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Handbook

5TH NILE BASIN DEVELOPMENT FORUM

5th Nile Basin Development Forum - Rwanda 2017

Theme: Investing in Nile Cooperation for a Water Secure Future

October 23 - 25, 2017. Radisson Blu Hotel and Convention Centre, Kigali

Join the conversation on facebook and twitter (#NileCooperation; #NBDF2017)

PLEASE HELP US IMPROVE!

We are conducting a survey to gather stakeholders' different views and perspective about the effectiveness and direction of the Nile Basin Initiative's communication and stakeholders' engagement.

The recommendations stemming from the survey results will be useful in driving Nile Basin Initiative's Communications and Stakeholders Engagement Strategy 2017 – 2022 and establish a baseline and targets to measure progress in the future.

Please take a moment and give us your valuable feedback by clicking: https://goo.gl/tkJRj3

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WELCOME STATEMENT

Dear Participants,

Welcome to Kigali!

On behalf of the Government and the people of Rwanda, I am glad to welcome you to our capital city Kigali, for the 5th Nile Basin Development Forum (NBDF).

Rwanda is hosting the NBDF for the second time. The first was in October 2011 when our Country hosted the 3rd NBDF. This is an indication of our conviction in the importance of this high level Forum that brings together diverse categories of stakeholders to exchange information and views on the collective steps necessary to achieve sustainable management and development of the shared Nile Basin water resources.

Dedicated to the theme, **'Investing in Nile Cooperation for a Water secure Future,"** the 5th NBDF provides a wonderful forum for you to refresh your knowledge base and explore the innovations towards a water secure future and to build a common understanding on shared risks, opportunities and prospects of the shared Nile Basin water resources.

At the same time, I hope you will seize the unique opportunity provided by the Forum to rekindle ongoing connections, spark new ones as well as take a little extra time to enjoy the beauty of Kigali and Rwanda in general.

Once again, welcome to Kigali and thank you for being part of the 5th Nile Basin Development Forum.

I look forward to the outcome of this Forum and wish you good memories of Kigali.

Vincent Biruta
Minister of Environment

MESSAGE FROM THE EXECUTIVE DIRECTOR

I am honored and delighted to welcome you to the 5th Nile Basin Development Forum, taking place at Radisson Blu Hotel and Convention Centre, Kigali and hosted by the government of Rwanda from 23 – 25 October, 2017.

The Forum is jointly organized by the Nile Basin Initiative (NBI) and the government of Rwanda.

The overall theme of the Forum, **'Investing in Nile Cooperation for a Water Secure Future,'** underpins the need for sustainable Nile cooperation to enable Nile Basin countries to jointly protect vulnerable water systems, mitigate the impacts of water-related hazards such as floods and droughts as well as safeguard access to water functions and services; and ensure sustainability of the shared Nile Basin water resources.

It is against this background that we have assembled an inspired array of sessions organized along eight subthemes, to address the overall theme and meet the diverse interests of our various stakeholders. The Forum will feature keynote speeches by renowned experts from the Nile Basin and beyond; scientific paper presentation sessions; panel discussions on legal, technical, socio-economic and environmental issues as well as a high level panel of policy makers.

The Forum will also offer ample opportunities for you to connect, interact and network.

Allow me to cordially invite you to the Nile Media Awards 2017 ceremony on October 23, during which, NBI and Media Awards 2017 Partners will be recognizing journalists, for excellent reporting on Nile Cooperation issues.

My sincere appreciation goes out to all who have contributed to the success of the 5th NBDF. I am highly indebted to the government of Rwanda and the Ministry of Environment for hosting the event. I also extend my sincere gratitude to the German government, the World Bank and cooperation in international waters.

To members of the Regional and National Organizing Committees respectively, thank you for the hard work and enthusiasm.

I wish you all fruitful deliberations and an enjoyable stay in Kigali.

