hence not suitable.
11	There is the need to identify common bottoms of rivers and the sampling approach identified. E.g. whether Sweep sampler or bolder sampler.
12	
13	
14	The sampling of crabs can be replaced by shredders
15	
16	
17	

A questionnaire which contained some of the 17 variables could be embedded in the ecosystem approach was distributed to the three groups for discussion so as to ensure a big picture assessment. Groups were to:

Comment on the extent of the questions
Provide suggestion on how to improve the questions

DAY FIVE (13TH JANUARY 2006)

Build-up Discussion II

Again, the three groups A, B and C went into discussion. This time a questionnaire designed to cover the 12 principles of the ecosystem approach was used. An average of 3 questions was asked for each principle.
The results from the group discussion is summarised in the table below

Principles	**Group A (Answer)**	**Group B (Answer)**	**Group C (Answer)**
1. *The objectives of management…*	The water course, the adjacent land are used by the communities living within and without them for domestic, fishing, farming, industrial, religious, medicinal purposes, among others.	The community, companies, wild animals, government can use the water course and adjacent land for purposes like farming, agric, fishing, lumbering, recreation etc	The local communities use watercourse and the adjacent land for domestic, fishing, farming, industrial and religious purposes, medicinal and livestock rearing, among others.
2. *Management should be decentralised…*	Local communities, Government, district assemblies, individuals make decisions about water flows, land use at site and in the catchment.	Decisions are made by individuals, traditional authorities and government about water flows and land use.	Traditional Authorities, Local government, Ghana Water Company Limited and Water Resource Commission, makes making decisions about the water flows and land use.
3. *Ecosystem management should…*	Farming, mining and improper disposal of sewage at adjacent areas will have adverse downstream impact Turbidity can be used as an indicator.	Activities such as mining, farming, felling of trees, waste disposal in the adjacent area can have adverse impact downstream Indicator – turbidity /colour.	Activities such as mining, farming, bush burning use of pesticides for fishing, waste disposal in the adjacent area can have adverse impact downstream.
4. *Recognising potential gains…*	Land use activities such cocoa farming, the President Special Initiative on cassava, oil palm have subsidies.	There are subsidies and artificially controlled price structures on cocoa, diamond and gold.	Subsidies for cocoa and pineapple farmers for example.

5. *Conservation of ecosystem…*	The outcome of the biophysical tool-kit provides an indication of the state of conservation and of ecosystem structure and functioning.	The outcome of the biophysical tool-kit provides an indication of the state of conservation and of ecosystem structure and functioning	The outcome of the biophysical tool-kit provides an indication of the state of conservation and of ecosystem structure and functioning
6. *Ecosystem must be managed…*	Management is within the limits of functioning.	Management is within the limits of functioning.	There is management authority but its extent and whether is within limits of functioning is not known.
7. *The ecosystem approach…*	Hydrological maps, site-specific maps from water research institutions can provide a great deal of information.	Information can be provided using maps.	Information can be acquired from maps.
8. *Recognising the varying…*	To restore riverine biodiversity activities like pollution, deforestation, bad fishing practices should be looked at.	Agro-forestry, education of communities and their involvement in the enforcement of laws can help restore riverine biodiversity.	People should not be allowed to farm within certain limits around rivers as well as restricting them from washing and bathing in rivers.
9. *Management must recognise…*	Changes such as estate development, census figures, climatic changes, earthquakes are inevitable.	Changes in policies (government) are inevitable.	Changes like siltation and vegetation.
10. *The ecosystem approach…*	Maps can be used to determine the proportion of vegetated river marginal land to the catchment area used for agric, settlement and commercial purposes.	Maps can be used to determine the proportion of vegetated river marginal land to the catchment area used for agric, settlement and commercial purposes.	Maps can be used to determine the proportion of vegetated river marginal land to the catchment area used for agric, settlement and commercial purposes.

11. *The ecosystem approach…*	Baseline data, water quality assessment, portability test of water, EIA etc	The Water Research Institute and Water Resource Commission can provide information.	The Water Research Institute and Water Resource Commission can provide information.
12. *The ecosystem approach…*	NGOs, research institutions, traditional councils, district assemblies and unit committees.	Government, GWCL, research institutions, local communities, NGOs, VBRP and Academia.	Ministries such as Water Resources, Works and Housing, Land and Forestry, Health, Local Government, Energy, Fisheries, Ports and Habour and NGOs.

