The ecology of livelihoods in East African papyrus wetlands: wetland conservation and utilization in the context of local and global change (ECOLIVE): inception wor kshop: 20-22 August 2009, Kisumu Hotel, Kisumu, Kenya: report

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THE ECOLOGY OF LIVELIHOODS IN EAST AFRICAN PAPYRUS WETLANDS: WETLAND CONSERVATION AND UTILIZATION IN THE CONTEXT OF LOCAL AND GLOBAL CHANGE (ECOLIVE)

INCEPTION WORKSHOP

20-22 August 2009
Kisumu Hotel, Kisumu, Kenya

REPORT

UNESCO-IHE Institute for Water Education

AMIDSt Amsterdam institute for Metropolitan and International Development Studies

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1. Introduction

"The Ecology of Livelihoods in East African Wetlands" (ECOLIVE) is a research project funded by the UNESCO-IHE Partnership Research Fund (UPaRF). Project partners are UNESCO-IHE Institute for Water Education (The Netherlands), Egerton University (Kenya), VIRED International (an environmental NGO based in Kisumu, Kenya) and the University of Amsterdam. The overall objective is to develop approaches for conserving papyrus wetlands in East Africa so that their natural functions are protected while poor rural populations can rely on their livelihoods services. Wetlands need to be conserved because they perform vital functions (e.g., habitats for biodiversity, water purification and storage) and provide important services which represent an enormous value that is often not taken into account by decision makers. African wetlands are particularly important because they are hotspots of livelihoods services for rural populations. Papyrus wetlands cover large areas but they are fragile and under pressure of rural populations' livelihoods needs. The project will develop a transdisciplinary analytical framework that facilitates participation of stakeholders in development of sound policies for sustainable livelihoods in papyrus wetland ecosystems. New knowledge in an integrated framework will help to achieve policy goals of poverty reduction and ecosystem conservation.

The "Ecology of Livelihoods" concept is based on the notion that ecology and livelihoods are strongly linked. "Ecology" here represents natural ecosystems (e.g. wetlands) with their biodiversity, water, nutrient and energy cycles. "Livelihoods" represents the development of human societies. In Africa and elsewhere, people's livelihoods are often directly dependent on wetlands, notably through provision of food, water and biomass. Because of the human usage of wetlands for livelihoods, wetlands are under pressure and in many cases show signs of degradation or decline. The relationship between ecology and livelihoods is affected by a multitude of factors: natural factors (e.g. climate change) but also socio-economic and institutional (e.g. markets, democracy).

Specific scientific objectives of the ECOLIVE project are (between brackets: the sub-projects that address these objectives):

1. Understanding the eco-hydrological functioning of the wetland in a changing catchment and climate context (PhD1 - Patrick Khisa);
2. Understanding of wetland biodiversity, nutrient buffering and resilience in relation to levels and types of exploitation for livelihoods (PhD2 - Priscah Rongoei);
3. Understanding the livelihoods of communities depending on wetlands and wetland services (PhD3 - Serena Nasongo);
4. Understanding the institutional and governance aspects of the conservation and utilization of wetlands (PhD3 - Serena Nasongo);
5. Develop a transdisciplinary framework for wetland governance for ecological sustainability and livelihoods (Postdoc - Julius Kipkemboi).

Capacity building and development objectives are (between brackets: main activities addressing these objectives):

1. Make knowledge about wetland ecosystems and livelihoods available to communities, businesses and policy makers for improved wetland management and poverty reduction (stakeholder participation, publications, website);
2. Build capacity in African institutions for sustainable management of natural resources (PhD and MSc research, collaboration, networking)
3. Develop policy tools that can be used more widely in Africa and beyond (models, recommendations for "best practice")

According to the project proposal and workplan, annual project workshops will be held to plan the project activities and discuss progress. The organization of these annual workshops, including this first Inception Workshop, is the responsibility of Egerton University. Because of the necessity of visiting the field sites, the Inception Workshop was held in Kisumu. Subsequent meetings may be held at Egerton University, depending on practical considerations. The excellent organization of this Inception Workshop by the Egerton University staff (notably Dr. Kitaka and Dr. Kipkemboi) was highly appreciated by all participants.

2. Inception workshop objectives

Objectives of the Inception Workshop were:

1. Formally kick off the ECOLIVE project
2. Review annual workplan 2009 and evaluate progress
3. Framework for workplan years 2, 3 and 4
4. Discuss research proposals (PhD + Postdoc)
5. Visit field and agree on criteria for site selection
    - zonation and transects
    - overlap and differences projects
    - identify knowledge gaps for site selection
6. Agree on details of implementation
    - planning
    - equipment / procurement
    - stakeholder involvement
    - funding/financial issues
    - publications

3. Programme

WEDNESDAY, 19 AUGUST 2008

1400 ARRIVAL

THURSDAY, 20 AUGUST 2008

0800 – 0830 REGISTRATION

0830 Introductory welcome note by J. Kipkemboi

0830 – 0850 Self introduction

0850 – 0910 Official Opening by DVC Research and Extension, Egerton University

0910 – 0930 Overview of project and annual work plan Anne van Dam

0930 – 10.00 Progress reports by partners : IHE, VIRED, Egerton university, University of Amsterdam

[**Photo Session**]

1000 – 1030 TEA BREAK

1030 – 1130 Introduction to Nyando wetland (Prof. Okeyo)

1130 – 1700 Field visit

1900 DINNER

FRIDAY, 21 AUGUST 2008

0830 – 0850 Research on wetlands and livelihoods (Serana Nasongo, VIRED International, Kenya)

0850 – 0920 Research on wetland ecosystems integrity (Priscah Rongoei, Egerton University, Kenya)

0920 – 0950 Research on wetland Hydrology (Patrick Khisa, Water resource management Authority, Kenya)

0950 – 1010 Integration of hydrological, ecological and socio-economic data(J. Kipkemboi)

1010 – 1030 *TEA BREAK*

1030 – 1300 Discussions on research programme (incl. key stakeholders)

1300 – 1400 *LUNCH*

1400 – 1530 Implementation of field work: discussion in sub-project groups

1530 – 1600 *TEA BREAK*

1530 – 1730 Presentation of group results and disussions

1900 *WORKSHOP DINNER AT PUBLIC SERVICE CLUB, KISUMU*

SATURDAY, 22 AUGUST 2008

0830 – 1500 Field visit (J.B. Okeyo) (packed lunch)

1500 – 1700 Final discussions and wrap-up of Inception workshop

1900 *DINNER*

SUNDAY, 23 AUGUST 2008

0830 Travel to Egerton/home

4. Results

4.1. Formal kick-off of the ECOLIVE project

The ECOLIVE Inception Workshop was formally opened by Prof. Jude Mathooko, Deputy Vice-Chancellor for Research and Extension of Egerton University. In his opening address, Prof. Mathooko gave a brief overview of the history of collaboration that exists between Egerton University and UNESCO-IHE, e.g. in the IPGL-programme (International Post-Graduate programme in Limnology, jointly with Austria), the EU-funded Fingerponds project and the recent joint MSc-specialization "Limnology and Wetland Ecosystems" which is part of the MSc-programme in Environmental Science based at UNESCO-IHE. Prof. Mathooko reminded the participants that research is not easy and often consists of only 10% inspiration and 90% perspiration. However, he assured the partners that Egerton University is very committed to these joint activities and will make sure that the projects will be handled efficiently and every possible assistance will be offered to make the project a success. He also underlined the importance of linking with the communities and stakeholders who are the "end users" of the research and asked the partners to avoid as much as possible doing "blue sky" research.

Inception workshop participants, Kisumu Hotel, Kisumu, Kenya.

Prof. Jude Mathooko during the opening address.

Group photograph of ECOLIVE team. Front row, left to right: JB Okeyo-Owuor, Priscah Rongoei, Jude Mathooko, Nzula Kitaka, Patrick Khisa, Serena Nasongo. Back row, left to right: Julius Kipkemboi, Frank Masese, Edwin Hes, Jay O'Keeffe, Fred Zaal, Anne van Dam, Stefan Uhlenbrook, Jochen Wenninger, Phillip Raburu.

4.2. Review annual workplan 2009 and evaluate progress

Anne van Dam gave an overview of the specific objectives for 2009 from the Annual workplan of the ECOLIVE project as circulated in early 2009. Table 1 summarizes these objectives and indicates the current status of the related activities. Generally, it can be concluded that proejct activities are progressing well. Main emphasis for the rest of 2009 should be on the start-up of the field work.

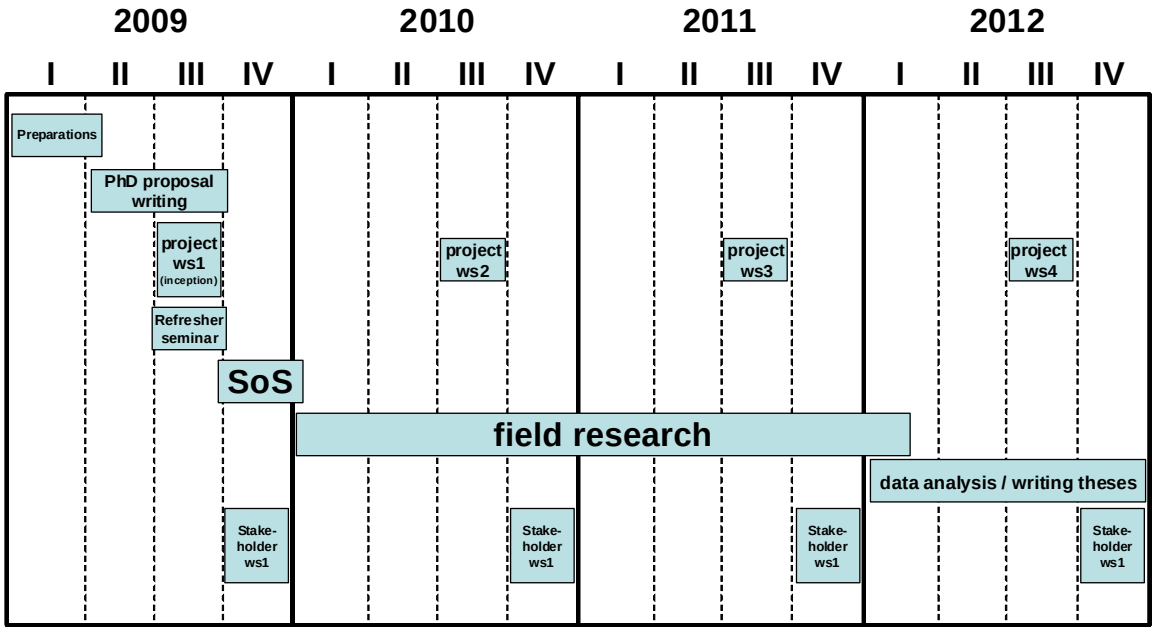
Table 1. Summary of workplan 2009 and progress.

Objective	**Current status**
Let PhDs travel to the Netherlands to prepare proposals and discuss with supervisors	Done. Students were in The Netherlands from April to mid-August. Several meetings with supervisors were held. Two formal project meetings were held (on 14 May and 16 July, both in Delft).
Develop detailed research proposals for PhDs and Postdoc	In progress. Literature reviews done for a large part, methodology and site selection for field work to be done.
Have the project inception workshop	Done.
Organize the ECOLIVE Refresher Seminar	Done. Seminar was held on 24-28 August 2009 at Egerton University with a total of 33 participants from 12 countries.
Set up the project website	Done. See www.unesco-ihe.org/ecolive See also Annex 1.
Obtain research permit from NCST	Done.
Develop a paper on the "Ecology of Livelihoods" concept	In progress by Fred Zaal and Anne van Dam. Fred Zaal will give a presentation on this during the Refresher Seminar at Egerton University.
Procure necessary equipment	To be done.
Get the field work started	To be done.
Develop proposals for additional funding	To be done.

4.3. Framework for workplan years 2, 3 and 4

Figure 1 gives an overview of the main activities in the ECOLIVE project in the period 2009-2012.