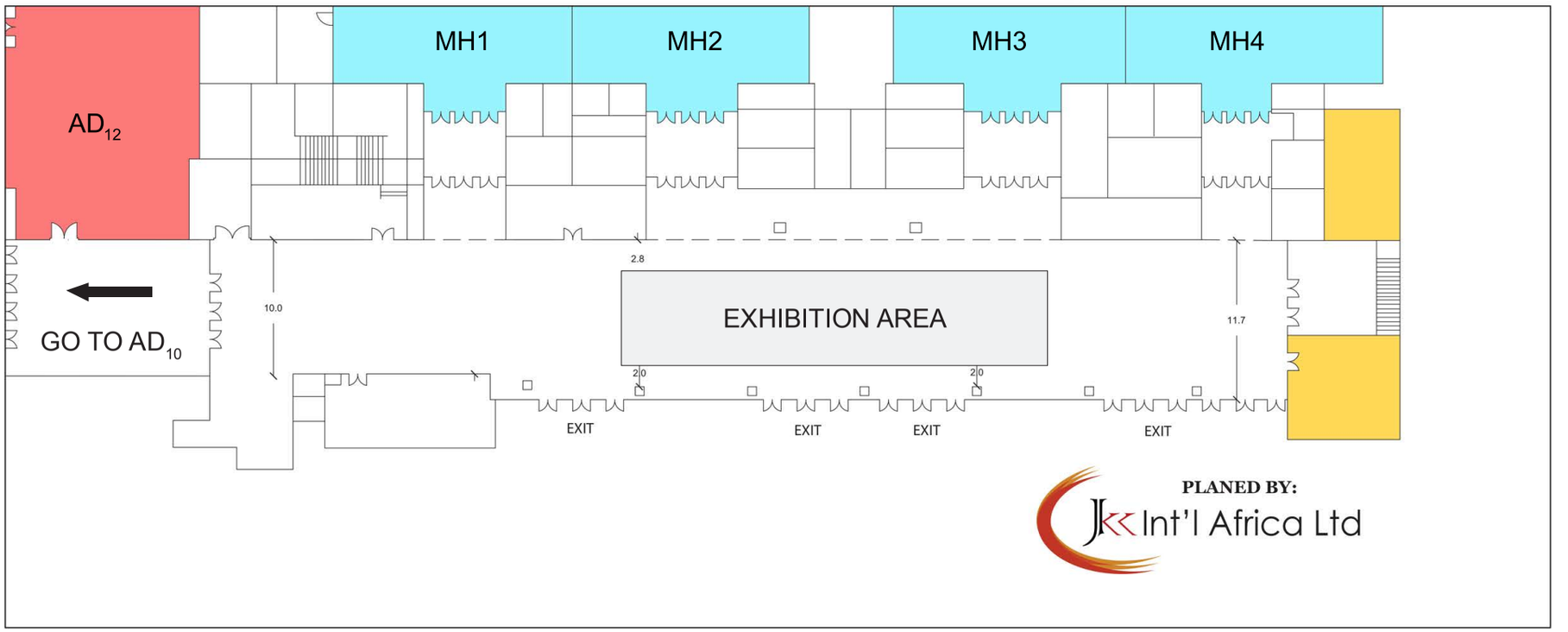
Once again, you are most welcome!