Build-up Discussion III

Principles	Comments
1	Additional questions predicting possible future use of resources can be added. Questions should be modelled in matrix format to capture more information.
2	Efforts should be made to improve the decision making process of water flows and land use.
3	Ghana Poverty Reduction Strategy (giving loans to farmers) can stimulate the expansion of farms, thus putting pressure on environmental resources
4	
5	The ecosystems functioning are not enough to say they are on sustainable basis but there are examples to show that some of the resources are on pressure. E.g. Reduction in the sizes of animals caught from freshwaters (fish), medicinal herbs are disappearing in our forest.
6	Ecosystem management should also be based on life cycles as well as the type of species.
7	
8	Most projects operate within political timeframes and are normally characterised by rush so as show rapid results. Hence some long term set objectives are defeated.
9	Other inevitable changes include social aspirations, cultural practices, evasive species, technology etc.
10	
11	Checklist that provides all forms of relevant information to the study area including sites characteristics as well as information about the indigenous people will be useful.
12	We should also take account of all the stakeholders involved.

Closing Ceremony

Closing Remarks

Prof. Asomaning (The Interim Director of Operation, CAW) and Mr. A. T. Konu (The Registrar of the University of Ghana) joined the participants for the closing ceremony. Prof Chris Gordon in his closing remarks mentioned that the workshop has been useful. He indicated that the workshop was initially intended for six project team members but rationally, there was the need to increase the number of beneficiaries. This decision brought some budgetary constraints but he was quick to add that the benefits of the workshop outweighed its cost. He encouraged participants to feature articles on the twelve principles of the Ecosystem Approach and that he was ready to facilitate this exercise.

Leaders of the various institutions including Water Research Institute, Ghana Wildlife Society, Department of Zoology, Environmental Science Programme, Department of Botany and Volta Basin Research Project expressed their satisfaction with the content and delivery of the workshop. They indicated that the workshop has broadened their knowledge in general and their understanding of ecosystem-based approach in particular.

Certificates were presented to all participants. Some gifts were also presented to the three resource persons in appreciation of their contribution to the project so far. Prof. Edward Maltby presented some gifts to Matilda Bissah and Mrs. Mabel Owusu-Addo in appreciation of their services throughout the workshop. He acknowledged the dedicated efforts of Prof. Chris Gordon in bringing the Centre for African Wetlands this far. Prof. Maltby also thanked all participants for making the workshop a success.

Prof. W. A. Asomaning in his closing remarks thanked the resource persons for the knowledge imparted and reiterated the need for co-operation to ensure success in the entire project.

Conclusion

The problems of degradation and fragmentation of riverine eco-systems have resulted from decades of mismanagement and piece-meal attempts at restoration that largely failed because they neglected to understand the riverine system ecology. The few riverine protection policies that exist have failed to address the actual processes and functions of riverine systems. Restoration policies generally focus on single species (usually game fish), the most degraded stream segments, or on the chemical aspects of water quality. A new understanding of ecosystems is emerging, and this understanding was the basis for discussions during this workshop

This project seeks to develop practical tools in Ghana, which would be useful for the management of river resources. The Workshop on Toolkits for the management of Ghana’s Riverine Biodiversity was aimed at engaging local stakeholders in decision-making on how Ghana's river resources must be managed. A common understanding on the Ecosystem Approach has been achieved.

Annex I

Questionnaire - Ecosystem Based Approach

Principle 1

Who uses the water course?
And for what purposes (list)
Who uses the adjacent land? (to the catchment boundary)
And for what purposes (list)
Who uses the biota?
(of the river)
(of the land adjacent)

And for what purposes (list)
River
Land adjacent

Principle 2

Who are making decisions about:
Waterflows
Land use
At the site
In the catchment

Principle 3

Are there activities in the adjacent area which are likely to have an adverse downstream impact?

Indicators would include - bare soil > 10%
- ditches to channel

Principle 4

Are there land use activities which are the result of subsidies or otherwise artificially controlled price structures?