Figure 1. Framework workplan 2009-2012 ECOLIVE project.



4.4. Discuss research proposals (PhD + Postdoc)

In the morning of 21 August, the three PhD researchers and the Post-doc gave presentations of their research proposals. During these presentations, key project stakeholders were present to be informed about the progress of the project and to be involved in the discussions on research. The Powerpoint slides of the presentations are presented in Annex 2.

The main comments of the stakeholders were:

- It is important to involve key stakeholder right from the start of the project.
- We need to think about how to approach and involve the different stakeholder groups in an appropriate way. Some of the stakeholders felt that the presentations were very scientific and that this would not be appropriate for all stakeholders. Information about the project needs to be packaged for each stakeholder group.
- A lot of information that is relevant to the ECOLIVE project is available from earlier research projects, e.g. from the research funded by VICRES.

During the afternoon of 21 August, group discussions were held around each sub-project (PhDs 1-3, Postdoc) to accomplish the following tasks:

1. Working titles for thesis chapters (papers);
2. Content of SOS/reconnaisance study (September - December 2009);
3. Research needs (equipment, assistance, etc etc) and cost estimation;
4. Titles for possible MSc research;
5. Concrete idea for IFS proposal.

The Post-doc group focused on drafting a framework for the trans-disciplinary analytical framework.

Composition of the groups:

PhD1: Patrick Khisa, Stefan Uhlenbrook, Jochen Wenninger, Ann van Griensven
PhD2: Priscah Rongoei, Anne van Dam, Edwin Hes, Frank Masese
PhD3: Serena Nasongo, Fred Zaal, JB Okeyuo-Owuor
Post-doc: Julius Kipkemboi, Jay O'Keeffe, Nzula Kitaka

Results were as follows:

1. Working titles for thesis chapters (papers);

PhD1	1. State of system analysis - statistics 2. Land use catchment processes and modelling in the last four decades 3. Hydrological exchange processes at the wetland level (groundwater soil moisture modelling 4. Conceptual model development and synthesis
PhD2	1. Historical and current status of Nyando wetland 2. Identify and quantify pressures on wetland ecosytem caused by livelihood activities 3. Impact of major livelihood activities on wetland vegetation and bird habitat 4. Effect of major livelihood activities on nutrient retention function of wetland 5. Balance between livelihood activities and wetland functions
PhD3	1. Introduction 2. Literature review & conceptual framework 3. General methodology 4. State of the System 5. Mapping the wetland world 6. Institutional analysis 7. Governance 8. Livelihoods and resource use 9. Conclusions and recommendations

2. Content of SOS/reconnaisance study (September - December 2009);

PhD1	PhD2	PhD3
Statistical analysis - hydrological, wet data Change detection - remote sensing data analysis Rehabilitation of RGS stations Installation of RGS stations Inventory of boreholes in Kano planes Identification of sites for experiments	Drivers of change, e.g. hydrology, climate change, land use change, introductin of exotic species, pollution Components - water, soil vegetation, fauna	??

(Comment: this part can be replaced by the plan made by the PhD students during the refresher seminar)

3. Research needs (equipment, assistance, etc etc) and cost estimation;

Based on the work of the separate groups, a combined list of equipment and personnel needs was drafted (see Annex 3). This list will be further refined (technical specifications, quotations for specific items, etc.) and finalized. Subsequently, the list will be divided among the project budgets of VIRED and Egerton University (in which the funds for research are reserved) and procurement procedures can then be started as soon as possible.

4. Titles for possible MSc research;

PhD1	1. Characterization of groundwater situation in lower Nyando 2. Hydrochemistry
PhD2	10. Impact of major livelihood activities on wetland vegetation and bird habitat 11. Effect of major livelihood activities on nutrient retention function of wetland
PhD3	1. Marketing chains for wetland products 2. Plot/area histories in Nyando river wetland 3. Wetland resources and property rights 4. Life histories 5. Health and livelihoods in Nyando river wetland 6. Attitudes and practices on wetland management

5. Concrete ideas for IFS proposal.

PhD1	Procurement of equipment, operational funds
PhD2	Proposal should be about objective 4 (nutrient retention function)
PhD3	Software, hardware, survey production, survey costs (fuel)

4.5. Visit field and agree on criteria for site selection

Two field visits were made. On Thursday 20 August in the afternoon, we visited Okano wetland where the community has been involved in a project to restore the papyrus wetlands. Okana is not located in the actual lower Nyando wetland but can be regarded as a satellite wetland that is fed by (stream xxxx). In addition, the river Nyando was followed to the upstream parts of the lower catchment to observe land use and look at the status of the river channel.

On Saturday 22 August, a trip was made to the lower Nyando wetland. The following locations were visited: Singida and Ogenya. Also, the hydropower station in the Sondu-Miriu river just south of the Nyando river wetland was visited to get an overview of the whole Nyando wetland. Unfortunately, there was no time left to visit the Nyalunga and Wasari sites.

General observations with regard to sites

Clear transitions between different zones could be observed in the wetland. From the lake and the river, there is a zone of permanently flooded papyrus wetland. Directly at the landward edge of the papyrus, the vegetation is removed by cutting and burning and crops such as maize, sweet potatoes, beans, cassava, etc. are grown. In this zone, there is also considerable growing of sugarcane. Landward from this crop zone there is a zone of seasonally flooded grassland with livestock grazing, homesteads and some crops.

Three gradients can thus be distinguished:

- a hydrological gradient (Figure 2)
- a disturbance gradient (Figure 3)
- a wetland dependence gradient (Figure 4)

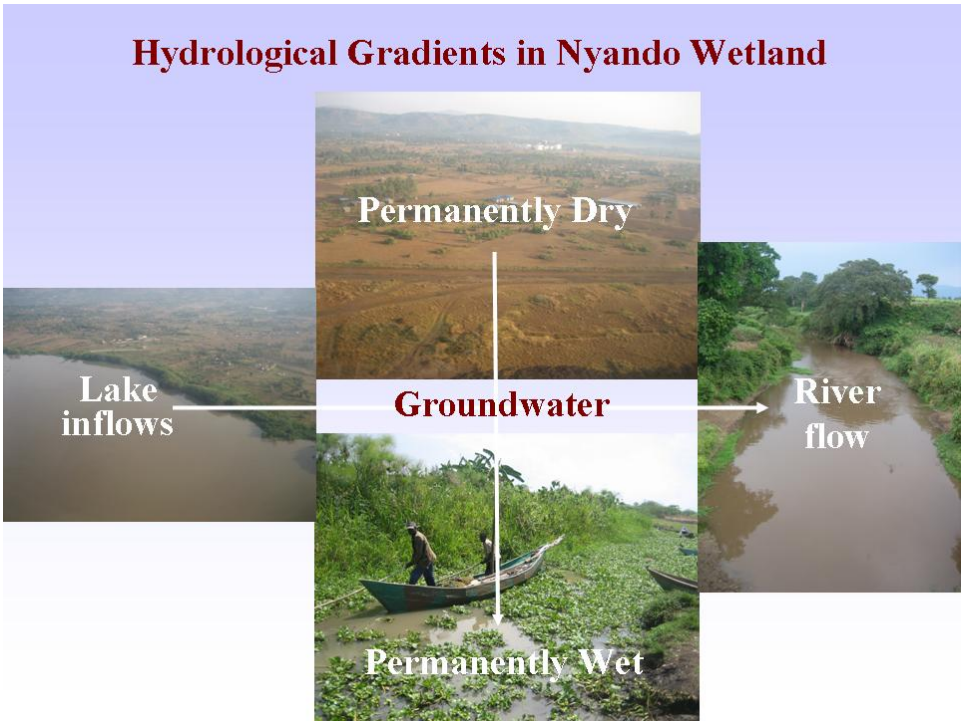


Figure 2. Hydrological gradients in the Nyando wetland: from permanently wet to permanently dry, and from depending on lake inflows to depending on river inflows (photos by Jay O'Keeffe).

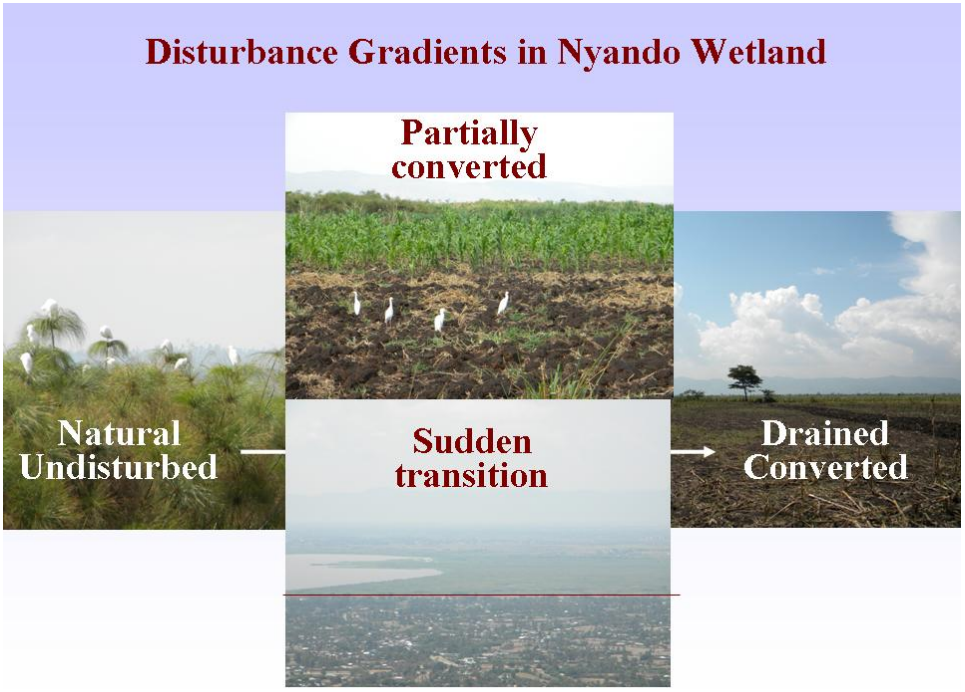


Figure 3. Disturbance gradients in the Nyando wetland, from undisturbed in some of the papryus areas fringing the river and the lake, to partially converted right behind the papyrus fringe, to completely drained further inland (photos by Jay O'Keeffe).

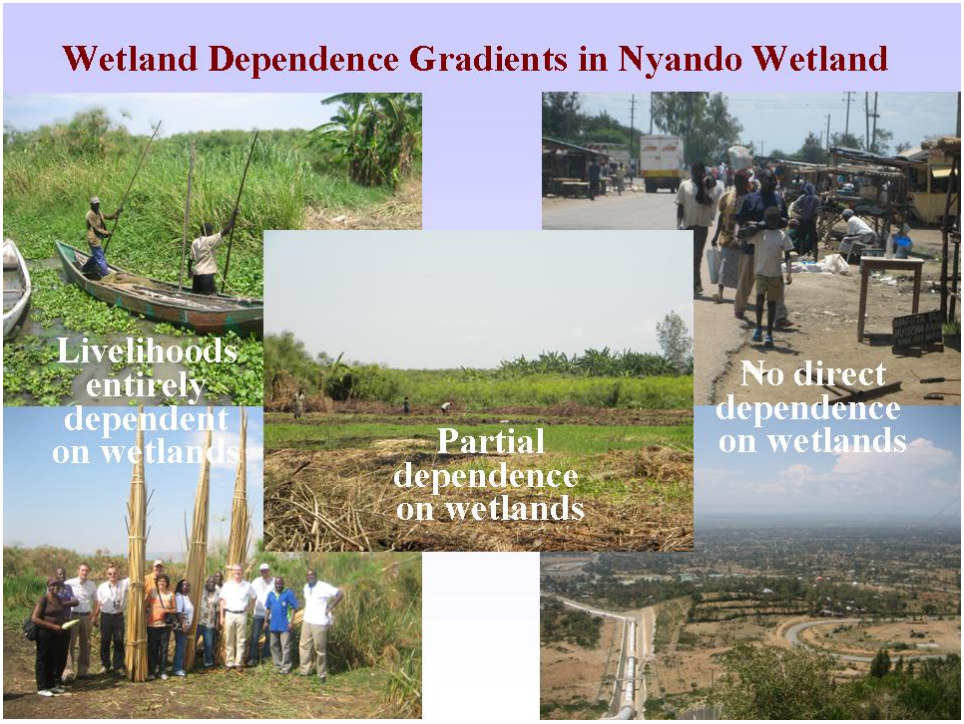


Figure 4. Wetland dependence gradients in Nyando wetland, ranging from communities living close to the wetland and depending (almost) entirely on wetland resources for their livelihoods; to communities living at a distance from the wetlands and not depending directly on the wetlands. In between are people who depend on the wetlands partially (photos by Jay O'Keeffe).