Eng. Innocent Ntabana
Executive Director

PROGRAMME OVERVIEW

Day 1 – October 23, 2017					
15:30 – 18:00	**Opening Session** - *Room MH 1 + 2*				
16:00 – 21:00	**Nile Media Awards ceremony and concert by The Nile Project** – *Room MH 3 + 4*				
Day 2 – October 24, 2017					
09:00 – 10:00	**Plenary Session 1 – Water Security – from concept to practice** – *Room MH 1 + 2*				
10:00 – 10:30	*Coffee break*				
	Paper presentation sessions – Taking stock of what we know				
	Ensuring Water Availability (WA) for a growing demand	**Sustaining the water Ecosystems (ECO) of the Nile Basin**	**Water-Energy-Food Nexus (WEF)**	**Governance (GOV) in the Nile Basin**	**Economic (ECN) Perspectives for Basin Management**
	Room MH 1	*Room MH 2*	*Room MH 3*	*Room AD 12*	*Room AD 10*
10:30 – 12:00	WA1 - Climate change	ECO1 - Catchment/Watershed management	WEF1 - Food production and water management	GOV1 - Transboundary cooperation: sharing experiences	ECN1 - Economic valuation of ecosystem services
12:00 – 13:30	*Lunch Break*				
13:30 – 15:00	WA2 - Water Resource (WR) Availability and Variability	ECO2 - Sustainable management of wetlands	WEF2 - Multi-sector planning and tradeoffs	GOV2 - Hydro-politics of the Nile Basin	ECN2 - Hydro-economics of water allocation
15:00 – 15:30	*Coffee Break*				
15:30 – 17:00	WA3 - Enhancing water resources supply	ECO3 - Environmental flows	WEF3 - Coordinated planning and management	GOV3 – Multi-track hydro diplomacy	ECN3 – investment and trade: the current landscape
Day 3 – October 25, 2017					
08:30 – 10:15	**Plenary 2 – Water Security in the Nile Basin** - *Room MH 1 + 2*				
10:15 – 10:45	*Coffee Break*				
10:45 – 12:15	**Panel Sessions – Exploring solutions and pathways**				
	Thematic Panel 1: Options for conserving and diversifying water source	Thematic Panel 2: Reconciling ecosystem sustainability with water resources investment planning	Thematic Panel 3: Towards a basin approach for efficient agricultural water management and food security	Thematic Panel 4: Regional integration through hydraulic infrastructure	
	Room MH 1 + 2	*Room MH 3*	*Room AD 12*	*Room AD 10*	
12:15 – 13:30	*Lunch Break*				
13:30 – 15:15	**Synthesis Panel Sessions – How to take it forward**				
	Synthesis Panel 1: Nile Cooperation, how to make the qualitative leap forward?		Synthesis Panel 2: Rethinking basin planning and investment in the Nile Basin		
	Room MH 1		*Room MH 2*		
15:15 – 16:00	*Coffee Break*				
16:00 – 17:00	**High level panel** - *Room MH 1 + 2*				

FLOOR PLAN


MH1
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Participants during the 4th NBDF held in Nairobi, Kenya in 2014

About the Nile Basin Development Forum

The Nile Basin Development Forum (NBDF) is a high level regional event organised by the Nile Basin Initiative (NBI), in collaboration with Member States and in partnership with development partners.

The Forum is a continuation of the Nile 2002 conferences, which were successful informal fora that brought together a broad spectrum of Nile Basin stakeholders and friends of the Nile from within and beyond the Nile Basin. The purpose is to exchange information and views on the steps necessary to achieve sustainable development of the shared Nile Basin water resources. NBDF came into being as a result of a proposal of an independent evaluation of the Nile 2002 conferences, which proposal was adopted by the Nile Technical Advisory Committee (Nile-TAC) and confirmed by the Nile Council of Ministers (Nile-COM).

The biennial Forum, which was first held in 2006 brings together Ministers in charge of Water Affairs and other government officials in Nile Basin countries, Members of Parliament, water resource managers, environmentalists, economists, development planners, academia and researchers, to deliberate on opportunities and challenges of Nile cooperation. Other stakeholders are river basins organizations, regional, continental and international organizations, civil society, private sector as well as media practitioners.

The aim is to create communities of people who are well informed, actively engaged in and promoting Nile cooperation as the only means of achieving sustainable management and development of the shared Nile Basin water resources as well as addressing shared risks, threats and challenges across the Basin.

NBDF Objectives

- To provide a Forum to exchange latest scientific information, knowledge and best practices in transboundary water resources management and development
- To deliberate on opportunities, challenges and prospects in transboundary water cooperation
- To build partnerships and networks among the various stakeholders in water resources management and development

5th Nile Basin Development Forum 2017

Theme: 'Investing in Nile Cooperation for a Water Secure Future'

The Forum will feature keynote speeches by renowned experts from the Nile Basin and beyond; scientific paper presentation sessions; panel discussions on legal, technical, socio-economic and environmental issues as well as a high level panel of policy makers. It is designed to focus on key Nile Basin Initiative processes as follows:

i. **Advancing a regional investment program for the Nile Basin**: Secure preliminary consensus on a regional investment program for the Nile Basin; explore available options for program components, its processes and targets; explore options for regional coordination among key actors in the Nile Basin region (IGAD, EAPP, LVBC, PIDA, etc)

ii. **Strengthening coordinated management of the Nile Basin water resources**: Identifying common ground for coordinated management of Nile Basin water resources; explore building blocks for a basin water resources management plan; explore policy frameworks; identify synergy opportunities and collaboration mechanisms with main regional actors

iii. **Towards more effective transboundary water governance:** Explore options for enhancing NBI's impact at national level; strengthen NBI inclusivity; strengthen institutions; options for higher level country representation in NBI affairs