Principle 5

Outcome of the biophysical tool-kit provides an indication of the state of conservation of eco-system structure and functioning

Principle 6

And the extent that current management is within the limits of functioning (P6)

Principle 7

How large is the catchment area?
What is the stream order at the site?
What is the maximum stream order?
Is there an important source of ground water from outside the surface water catchment

Principle 8

What actions can be carried out which can help maintain or where necessary restore riverine biodiversity?

(a) at the site. eg land use, BMPS (Best Management Practices)
(b) in the wider catchment
e.g afforestation, environmental flows, reduced over-fishing

Principle 9

Is there information about inevitable future changes?

Population levels
Hydrological flows
Others

Principle 10

What is the proportion of vegetated river marginal land to the catchment area used for agriculture, settlement and commercial purposes? (km / km^2)

Principle 11

List the information available about the riverine environment including uses :

Water chemistry
Biology Human uses
Management actions

Principle 12

Identify all the groups with an interest in the river environment and the adjacent land use.

Annex II

Convention on Biological Diversity - Ecosystem approach

Aim: To use a wider (ecosystem catchment related) set of variables to assess the quality of a river habitat and create a way of comparing the present quality with a reference (baseline) under listed habitat.

Theory:

- The river ecosystem is more than just the dry season channel. It involves the riparian zone and the wider catchment
- Three basic characteristics of all ecosystems that are undisturbed are: available nutrients scarcity; characteristic structure (including food web); high connectivity with other systems (catchment, upstream/downstream)
- A scheme (system, tool) is needed that is inexpensive, measures basic characteristics and can be used widely to give a measure of the amount of change
- When the amount of change is known suggestions can be made for important, if desired or required towards the baseline state
- Major changes to river ecosystems in Ghana and West Africa in general are: deforestation, wash-off of nutrient and soil from catchment; loss of riparian zone; alteration of hydrology (barrages, diversion)

Suggested scheme:

A range of variables is measured at one or more reference sites (in National Parks) or the values are compiled from literature and other information

The same variables (or as many as possible) are measures at the sites understudy, preferably at least once

The amount of change (as a percentage) from the reference state is calculated and judgement is applied to each variable, based on local experience, to decide if the river site is **excellent** (close to reference), **good** (changed but still has a lot of biodiversity), **fair** (greatly changed, still has modes biodiversity), or **poor** (very low biodiversity). The scale is decided for each variable. For each variable judgement is used to allocate particular percentage threshold.

The habitat is then described in terms of the profile of excellent/good/fair/poor features. This profile is then used to assess possibilities for important, if required or desired. Biodiversity is assumed to increase as the reference state is approached.

Suggested variables based on field visit

1. Percentage of catchment still covered in natural/semi-natural vegetation (Determined from aerial photographs, maps, GIS or hilltop survey)
2. Change in hydrology (measured as run-off per km^2 of catchment, corrected for regional variation in rainfall (data from water resource commission?)

3. Number of dams upstream of site (determined from maps)
4. Percentage of bank length (100m section) on both sides still occupied by natural/semi-natural vegetation (determined by visual estimate).
5. Concentration of available phosphate – P(analysis)
6. Concentration of available nitrates – N(analysis)
7. Concentration of available ammonium– NH_4 (analysis)
8. Concentration of total suspended solids – N(or Secchi disc depth)(measurement at site)
9. Number of species of submerged native plants (podostemonads, bryophytes) (counted at site)
10. Number of species of introduced plants (eg Pistia, Azolla) (counted at site)
11. Percentage of benthic fauna that are other than deposit feeders (based, as in other benthic estimates) of combined samples of all major habits done in a systematic way (measured on sorted samples)
12. Percentage of benthic fauna (numbers, families) that are Ephemeroptera + Trichoptera + Plecoptera (measured on sorted samples).
13. Percentage of benthic fauna (numbers, families) that are predators (measured on sorted samples)
14. Number of crabs per standard sampling (traps, perhaps using local people)
15. Mean age of crabs (measured by local people)
16. Number of fish species (test fishing at site or compiled by local people)
17. Number of bird species recorded in standard time over 100m length of the river (assessed at site)

Annex III

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