Conclusions about site selection

Based on the field visits and discussions, the following considerations can be made with regard to site selection for the ECOLIVE research:

1. Sites need to take into account the three gradients/axes: hydrology, disturbance and dependence on the wetlands. These gradients coincide largely with the three PhD studies (PhD1, 2 and 3, respectively) but there are also several cross-links between the gradients and the PhDs.
2. The hydrology gradient has two aspects:
    a. from river to lake. This can be captured by selecting at least one site that is influenced only by river hydrology (e.g. Wasari), one site influenced only by the lake (Ogenya), and one site under influence of both river and lake (e.g. Singida).
    b. from wet (lake/river) to dry (upland); this would be covered by looking at transects from water to dry land at each research site.
3. The disturbance gradient can be observed everywhere. Coming from Ahero and moving towards the lake, completely drained and converted wetland can be seen that may flood occasionally in the rainy season but are largely dry and used for agricultural crops. In these areas, there are depressions (e.g. ditches

along the road) that are more or less permanently moist or wet with some emergent or even floating aquatic macrophytes. Coming closer to the lake or river edge, sugar cane plantations can be seen as well as other food crops such as maize, banana, sweet potato, beans, cassava, etc. In the lake floodplain, there are also wide grassy areas that are used for livestock grazing. This zone is seasonally flooded. Bordering this zone is the papyrus wetland which is permanently flooded. The transition from papyrus to cropland is very abrupt. However, in the transition zone the papyrus vegetation may be removed but some of these areas are too wet to grow crops. Inside the papyrus zone, there is a lot of fishing (using traps) and also papyrus culm harvesting for mat making etc.

4. The wetland dependence gradient strectches from the wetland itself to the urban areas. In between, dependence on the wetland changes from being completely dependent (for fish, food crops, building materials, cash) on the wetland, to partial dependence in the large area between the papyrus fringe and urban centers like Ahero or Kisumu, and only slight dependence in the towns where people may buy wetland products (mats, fish, food) but have alternatives as well.
5. Site selection would need to take these gradients into account. For the characterization of the Nyando wetland during the SoS phase, a number of sites within but also outside the Nyando wetland (e.g., Okana) could be studied. For more detailed hydrological and ecological studies, a selection of three sites (river, lake, mixed) and a transect in each of these sites (covering disturbance and wet-dry hydrology) would be sufficient. For the socio-economic work, even communities staying outside the wetland but benefitting from wetland resources might be included. A definitive decision about site selection can only be made after the SoS phase.

4.6. Agree on details of implementation

After the field visit on Saturday 22 August a brief final meeting was held to agree on further activities for implementation. The following points were discussed:

Deadlines for finalization of detailed PhD research proposals and for draft IFS proposals were set at 1 October 2009.

With regard to the *methodology of the State-of-the-System (SoS)* analysis, it was agreed that the PhD researchers would work out a more detailed plan during the refresher seminar at Egerton in the week after the inception workshop. This detailed plan is in Annex 4 of this report. The SoS phase will be implemented in the period September-December 2009.

Based on the results of the group discussions, an overall *list of equipment and assistence* for procurement was drafted (see Annex 3). This list will be refined and finalized in September after which Van Dam, Okeyo-Owuor and Kipkemboi will discuss budget implications and start procurement procedures.

Monthly *project management meetings* will be organized in Kenya by Okeyo-Owuor and Kipkemboi. All researchers will take part in these meetings to discuss and coordinate working arrangements, recruitment of Ph.D. assistants, stakeholders meetings plans, transport requirements and arrangements, and harmonisation of procurement list and plans.

Van Dam requested both partners in Kenya to submit *detailed financial reports* by October 1 to allow an assessment of the financial situation and if necessary make arrangements for further trasnfer of funds for procurement.

Khisa and Ringoei informed the meeting that, as they did not receive their residence permits yet during their stay in Delft, they have to return to The Netherlands before 15 February 2010. It is sdtrongly recommended to do this as soon as possible in the new year and not stay any longer than necessary to be back in Kenya for start of the field work.

5. Participants

Name	Organization	Role in ECOLIVE project
JB Okeyo-Owuor	VIRED International	xxx; Supervisor PhD3
Phillip Raburu	VIRED International	Research partner
Julius Kipkemboi	Egerton University	xxx; Supervisor PhD2; Post-doc researcher
Nzula Kitaka	Egerton University	Research partner
Stefan Uhlenbrook	UNESCO-IHE	Promotor PhD1
Jay O'Keeffe	UNESCO-IHE	Promotor PhD2
Jochen Wenninger	UNESCO-IHE	Supervisor PhD1
Ann van Griensven	UNESCO-IHE	Supervisor PhD1
Anne van Dam	UNESCO-IHE	Project leader; Supervisor PhD2
Edwin Hes	UNESCO-IHE	Research partner
Fred Zaal	UvA / KIT	xxx; Supervisor PhD3
Patrick Khisa	Water Resources Management Authority (WRMA), Lake Victoria-South Catchment	PhD-researcher project 1
Priscah Rongoei	Egerton University	PhD-researcher project 2
Serena Nasongo	VIRED International	PhD-researcher project 3
Frank Masese	Moi University	Research partner
John Mumbo	National Environmental Management Authority (NEMA)	Stakeholder
Margaret Abira	Water Resources Management Authority (WRMA), Lake Victoria-South Catchment	Stakeholder
George Sekoyo	Lake Victoria Basin Commission (LVBC)	Stakeholder
Domitila Chula	Kenya Marine and Fisheries Research Institute (KMFRI)	Stakeholder
xxx	Kenya Wildlife Service (KWS)	Stakeholder

6. Annexes

Annex 1. Screenshot of ECOLIVE website (www.unesco-ihe.org/ecolive)

Annex 2.

Powerpoint presentations.

UNESCO-IHE
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Ecohydrological functioning of Nyando Wetland in a changing catchment and climate context

Patrick Sifuna Khisa

Promoter: Prof. Stefan Uhlenbrook

Supervisors: Dr. Jochen Wenninger

Dr. Ann van Griensven

Dr. Julius Kipkemboi

PhD PRPOSAL

FIRST DRAFT

UNESCO-IHE
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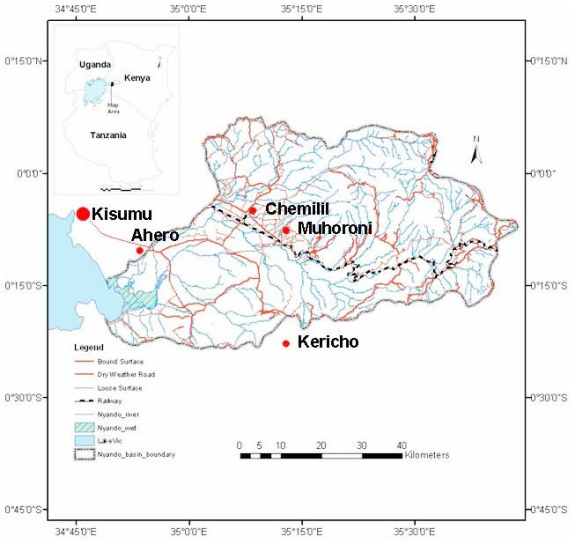
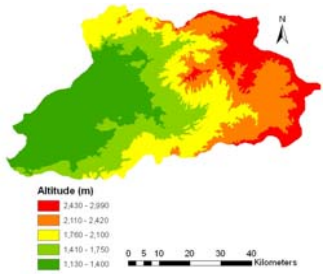
Introduction



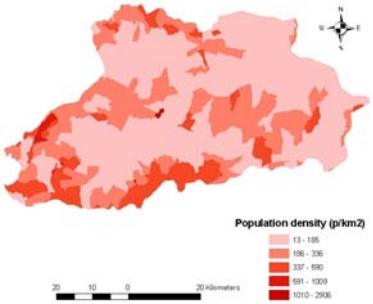
Location of Nyando catchment

Administrative Units

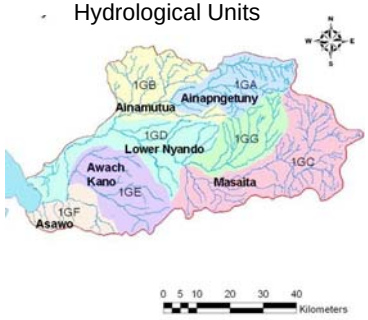
Topography



Population density

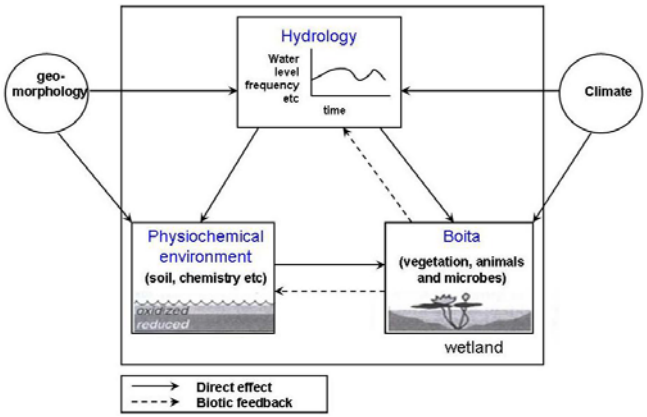


Hydrological Units



Basic components of a wetland definition

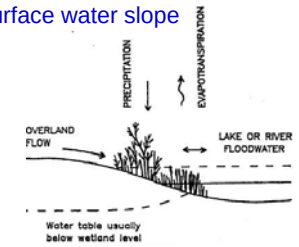
The term ‘wetland’ refers to a habitat that occupies a position somewhere between dry land and deep aquatic ecosystems (Mitsch and Gosselink, 2000).