The specific objectives of the 5th Forum are to:

- Build a common understanding on shared risks, opportunities and prospects of Nile Basin water resources
- Set NBI's agenda and priorities
- Gather support and galvanize consensus on key actions for NBI programs
- Showcase NBI's achievements and make a compelling case for NBI
- Harvest new ideas, insights, and innovations

A participant contributes to the discussions during the 4th NBDF held in Nairobi, Kenya in 2014

A short guide to the 5th NBDF

NBI is pleased to offer the participants of the 5th Nile Basin Development Forum a total of 26 sessions over the course of two-and-a-half days. Following the official opening on Day 1, the programme is designed to first collect the existing knowledge and experience in the basin and steadily filter out the key messages, ultimately feeding into a highly condensed and focused discussion of high-level decision makers.

Step 1 – Taking stock of what we know

Day 2 is largely organized around paper presentation sessions aiming to take stock of the current knowledge and practices available across the Nile Basin and pave a way forward for riparian countries to explore joint solutions to river basin management. To cover the multitude of issues relevant to such cooperation, five parallel thematic session series (as shown in Figure 1) will allow a total of 60 presenters to take the stage.

Step 2 – Exploring solutions and pathways

On Day 3, four parallel panel sessions draw on the vast knowledge collected on Day 2 and begin to explore possible solutions and pathways to the sustainable and cooperative management and development of the Nile Basin's resources.

Two parallel synthesis panels then seek to further focus the discussions of the previous days and translate them into specific options for Nile Basin countries to take move their cooperation forward.

Step 3 – Moving the agenda forward together

The discussions of the 5th NBDF will ultimately culminate in the High Level Panel of Nile Basin Ministers in charge of Water Affairs and senior diplomats engaged on Nile Affairs. Our most high-profile guests will deliberate on the messages and possible solution pathways emerging from this year's NBDF.

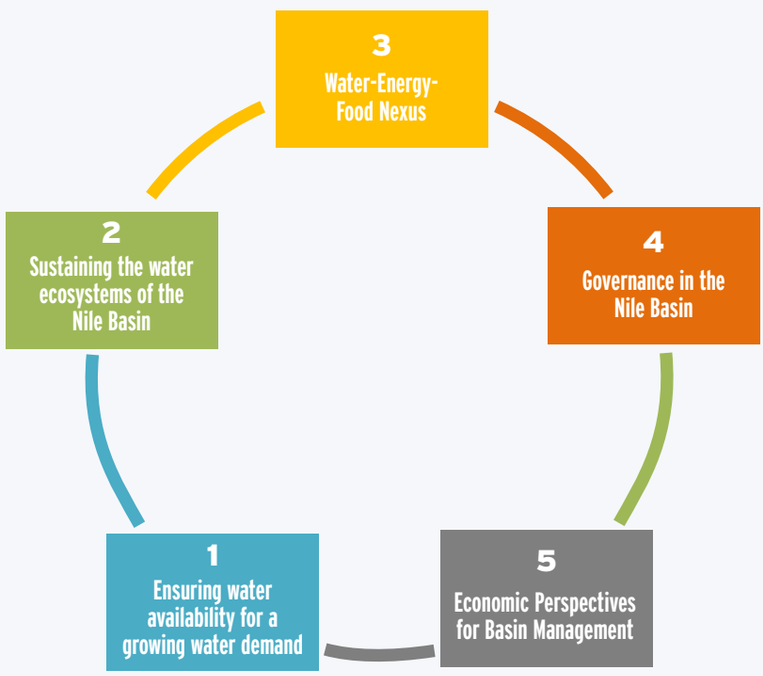

Figure 1. The five series of paper presentation sessions explore five different thematic areas

Expected outcomes

- Informed policy makers and other key stakeholders on transboundary dimensions of cooperation for water resources management and development
- Availed platform for knowledge building and experiences sharing between science and policy decision interface
- Enhanced opportunities for regional cooperation and a collective sense of custodianship regarding the Nile as a vehicle to contribute to the water related Sustainable Development Goals
- A Forum Declaration and Recommendations, as well as a report of the proceedings.