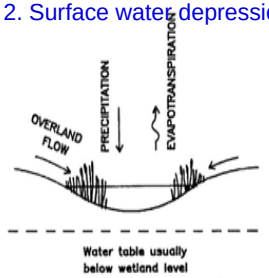
(Adapted from William and James, 2000)

Wetland classification

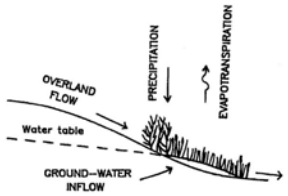
1.Surface water slope



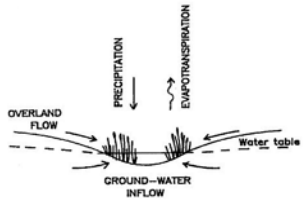
2. Surface water depression



3.Groundwater slope



4.Groundwater slope

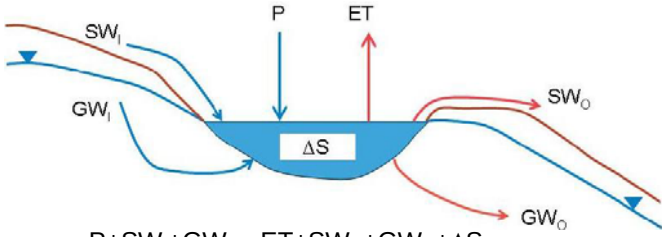


(Adapted from Novitski, 1979)

Wetland Hydrology

The term wetland hydrology generally refers to the inflow and outflow of water through a wetland and its interaction with other site factors

1. Water balance



$P+SW_I+GW_I = ET+SW_O+GW_O+\Delta S$

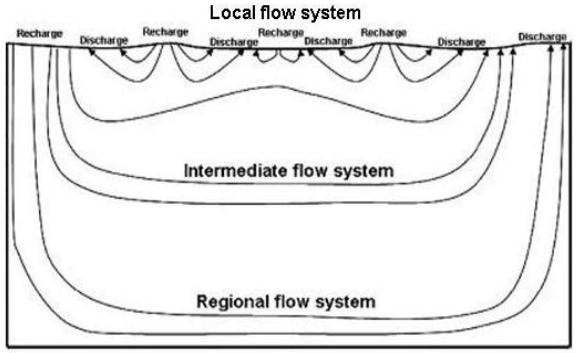
2. Wetland water regime

Water table fluctuations
Hydroperiod

GW-SW Interactions

Hydrological conceptual frameworks

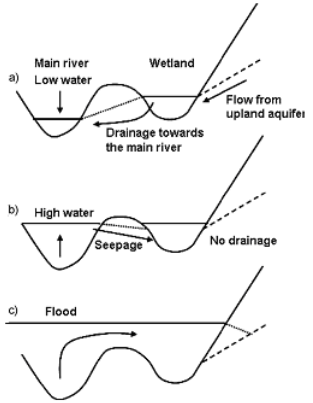
Groundwater flow systems



(Toth (1963)

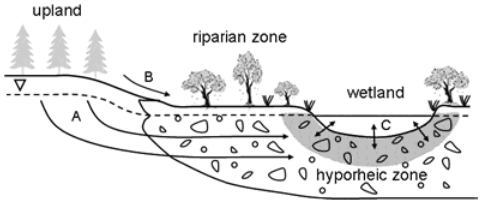
Hydrological exchange processes

Large scale hydrological exchange process of rivers and groundwater



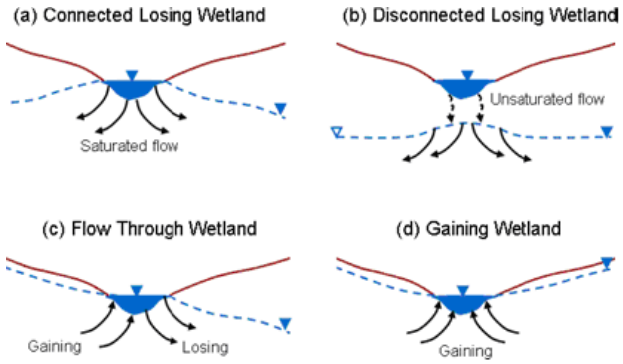
(Amoros and Bornette, 2002).

Small scale hydrological exchange processes of wetlands at hyporheic zone



(Hayashi and Rosenberry (2002)

Theoretical frameworks for GW-SW Interactions of wetlands



Nield *et al*. (1994); Townley and Trefry (2000); Smith and Townley (2002) and Turner and Townley (2006),

Ecohydrology

Definition

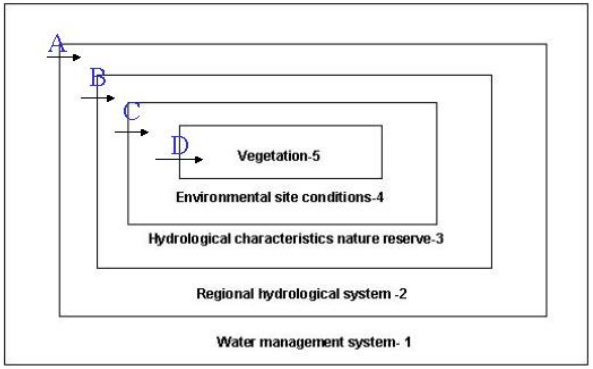
Zalewski (2000) defines ecohydrology to be 'the study of the functional interrelations between hydrology and biota at the catchment scale' and 'a new approach to achieving sustainable management of water'

Branches

1. spatial patterns and the dynamics in vegetation structure

2. relationships of hydrology and biodiversity, especially the relation between hydrology and the occurrence of individual plant species and plant communities. Witte et al. (2004)

Ecohydrology: Approaches



Step A geohydrology
Step B geohydrology/ ecohydrology
Step C agrohydrology/geohydrology/hydrochemistry/soil science: ecohydrology
Step D hydro-ecology

(Garritsen, 1993)

Ecohydrological models

Hydrodynamic models

used coupled hydrodynamic and hydrological based models to assess the effects of climate and land use change to riparian wetlands. The hydrodynamic based models simulate detailed flow patterns and distribution within a wetland system.

Hydrological models

focus on predicting the variables of interest downstream of a riparian without modelling the details of hydrological processes in the wetland

Examples

SWAT, MIKE SHE-MIKE 11

Proposed Research

Problem statement

- Conversion of wetland to farmlands
- Degradation of upper catchment
- Climate change
- Nyando river modifications: dyking, channeling, abstractions
- Eutrophication of Lake Victoria
- Livelihoods
- To understand these issues requires ecohydrological modelling

Research Questions

- How do climate and land use changes affect the ecohydrological functioning of the wetland?
- How does a wetland interact with subsurface water, including soil water and groundwater
- What is the relationship between the river and wetland? How does the amount of surface water stored in a wetland change over time?
- What hydrological exchange processes exist between the wetland and lake? When does the lake provide water to the wetland?
- Which would be suitable data sources to undertake experimental analysis? How would a conceptual model be developed from the qualitative analysis?
- What is the effect of model uncertainty on the applicability of the models for scenario evaluations and management purposes?

Objectives

Main Objective

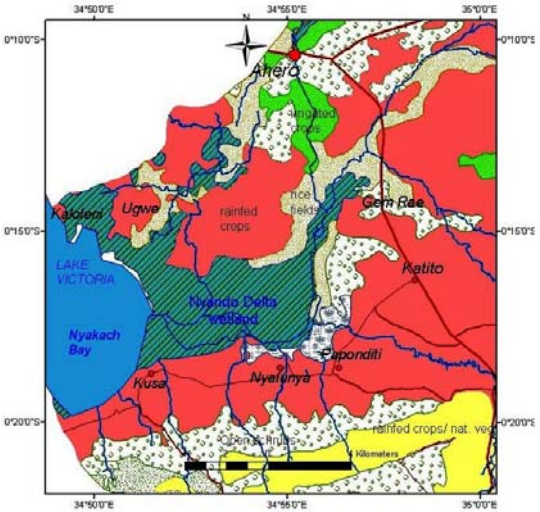
Understand the impact of climate and land use change on the ecohydrological functioning of Nyando wetland.

Specific Objectives

- To investigate the impact of climate and land use changes on the hydrological flow regime of Nyando River.
- To determine groundwater – surface interaction mechanisms in the Nyando wetland in relation to the aquifer, river and lake.
- To determine the relationship between wetland water regime and vegetation occurrence
- Develop a conceptual model that describes hydrological processes in the Nyando catchment and its wetland, and predict best management practices

Methods

Experiment sites



Choice of methods

- Choice of methods is dependent on type of hydrological zone [aquifer, surface water, transition zone]
- First Approach: based on Darcy's law (Darcy, 1856) which states that water flux is a function of hydraulic gradient and hydraulic conductivity
- Second Approach: based on water budget equations, resulting in the calculation of inflow and outflow portions or in the determination of individual flow components

Methods applied in the aquifer

- Hydraulic gradient: use of piezometers and data loggers to measure water levels
- Hydraulic conductivity: Grain size analysis, slug and bail tests, pumping tests
- Soil moisture: use of time domain reflectivity (TDR) meter in the unsaturated zone/root zone
- Inflitration rates: use the double ring method in the unsaturated zone
- Geophysical prospecting: Apply VES and ERT to determine water table and geological formations/structures

Methods applied in surface water

- Incremental streamflow: use of velocity area and dilution methods in stream flow measurements
- Hydrograph separation: graphical and automated techniques to separate hydrograph into baseflow and quickflow
- Environmental tracers: use of stable isotope tracers, e.g stable oxygen and hydrogen isotopes to determine sources of water into wetland
- Meteorological parameters: use of automated weather station, rain gauges, pans to measure climatic variables

Methods applied in the transition zone

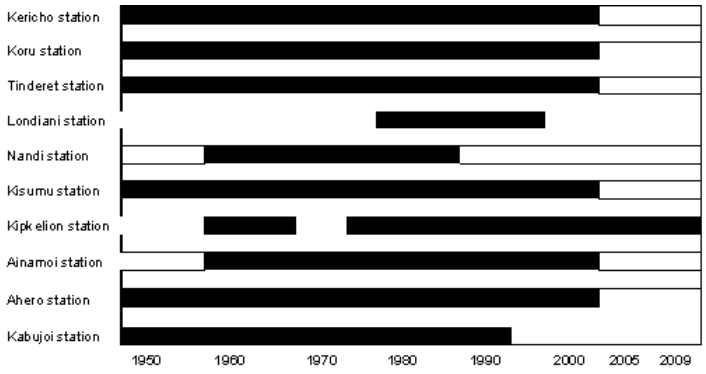
Methods applied in the aquifer to determine hydraulic gradient and hydraulic conductivity are applicable e.g use of seepage meters

Remote sensing methods

Satellite imageries will be analyzed for temporal change detection in vegetation using ERDAS IMAGINE software.

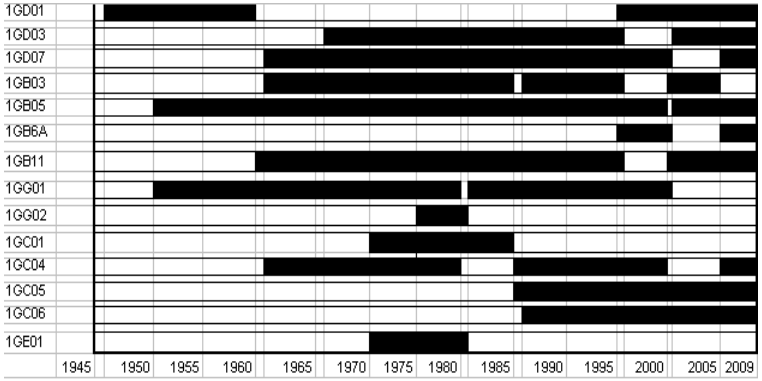
Data availability analysis

Rainfall data

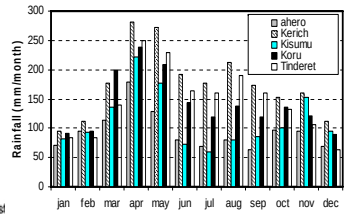


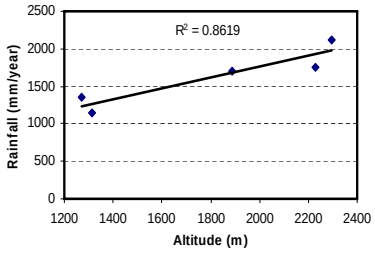
Data availability analysis

River flow data

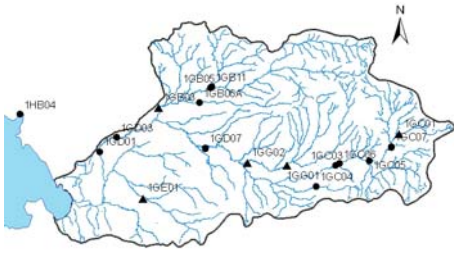


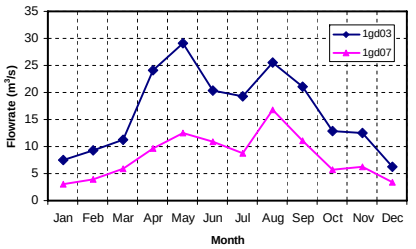
Preliminary findings

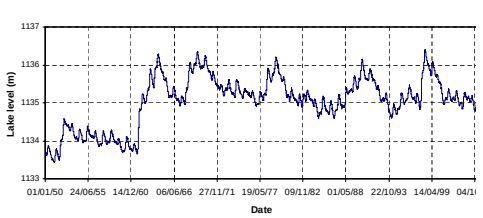


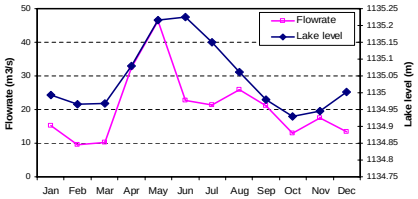


Preliminary findings



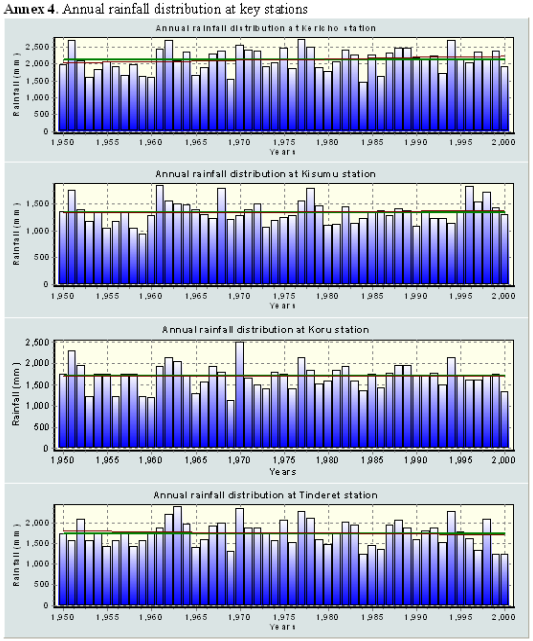






Preliminary findings

Annex 4. Annual rainfall distribution at key stations



Modelling

Conceptual model will be developed after baseline data analysis of the catchment.

Two models proposed

- Hydrodynamic model: flow analysis in the wetland
- Catchment model: simulation of runoff from the catchment

Work plan

	Activities	2009				2010												2011												2012											
		A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D
1	Conference																																								
2	State of system analysis																																								
3	Proposal																																								
4	Field experiments																																								
5	Short courses																																								
6	PhD Seminar																																								
7	Baseline analysis of hydrological processes																																								
8	Journal paper																																								
9	Model set-up																																								
10	Model integration																																								
11	Model calibration, validation																																								
12	sensitivity analysis																																								
13	Journal paper																																								
14	General discussions, conclusions																																								
15	Writing corrections																																								
16	Submission of Draft																																								
17	Defence Graduation																																								

Thank you

Wetland ecosystem integrity in Relation to Exploitation for Livelihoods in Nyando Wetland, Kenya

Priscah J. Rongoei

Promoter: Prof. Jay O'Keeffe (UNESCO-IHE)

Co-Promoter: Dr. Anne van Dam (UNESCO-IHE)
Local Supervisor: Dr. Julius Kipkemboi (Egerton University)

ECOLIVE Project Inception Workshop 19-22 August 2009
Kisumu Hotel, Kisumu city, Kenya

Presentation outline

- Introduction
- Analytical framework
- Problem statement
- Objectives
- Methodology
- Work plan

Introduction

- Issues:- Ecosystem integrity, resilience, livelihoods
- Wetlands face unprecedented array of threats (MEA, 2005)
- Livelihood related pressures may have catastrophic impacts on biodiversity and wetland functioning
- Affect supply of goods and services of value to humanity

Uganda: uncontrolled papyrus cutting wastewater discharge into papyrus wetlands

Rwanda: Upland and flood plain wetlands

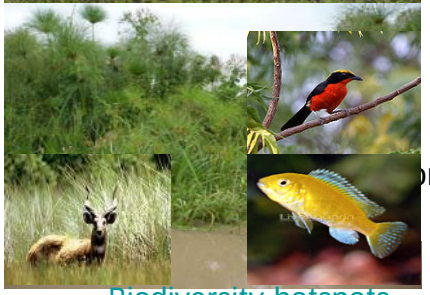
Most upland valley bottoms are under high pressure from agriculture leading to erosion, fertility loss and water quality problems downstream

Floodplain papyrus vegetation is removed for agriculture

Nyando wetland, Kenya

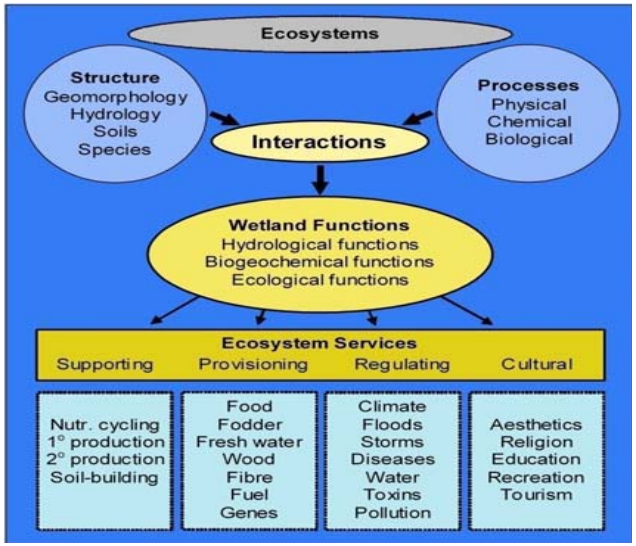
Problem - question of balancing

- Wetland loss ~ 34-60% since 1960s (Owino & Ryan, 2007)
- Water level fluctuation (Awange and Ong'ang'a, 2006)
- Uncertainty in the relationship btw hydrological functions, biodiversity loss and change in livelihood patterns
- Need to have a tradeoff between use and not loosing them



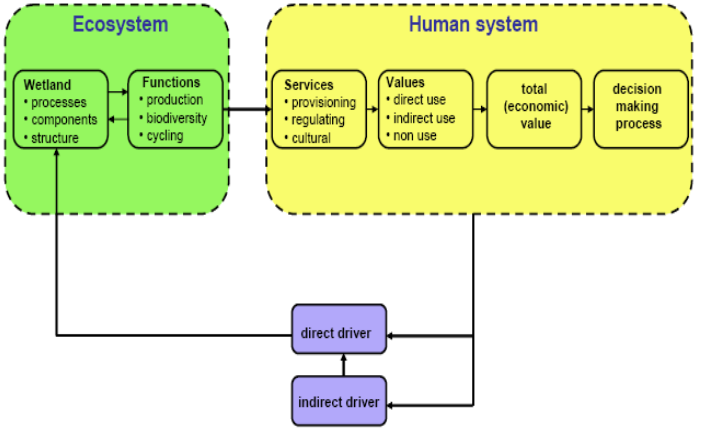
Biodiversity hotspots

Sources of ecosystem services



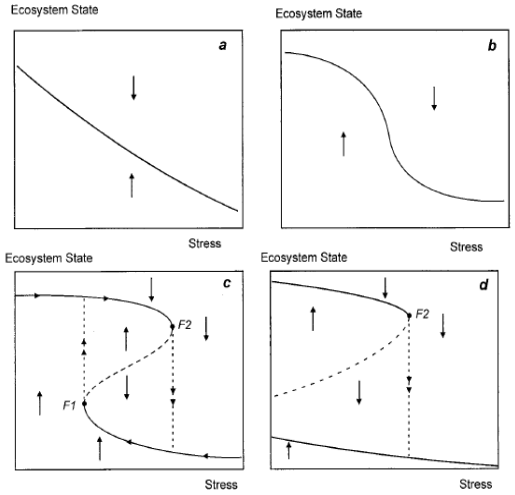
(Adopted from Maltby 2007)

Analytical Framework



Source: Hes et al., 2008, Based on: Brouwer et al., 1999; Turner et al., 2000; de Groot et al., 2002 and MEA 2003.

Possible ecosystem states from human use



- Possible responses of ecosystems to stress
- Line represent equilibrium states
- Arrow indicate direction of change

Source: Scheffer *et al* 2000

Why this research?

- Significant contribution wetlands make to livelihoods which arise from their functions.
- Growing concern on sustainable development – Vision 2030 of Kenya
- Understand the response of ecosystem to stress to assist in setting priorities and enable appropriate balances between wetland functioning and services
- Understand factors that determine resilience of papyrus dominated ecosystem.

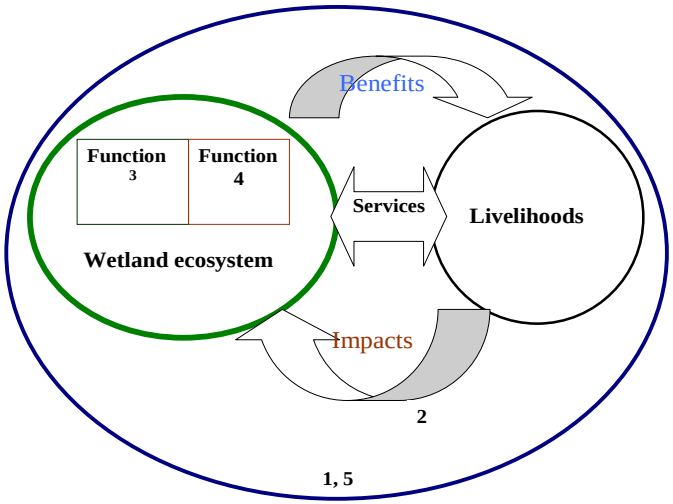
Overall Objective

- To gain a better understanding of the ecological and biogeochemical wetland ecosystem functions in relation to livelihood pressures

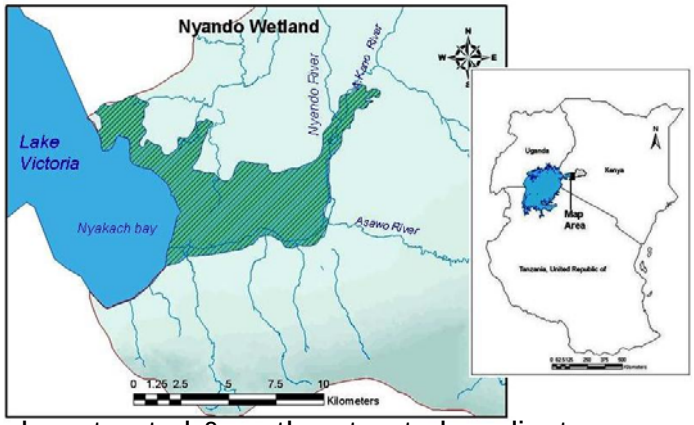
Specific Objectives

1. An overview of the current status and historical wetland ecological changes in Nyando River wetland since 1960
2. To analyze livelihood activities that put pressure on the wetland ecology
- To assess the spatio-temporal composition, abundance and distribution of wetland vegetation at different levels of livelihood pressure (ecological)
- To evaluate the role played by macrophytes community in nutrient retention at different levels of pressure (biogeochemical)
- To asses the tradeoffs between wetland ecosystem function and services

Schematic Overview of study approach



Study site



Lake saturated & partly saturated gradient
River saturated and unsaturated gradient
impacted & least impacted sites

Methodology I

Objective 1: Historical and current status of wetland ecological changes in Nyando River wetland since 1960

Research area	Data requirement	Methods of data collection
Wetland status in the past	Vegetation and livelihood changes over time	Maps and review of satellite and topographic images PRA, Reports, questionnaires, interviews
	Major events that led to change	
Current status	Livelihood activities Vegetation and area extent	

Methodology II

Objective 2: Major livelihood activities impacting on wetland ecology

Research area	Data requirement	Methods of data collection
Major livelihood pressure on wetland ecosystem function	Ranking of livelihood activities that impact on wetland	Survey questionnaire Observation
Intensity of pressure and seasonal variation	Frequency and how much it is harvested at different seasons	Field observation Field measurements Participatory monitoring
Impact on wetland ecology	Physical parameters (DO, Temp., pH), water depth,	In-situ measurement at impacted and least impacted sites