Special Events

Monday, October 23
15:30 – 21:00

- Official Opening Ceremony & Keynote Presentation
- Official Tour of the Exhibition led by Guest of Honour

All are welcome to the official tour of the exhibition. The exhibition is an important component of the NBDF as it offers unique opportunities to show case one's products, maximize your organization's exposure and network. The exhibition also serves as a strong compliment to the discussions taking place during the Forum.

The Exhibit will be open on October 23 and 24 with morning and afternoon breaks hosted in the exhibition area.

**The display of products in the exhibit area does not constitute endorsement of those products by the NBI.*

- Nile Media Awards 2017 Ceremony

Join NBI and Nile Media Awards 2017 Partners as we recognise winners of the Media Awards competition.

The Forum in numbers

2.5	DAYS
500	PARTICIPANTS
02	PLENARY SESSIONS
05	KEYNOTE SPEAKERS
15	PAPER PRESENTATION SESSIONS
60	PAPER PRESENTATIONS
06	PANEL DISCUSSIONS
01	HIGH LEVEL MINISTERIAL PANEL
01	NILE MEDIA AWARDS CEREMONY

This year's biennial event is organized with the support of the German government and in partnership with Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ), Global Water Partnership Eastern Africa, Nile Basin Discourse, Intergovernmental Authority on Development (IGAD), Deutsche Welle (DW), Media in Cooperation and Transition (MiCT), Water Journalists Africa.

- Performance by The Nile Project

Wednesday, October 25
16:00 – 17:30

High Level Panel – *Moving the agenda forward together (Ministers in charge of Water Affairs from Nile Basin countries deliberate on issues and solution options synthesized from the sessions.*

- Messages from the forum
- Event closing

Previous Fora

	WHEN	WHERE	THEME
1st NBDF	2006	Addis Ababa, Ethiopia	The role of the River Nile in Poverty Reduction and Economic Development
2nd NBDF	2008	Khartoum, Sudan	Environment and Water Resources Management for Peace and Cooperation in the Nile Basin
3rd NBDF	2011	Kigali, Rwanda	Climate Change and its Implications for Sustainable Development and Cooperation in the Nile Basin - Threats and Opportunities to Nile Basin Cooperation
4th NBDF	2014	Nairobi, Kenya	Building Sustainable Transboundary Cooperation in a Complex River Basin: Challenges, Lessons and Prospects.

About Nile Basin Initiative

The Nile Basin Initiative (NBI) is an intergovernmental partnership of 10 Nile Basin countries, namely Burundi, DR Congo, Egypt, Ethiopia, Kenya, Rwanda, South Sudan, The Sudan, Tanzania and Uganda. It was established on February 22, 1999 by Ministers in charge of Water Affairs in the Nile Basin countries to work towards a Shared Vision Objective: '*to achieve sustainable socio-economic development through the equitable utilization of, and benefit from, the common Nile Basin water resources'.*

NBI provides the Member States with the only basin-wide and impartial platform to discuss with trust and confidence how to jointly take care of and utilize the shared Nile Basin water resources for win-win socio-economic benefits and to promote regional peace and security.

What we do - Core functions

- **Facilitating Basin cooperation:** This function is undertaken to provide a common platform for countries to engage, consult and deliberate with each other and other Nile stakeholders on a regular basis. The aim is to build broad political and civic support for transboundary water cooperation in the basin.
- **Water Resources Management:** This function provides critical services in building basin wide technical competencies and capabilities and supporting science/knowledge based decision making to monitoring, protecting and sustaining the Nile water resources.
- **Water Resources Development:** This function focuses on identification and preparation of multi-country and multi-sectoral investment projects that demonstrate to the basin population, benefits accruing from cooperation.