Methodology III

Objective 3: Impact of pressures on macrophytes community

Research area	Data requirement	Methods of data collection
Survey the emergent Macrophytes species	Species composition (presence)	Collection of samples at impacted and least impacted, identification
Distribution and abundance at different pressure sites	Emergent macrophytes diversity (number of species)	Species richness in the impacted and least impacted sites
Effect of season on macrophytes production	Macrophyte biomass	Measure biomass and girth at impacted and least impacted sites

Methodology IV

Objective 4: Role of macrophytes community in nutrient retention at different levels of pressure types

Research area	Data requirement	Methods of data collection
Factors affecting nutrient retention	Physical parameters like pH, temperature, DO	Measured insitu in impacted and least impacted
	Nutrients (N & P) in water and soil	Collect samples in impacted and least impacted
Biomass and nutrient retention in dominant macropyte	Nutrients in plant parts Growth rate	Collecting samples and measuring biomass at impacted and least impacted
Impact of pressure level on nutrient retention	Comparing papyrus with cocoyam plots	Collect samples from papyrus and crop parts

Methodology V

Objective 5: Balance between wetland ecological function and services

Research area	Data requirement	Methods of data collection
How to achieve a balance	Type of pressure acceptable (rice, vegetables, harvesting)	Interviews, questionnaires
	Level of pressure acceptable (Frequency, amount, size of land)	Participatory monitoring Measured indicators
Impacts of pressures	Quantified functions that are linked with pressures	Working wetland potential (WWP)

Expected output

- ❑ PhD thesis
- ❑ At least two MSc. Thesis
- ❑ Scientific publications
- ❑ Local reports
- ❑ Better understanding on the potential impacts of livelihood activities on the integrity of wetlands
- ❑ Understand which livelihood activities are acceptable in achieving sustainability in the wetland

Study Work plan

YEAR	ACTIVITIES					
	Proposal writing	Submission and initial survey	Data collection	Data analysis and publications	Thesis preparation and modeling	Submission and defense
2009						
2010						
2011						
2012						

Putting the house in order: Institutions and governance in the management of Nyando River Wetlands, Kenya

A PhD research proposal
by
Serena Adhiambo Adede Nasong'o
Promotor: Prof. Ton Dietz
Supervisor: Dr. Fred Zaal
Field Supervisor: Prof. J.B.Okeyo-Owuor

Amsterdam Metropolitan Institute of Development Studies
(AMIDst)
Faculty of social and behavioral studies

Introduction

- Wetlands are known to perform crucial **functions** and provide vital **products** and **services** essential for environmental integrity and **human well being**.
- Wetlands are an important source of commercial fishing, agriculture, seasonal livestock grazing, wood collection and ecotourism(Adede,2008; Denny, 1997 Kairu, (2001).
- Being hugely diverse in their **interactions**, they have developed intricate **relationships** with human **livelihood patterns** and environmental phenomena influencing human behaviour and **environmental characteristics/features** wherever they occur.
- A high population in developing countries depends upon the utilization of wetland resources in one way or another for their livelihoods. Silvius et al. (2000)

Threats to the Nyando River Wetlands(NRW)

The Nyando River wetlands are an important life-supporting ecosystem yet they are threatened due to:

- Increased population and settlements especially the cultural factor of establishment of new homes (*Go Dala*)
- Increased levels of unemployment(2007 post election violence)
- Increased demand for wetland products in the commercial market
- Increased demand for foodstuffs in the urban centres
- Increased frequency of drought and hence increased need for dry season grazing for longer periods.
- Lack of a national wetland policy and Sector based policies that give conflicting policy statements.
- The prevalence of HIV/AIDS scourge which has contributed to the emergence of child –headed homes and elderly guardians.
- Land-use changes
- Poverty

Some threats to wetlands

a) A woman 'hunting' lung fish
b) Burning
c) Conversion of wetlands to farms for horticulture (Cowpeas)
d) Conversion of wetlands cash crops (Sugarcane)

Cont' Some threats to wetlands

e) Settlements
f) Overharvesting of wetland products
g) Overgrazing

Statement of the problem

- Riparian communities do not know the value of wetlands in terms of their functions and services since these are rarely quantified in economic and monetary terms. (Lambert, 2003).
- As more of these areas are reclaimed the wetlands ecosystem balance is distorted thus communities that depend on wetlands for much of their livelihoods are bound to face uncertain future due to unsustainable depletion of the sources of livelihoods.
- Even as the degradation of wetlands puts the livelihoods of communities and the biological diversity at risk there is lack of understanding of :

1. the factors influencing people's access and decisions on use of wetland resources
2. the factors influencing rural household decisions on use of wetland resources in the Nyando River Wetlands (NRW)
3. and how institutions and governance affects livelihood choices and conservation of wetland functions and services

OBJECTIVE OF THE STUDY

To find out the institutions and governance systems that determine the use of the Nyando River Wetlands (NRW) in order to promote or hinder their ability to maintain wetland functions and services, thus endangering or safeguarding the livelihoods of riparian communities who are dependent on them.

Main research question

How do institutions and governance systems affect wetland resource use (ownership and access), and the management of the Nyando River Wetlands (NRW), Kenya , with the view of conservation of wetland functions and services?

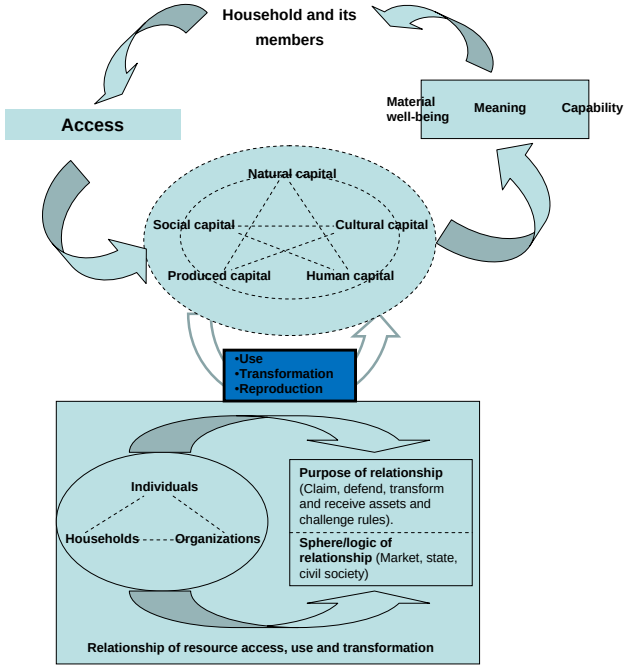
SUB- RESEARCH QUESTIONS:

- What are the current uses of the Nyando River Wetlands (NRW) during the different seasons of the year?
- What are the differences between the current uses and the past uses of the Nyando River Wetlands (NRW) and why?
- What are the problems arising from the use of wetland resources in the Nyando River Wetlands (NRW)?
- How do communities within the Nyando River Wetlands (NRW) relate wetland resource use to wetland functions and services?
- What is the relationship between wetland resource use and household livelihoods in the Nyando River Wetlands (NRW)?
- What is the role of institutions in wetland resource use in the Nyando River Wetlands (NRW)?
- What governance systems found in the Nyando River Wetlands (NRW) are relevant to the use wetland resource?

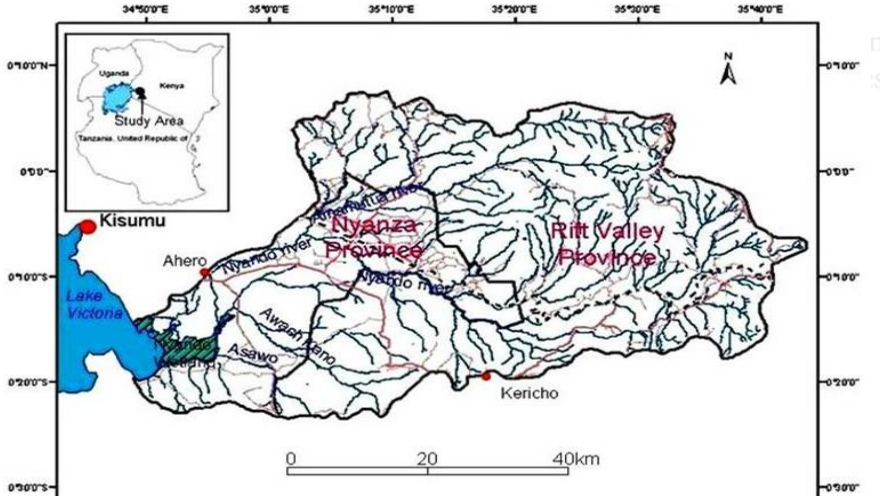
Theoretical framework: Capitals and capabilities framework (Bebbington, 1999)

- The framework argues that the analysis of rural livelihoods needs to have an understanding of the following:
- People's access to capital assets (Cultural, Human, Natural, Produced and Social capital)
- The ways in which they combine and transform these assets into livelihoods
- The ways in which they expand their asset bases by engaging with other actors through relationships governed by the logics of state, market and civil society (institutions); and ,
- The ways that people are able to deploy and enhance their capabilities to change rules and relationships governing how resources are controlled, distributed and transformed in society.
- Human well-being is fundamentally dependent on ecosystems, due to the provisioning, cultural and regulating services they provide (The Millennium Ecosystem Assessment (MA), 2005).

Capitals and capabilities framework (Bebbington, 1999)



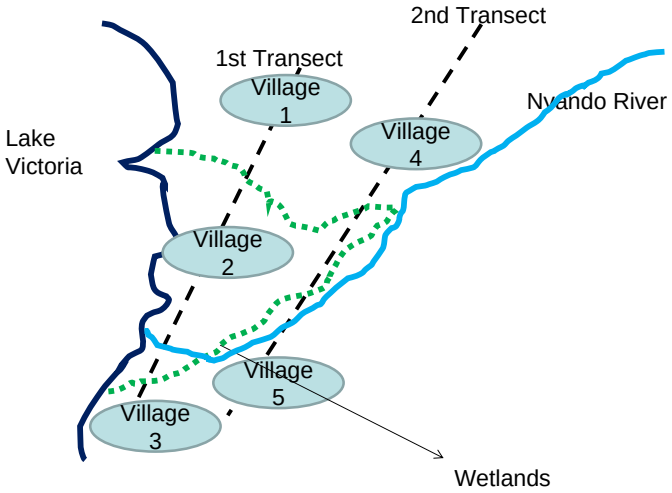
Map of the study area



Methodology and Design

- The first stage will involve the characterization of the wetlands based on, hydrology, land tenure, clans, vegetation cover and wetland activities on riparian communities.
- Transects will be drawn and communities will be selected along in the transect.
- For the survey, 5 villages will be selected (3 from the first transect and 2 from the second transect).
- There are different types of households(polygamous, female-headed, child-headed etc).
- 50 households will be selected and for each a male and a female will be interviewed.
- For selection of Key informants- snowballing, accidental, and common sense sampling.

Selection of villages



Data collection

- Primary data will be collected through a combination of :

1. Community meetings,
2. In-depth interviews, incl. life histories
3. Informal focus groups discussions,
4. Participant observation, and
5. Structured direct observations.