DETAILED PROGRAM

DETAILED PROGRAMME

DAY 1 – Monday, October 23, 2017

Participants are expected to register for the event at the Opening Session. Organisers, hosts and partners welcome participants to the Fifth Nile Basin Development Forum and introduce the programme for the following days. The Guest of Honour will visit the exhibition which will be open to participants on October 23 and 24, 2017. Participants are invited to Nile Media Awards 2017 ceremony as well as a concert by the Nile Project.

Opening Session

Room MH 1 + 2

15:30 – 16:00	Registration over tea and coffee
16:00 – 16:05	Welcome by MC
16:05 – 16:15	Poem presentation by Mashirika Performing Arts and Media company
16:15 – 16:25	Remarks by Eng Innocent Ntabana, Executive Director, NBI Secretariat
16:25 – 16:35	Remarks remarks by HE Amb. Rolf Welberts, German Special Envoy for Nile Cooperation Affairs
16:35 – 16:45	Remarks by World Bank representative
16:45 – 16:55	Welcome remarks (possibly) Nile-COM member of Rwanda
16:55 – 17:05	Official opening speech by the Guest of Honor
17:05 – 17:25	Introduction to the program by MC
17:25 – 18:00	Exhibition

The Nile Media Awards 2017 seek to recognize journalists from within the Nile Basin for excellent reporting on Nile cooperation issues in order to promote increased, factual balanced and accurate reporting on these issues.

Nile Media Awards 2017 Ceremony and Nile Project Concert

Room MH 3 + 4

18:00 – 19:00	Nile Media Awards Ceremony (incl. dinner)
19:00 – 21:00	The Nile Project Concert

DAY 2 – Tuesday, October 24, 2017

As water in the Nile Basin becomes an increasingly scarce resource, given the impacts of climate change, demand continues to rise with the growing populations and economies of the Nile Basin states. However, there are a wide range of options available to riparian states seeking to meet these growing demands by investing in cooperative solutions to managing water resources in an integrated and equitable manner. The first Plenary Session of the 5th NBDF will explore the concept of water security, what it means for the Nile Basin, and how cooperation can help achieve it for up- and downstream countries alike.

09:00 – 10:00	**Plenary Session 1:** *Water Security – from concept to practice* *Room MH 1 + 2* • Brief introduction to the programme and theme of NBDF; *MC* • Keynote 1: River Basin Management Pathways to Water Security; *Dr. Don Blackmore* • Keynote 2: Indicative scenarios of cooperative solutions for addressing up- and downstream water demands*; Prof. Dale Whittington*
10:00 – 10:30	*Coffee Break*

A first step in moving towards a basin-wide approach to managing the shared waters of the Nile is to take stock of the knowledge and solutions already available in the Basin. Three rounds of paper presentation sessions will collect the experience of scientists and practitioners on topics ranging from water resources and food security, energy access – and the nexus between these three –, water ecosystems, governance, financing options and knowledge assets. These have been arranged in five parallel session series, as outlined below, with each session featuring presentations from four experts as well as a short discussion.

Session Series	**Session Series I: Ensuring water availability for a growing water demand (WA)**	**Session Series II: Sustaining the water ecosystems of the Nile Basin (ECO)**	**Session Series III: Water – energy – food nexus (WEF)**	**Session Series IV: Governance (GOV)**	**Session Series V: Economic Perspectives for Basin Management (ECN)**
	Room MH 1	*Room MH 2*	*Room MH 3*	*Room AD 12*	*Room AD 10*
	Section Objective: to build common understanding on current and projected future availability, variability (natural and due to climate change) and accessibility of water resources in the Nile Basin and to generate options for enhancing water supply/availability for meeting the growing water demands.	**Section Objective:** to take stock of current understanding and knowledge of the two most critical elements of the Nile Basin environment – wetlands and catchments; explore options for their sustainable management, determining technical, policy and institutional requirements.	**Section Objective:** to identify key intra-, inter-sectoral and upstream – downstream tradeoffs and explore/ propose/recommend strategic options for regional coordinated approaches (infrastructure, institutions and policies) to meet the growing water, energy, and food demands in the Nile Basin	**Section Objective:** to identify the objective of this session is to identify constraints and opportunities for effective transboundary water governance, explore options and draw workable recommendations for cooperative management and development of the Nile Basin.	**Section Objective:** to create a shared understanding of how economic considerations are currently impacting the management of water resources, as well as the potential opportunities for economics, trade and business in furthering sustainable development of the Nile waters.