- A household survey will be conducted using a structured questionnaire to solicit for data on household socio-economic characteristics , land-use and wetland use patterns.
- Secondary data will include Area photographs and satellite imagery, Literature surveys/archival research (Official documents , Reports)

Data Analyses

Qualitative data

1. Interviews which will be transcribed and analyzed using ATLASti software ,
2. Resource mapping,
3. Social mapping
4. Stakeholder analyses

Quantitative data

1. SPSS and Excel and
2. Bayesian networks to show relationships between variables.

Work schedule/ programme		
Period	**Activity**	**Time frame**
Aug 2009	Mapping out the study area	1month
Sept 2009	Reconnaissance survey/Community mobilization and awareness creation/ Collection of population data (Households)	1 month
Oct- Nov 2009	Social mapping/well-being ranking/Resource using informal focus group discussions	11/2 months
Dec 2009- Feb 2010	Questionnaire design and pretesting./ Recruitment of enumerators/ Developing Sampling frame	I1/2 months
Feb -May 2010	Household survey/ Data entry and analysis	4 months
June –July 2010	Focus group discussions/ key informant interviews/ Data entry and analysis	2 months
August- Sept 2010	Stakeholder analysis (Workshop)/ Data entry and analysis	2 months
Oct –Nov 2010	Data entry and analysis and filing in gaps	1month
Nov 2010- March 2011	Writing first contour chapters of the thesis based on data based on these questionnaires	5 months
April- May 2011	Detailed studies of areas of interest	6 months
June –Dec 2011	Data Analysis and filling in gaps/ writing , expert consultation and collection of secondary data	6 months
Jan -June2012	Finalizing the writing of thesis	6 months

Expected outputs

Expected outputs include

1. A research thesis
2. Publications
3. Maps(Resource and social maps)
4. Information on institutions and governance in wetland resource use for policy formulation.
5. Development of community management plans for the Nyando wetlands.
6. Information on stakeholder roles and partnerships on wetland management

Trans-disciplinary framework for integration of the hydro-ecological, socio-economic and governance processes in Nyando wetland, Kenya

J. Kipkemboi
Egerton University, Kenya

Background

- For the 20 million riparian people of the Lake Victoria basin, wetlands provide valuable natural, cultural and economic resources.
- In the past decades wetland degradation and increasing excessive exploitation has lead to a decline of wetland goods and services leaving local communities vulnerable.
- Therefore, there is a need to for sustainable wetland management in order to ameliorate poverty and improve quality of life but at the same time maintain ecosystem integrity.
-

Threat to wetland integrity

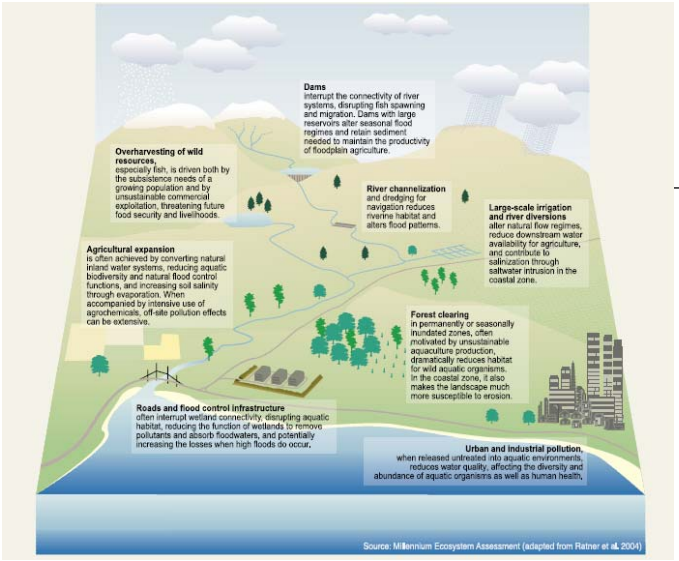
- Extensive conversion of wetland margin for crop production

Consequences cont'd.

Increasing pressure on natural biomass harvesting

Modification-Nyando river basin – Lower catchments

UNEP, 2003



Forcing factors

- Interventions- Terrestrial and aquatic ecosystems
  - Ecosystem destruction
  - Habitat modification- hydrological modification- excessive water abstraction, deforestation, Damming, River channelisation
  - Siltation-deforestation, agricultural expansion
  - Water chemistry- Eutrophication, organic pollution
  - Infrastructure development -Roads
  - Overexploitation of wetland resources
- ...

ECOLIVE Project

- Main Goal:
  - Sustainable management of wetlands
- Knowledge is needed on:
  - Hydrological processes
  - Ecological processes
  - Socioeconomic dimensions,
  - Governance and institutional arrangements?

Key questions

- How do:
  - modified by changes in climate and upstream water use govern wetland functions?
  - people's livelihoods drive their decisions about wetland?
  - institutions and policies affect decision making about wetlands at different levels ; international treaties to local resource use?

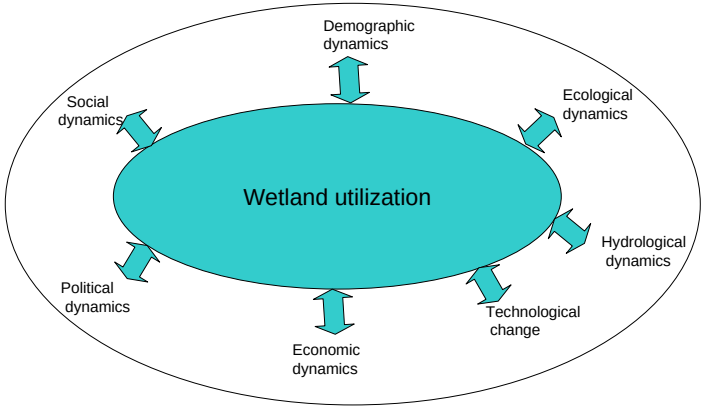
Drivers of change

- Demographic trends- Population density
- Food production trends and vulnerability
- Poverty trends
- Climate change
- Social dynamics-unemployment…
- …

Back to the questions

- Can we achieve sustainable management of wetlands in Africa?
  - Integrated natural resource management
  - balance between wetland use and conservation
  - Stakeholder participation

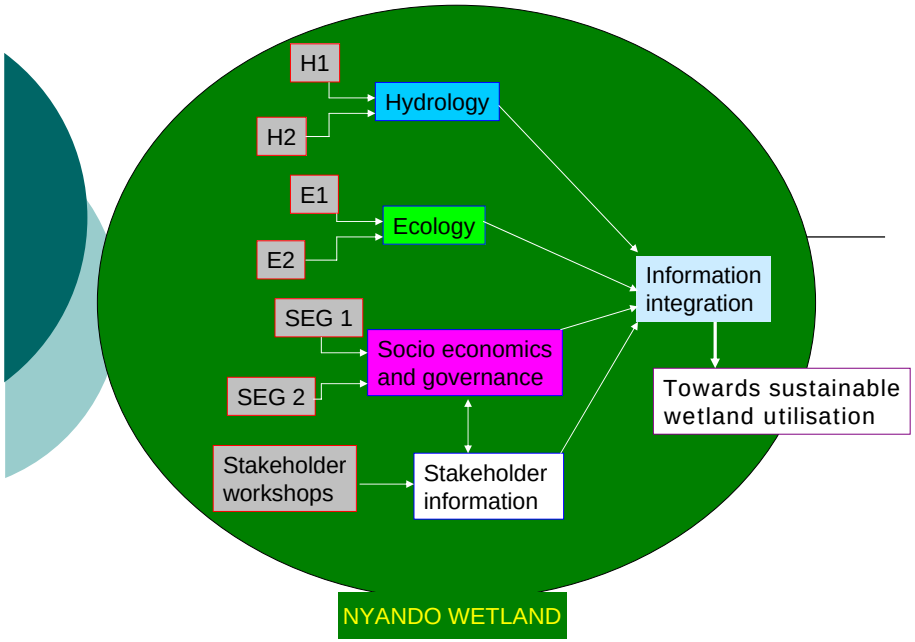
Dynamics related to Wetland utilisation



ECOLIVE Project Objectives

To:

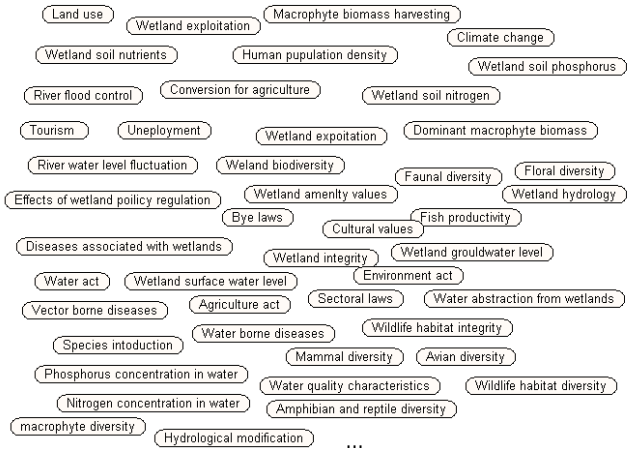
- (1)Understand the eco-hydrological functioning of the wetland in a changing catchment and climate context
- (2) Understand wetland biodiversity, nutrient buffering and resilience in relation to levels and types of exploitation for livelihoods
- (3) Understand the livelihoods of communities depending on wetlands and wetland services
- (4) Understand the institutional and governance aspects of the conservation and utilization of wetlands
- (5) Develop a transdisciplinary framework for wetland governance for ecological sustainability and livelihoods



Scope of research

- Hydrological aspects- water balance, Groundwater, Flood control, water level
- Ecological aspects- species introduction, productivity, habitats, physico-chemical characteristics
- Support functions- primary production, habitat, biodiversity etc.
- Socio-economics- levels of exploitation, diseases (vector borne diseases, water borne diseases)
- Governance issues- legal instruments, institutions, public participation ,land use changes,- (effects habitat loss)

Information expected to be generated



Challenge

- How can knowledge about these complex resource systems be integrated into one conceptual framework and used by decision makers and implementing agencies to reverse the negative trend of wetland degradation and to achieve sustainable management
- How do we deal with uncertainties?

Bayesian Belief Networks

- Graphical model (*Directed Acyclic Graph* or ***DAG***) used to represent a complex system in which variables (nodes) are linked by means of probabilities (Jensen 1996).

  Can accommodate diverse data in the form of probability values, and can deal explicitly with uncertainties.

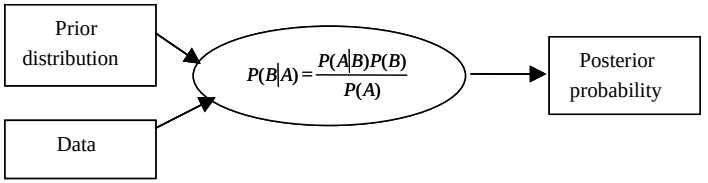
  Tool of analysis/thinking and often an aid in decision-making (Ellison 1996).

  Static or snapshot representation for a given period of time.

Introduction cont.

- A Bayesian model is based on three elements:
  - A set of nodes representing variables in the environmental system.
  - Links representing causal relationship between the nodes. The links are arrows originating from the cause (parents) to the effect (child). The relationships between the variables are defined by conditional probabilities.
  - Probabilities assigned to each node specifying state of a node given the states of those nodes that directly affect it. These probabilities can be used to generate Bayesian statistics, which can then form a basis for inference. The probabilities can be based on rating evaluations derived from empirical data, expert knowledge and historical knowledge of the wetland users and local communities etc.

Bayes Theorem



Objectives of this study

- Broad objective: To construct a trans-disciplinary framework for integrating hydrological, ecological, socio-economic information generated in ECOLIVE project
- Specific:
  - To select and engage stakeholders in collaborative learning
  - To generate information based on stakeholder knowledge and experience
  - To construct a Bayesian network and evaluate scenarios for decision making
-

Model development

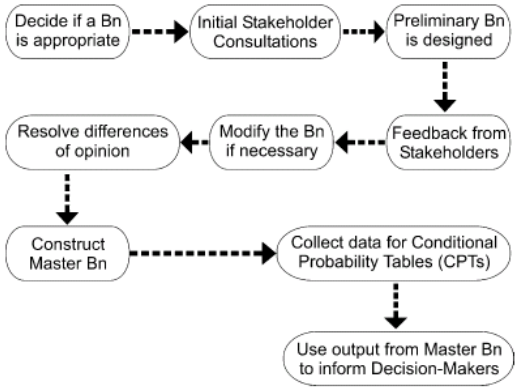


Fig. 3. Process of stakeholder engagement using Bns.

Based on Bromley et al., 2005

Model development ...

1. Define the context-Boundary, Areas of interest, Indicators
2. Identify the factors
   - Indicators
   -Stakeholder concerns
   -Synopsis of data sources (reports, models)
3. Built a pilot Bn -Important variables are identified
   -Variables with relationships are selected and linked
4. Data collection -Data from different sources are collected
   -data analysed and simple Bn prepared
5. Define states, input from stakeholders, field data etc
6. Construct conditional probability tables (CPTs), review the network at stakeholders meetings, through an interactive mode. Inputs can be from models or expert knowledge. Check the Bn for internal consistency
7. Collect feedback from stakeholders, add evidence from field data, update the network and draw conclusions.

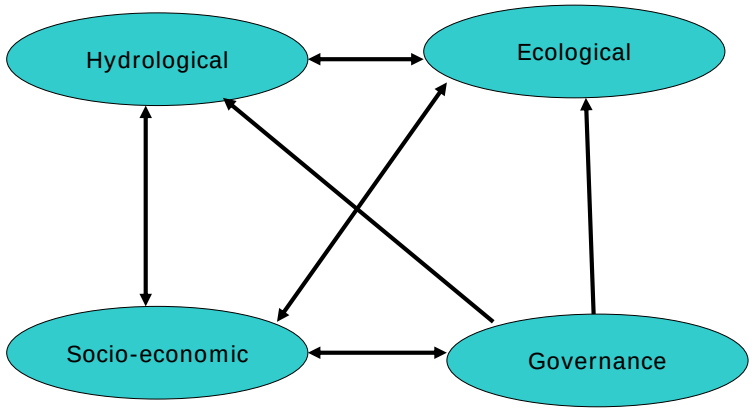
Who are the stakeholders in the ECOLIVE project?

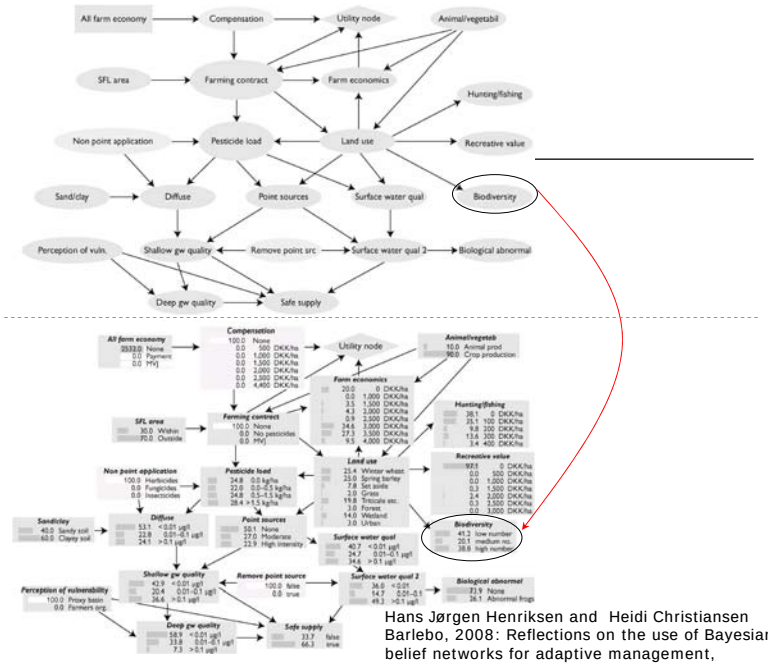
- ECOLIVE partners (UNESCO-IHE, Egerton, UvA, VIRED)
- Local research institutions KMFRI, Moi University etc)
- Government departments (Ministry of Agriculture, Ministry of water, Ministry of Forestry and wildlife(KWS), Ministry of Fisheries, Provincial administration, Local Government, Ministry of Environment, Ministry of Livestock etc.)
- NGOs- CARE Kenya etc
- Community Based Organizations (CBOs)
- Local communities at the study areas
- Other…

Stakeholder consultations

- Presentation of ideas and objectives
- Identifying cause –effect relationship between system variables
- Choosing variables to represent ideas. These can be in form of quantities such as water levels (piezometric), quality (water quality as it affects primary production-N&P), biological diversity, movement of things- resource flows, water flows etc
- Choosing states: The key assumption here is that variables will assume certain state e.g. good or bad, high or low. These qualitative features can be further assigned quantitative values, which are discrete of continuous.

Relationship between system variables





Hans Jørgen Henriksen and Heidi Christiansen Barlebo, 2008: Reflections on the use of Bayesian belief networks for adaptive management, Journal of Environmental Management, Volume 88, Issue 4, 1025-1036.

Construction preliminary BN

- The aim is to capture information elicited from the stakeholders
- To understand information from stakeholders
- To choose the variables and categorize them into interventions, objectives, drivers of change/controlling factors

Further stakeholder consultations

- To check the validity of the relationships of variables
- Agree on the sensible definition of states
- Check if BN accurately represents the perceptions of stakeholders.

Construction of master BN

- This forms the analytical framework

Data collection and specification of Conditional Probability Tables (CPT)

- This involves operationalisation of the BN.
- Here the BN is turned into a functional tool that can be used to generate scenarios and decisions.

CPT

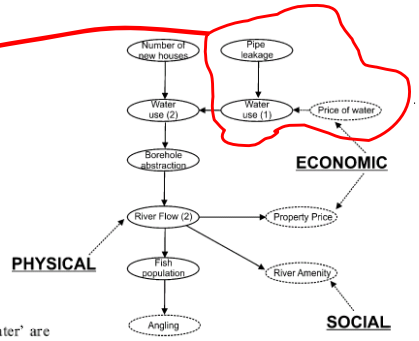


Fig. 1. A simple Bayesian network.

Conditional probability table: 'pipe leakage' and 'price of water' are the parent variables of 'water use (1)'

Pipe leakage	Price of water	Water use (1)		
		Increase	No change	Decrease
0%	Down (−10%)	0.2	0.75	0.05
5%	Down (−10%)	0.1	0.3	0.6
10%	Down (−10%)	0.05	0.25	0.7
0%	No change	0.1	0.9	0.1
5%	No change	0.05	0.1	0.85
10%	No change	0	.05	0.95
0%	**Up (+10%)**	**0.05**	**0.65**	**0.3**
5%	Up (+10%)	0.05	0.5	0.45
10%	Up (+10%)	.05	0.15	0.8

Sources of information

- Raw data collected by direct measurements e.g. GW depth, water quality etc and customized for the model
- Raw data obtained from stakeholder elicitation
- Model output and other forms of information output based on raw data
- Expert judgment

Time plan

	ACTIVITY	YEAR 1	YEAR 2	YEAR3	YEAR 4
1	Background and conceptualisation				
2	Identification of stakeholders and consultation				
3	Initial modeling workshop with stakeholders				
4	Specification of data requirement				
5	Choosing variables and ideas to represent hydrological, social, economic and governance parameters				
6	Choosing states to represent ideas				
7	Preliminary Bayesian network				
8	Further stakeholder consultations and checking if the BN diagram accurately represent stakeholder perceptions				
9	Construction of master Bayesian network				
10	Data collection and specification of conditional probability tables				
11	Updating the belief network				
12	Making scenarios and decisions with the master Belief network				

Making decisions

- Decision making is achieved by changing controlling nodes and seeing their effects on the child nodes.

Advantages of BNs

- Bayesian networks are diagrammatically based
- It is easy for stakeholders to understand how factors interact
- Factors are represented as cause and effect

Conclusion

- Bns offer one way to introduce the contribution of`stakeholders participation in data generation and decision making process.
- Networks provide a framework within which diverse data and the opinions of stakeholders can be fed.
- The final structure should be agreed by all stakeholders.
- The world around us is characterized by a lot of uncertainty and quantification of this uncertainty around certain variables of an ecological system may appear complex, but the graphical representations of causal relationships can prove their usefulness.

Thank you

Annex 3

Equipment list.

ECOLIVE project research equipment and personnel								
	Item	*PhD proj*	*unit*	*no. units*	*unit cost* (EURO excl. VAT)	*total cost*	*remarks*	
water level	mini divers	1	pc.	15	495.00	7425		
	mini divers materials	1		1	650.00	650		
	dipper + measuring tape for piezometers	1	pc.	1	195.00	195		
	staff gauges	1	pc.	5	20.00	100	made locally	Kip?
	piezometers	1,2	pc.	10	10.00	100	locally made	Kip?
discharge	flow propellor	1	pc.	1	466.00	466		
rainfall	raingauges logging	1	pc.	3	666.00	1998		
	reading unit + software	1	pc.	1	272.00	272		
	raingauges standard	1	pc.	10	10.00	100		
climate	climate station	1,2	pc.	1	3400.00	3400	repair Fingerponds station	Kip?
	evaporation pan (class A)	1	pc.	1	100.00	100	locally made	Kip?
water quality	EC-meter	1,2	pc.	1	1100.00	1100		
	DO-meter	2	pc.	1	1300.00	1300		
	pH-meter	1,2	pc.	1	760.00	760		
	chemistry kit HACH	1	pc.	1	1200.00	1200		
	laboratory materials and reagents	2	lump	1	1500.00	1500		Kip?
	glassware	2	lump	1	1000.00	1000		Kip?
soil	soil moisture sensor EC-5	1	pc.	15	99.00	1485		
	soil moisture loggers EM5b	1	pc.	3	247.00	741		
	TDR soil moisture	1	pc.	1	1500.00	1500		Jochen?
	seepage meter	1	pc.	1		0		Jochen?
	soil auger	1,2	pc.	1	50.00	50	available at Egerton?	
sampling	sampling bags (soil, vegetation)	1,2	lump	1	100.00	100		Kip?
	sampling bottles 60ml	1,2	10 pcs	100	10.50	1050		
	sampling bottles 250ml	1,2	10 pcs	5	19.50	98		
	sampling bottles 1000ml	1,2	5 pcs	5	19.25	96		
	isotope bottles 1.5ml	1	1000 pcs	1	102.00	102		
	isotope caps 1.5ml	1	1000 pcs	1	290.00	290		
	cool boxes	2	1 pc	2	50.00	100		
	field clothing, wader suit, boots	2	1 pc	1	200.00	200		
vegetation	botanical field key	2					available at Egerton?	Kip?

	Item	*PhD proj*	*unit*	*no. units*	*unit cost*	*total cost*	*remarks*	
	poles for marking quadrats	2		12	10.00	120	locally made	Kip?
	quadrat 1x1 m	2		1	10.00	10	locally made	Kip?
	laboratory spring weight	2		1	100.00	100		
	caliper	2		1	150.00	150		
	ruler	2		2	20.00	40		
	tape measure 30 m	2		2	50.00	100		
birds	bird field key	2		1	50.00	50		
	binoculars	2		1	350.00	350		
interviews	mp3-recorders	3		1	100.00	100		Fred?
	video camera	2		1	400.00	400		
	camera	2,3		2	300.00	600		
general	GPS	1,2,3		1	400.00	400		
	notebooks, clipboards etc.	1,2,3		1	200.00	200	lump	
software	SPSS	3			0.00		Surfspot	
	Atlas Ti	3					?	Fred?
	Stella	2			0.00	0	UNESCO-IHE license	
	ArcGIS	2			0.00	0	UNESCO-IHE license	
maps/imagery	Landsat images	1						Patrick?
	Quickbird images	1						
	topographic maps Nyando	2						
	other maps (geology, soils, etc.)	2						
	aerial photopgraphs	2						
	records: land cover, land use, wetland management, floodin	2						
not buy	ADCP (Acoustic Doppler Current Profiler)	1		1	20000.00	20000		
	ERDAS IMAGINE	1		1	10000.00	10000	Does UvA GIS centre have?	Fred?
assistance	assistant Serena	3	month	24			?	JB?
	assistant Priscah	2	month	24			?	
	driver	1,2,3	month	30			?	
	lab technician (Egerton)	2	month	24			?	
	enumerators / data typists	3	month	6			?	
TOTAL	materials					30097.75		
	materials excl. climate station, automatic rainfall					25097.75		
	software					0		
	imagery					0		
	assistance					0		

Annex 4

Detailed plan for SoS phase.