Paper presentation sessions: taking stock of what we know

10:30 – 12:00	**WA1 - Climate change**	**ECO1 - Catchment/Watershed Management**	**WEF1 – Food production and water management**	**GOV1 - Transboundary cooperation: sharing experiences**	**ECN1 - Economic valuation of ecosystem services**
	Room MH 1	*Room MH 2*	*Room MH 3*	*Room AD 12*	*Room AD 10*
	Climate Change projections for the Nile Basin: what do the climate models tell us? *Dr. Modathir Zaroug*	Soil and Water conservation, experiences from upper Blue Nile Basin, Ethiopia *Mr. Adugnaw Tadesse*	Harnessing water for food security: Challenges and options *Dr. Eltigani Abdelgalil*	Beyond legalisms: toward cooperative governance of resource security *Ms. Belynda Petrie*	The value of the Sudd Wetland: implications for integrated policies in the Nile River Basin *Dr. Hannes Lang* *Prof. John Gowdy*
	Analyzing the future climate change of Upper Blue Nile River Basin (UBNRB) using statistical down scaling techniques *Mr. Dagnenet Fenta Mekonnen*	Assessing impact of land use and land cover change on stream flow response: Dinder and Rahad *Eng, Khalid Hassaballah*	Technical efficiency of large scale irrigated wheat production in Blue Nile Basin, case of Koga irrigation scheme *Mr. Anteneh Belay*	Transboundary water governance and cooperation through Benefit Opportunities Assessment Dialogue in the Sio-Malaba-Malakisi sub-basin *Mr. John Owino*	Applying standardized methodology to value biodiversity and ecosystem services in the Lake Victoria Basin *Dr. Brenda Bergman*
	Impact of climate change on precipitation distribution and water availability in the Nile Basin *Mr. Zelalem Mekonnen*	Livelihood Contribution of landscape restoration; *Mr. Yitbarek Tibebe Welde Semaet*	Impacts of irrigation development in the upper blue Nile Basin using Nile Basin Decision Support System *Eng. Habtam Achenif*	Project based transboundary cooperation: The case of GERD-P *Eng. Gedion Asfaw*	Rapid Assessment of Ecosystem Service values at Yala Wetland, Kenya *Mr. Justus Amayo*
	The National Impact of 1.5 and 2 Degree Global Warming over Africa, and the role of aridity *Dr. Modathir Zaroug*	Catchment restoration for a sustainable renewable energy production in Upper Nyabarongo Catchment, Rwanda *Mr. Francois Tetero*	Satellite based ICT for improved crop production in the Gezira Scheme – Sudan *Prof. Younis Gismalla*	GERD and hydro-politics in the Eastern Nile, from water to benefit sharing? *Dr. Rawia Tawfik*	Economic Valuation of Wetlands Ecosystems for Wise Use Review and Case Studies from the Nile Basin *Dr. Amel Azab*
	Discussion	Discussion	Discussion	Discussion	Discussion

12:00 - 13:30	*Lunch Break*				
13:30-15:00	**WA2 - WR Availability and Variability**	**ECO2 - Sustainable use and management of Wetlands**	**WEF2: Multi-sector planning and tradeoffs**	**GOV2 - Hydro-politics of the Nile Basin**	**ECN2 - Hydro -economics of water allocation**
	Room MH 1	*Room MH 2*	*Room MH 3*	*Room AD 12*	*Room AD 10*
	Invited presentation on surface water availability; variability; climate change impacts; *Dr. Mohammed Ahmed Hassan*	Supporting Sustainable Management of the Mara Wetlands in the Mara River Basin *Mr. Emmanuel Mgimwa*	Eastern Nile Multi-Sectoral Investment Opportunity Analysis *Dr. Omer El-Awad*	Collective Action Theory and Nile Basin Cooperation: Past Experience, Future Directions *Dr. Alan Nicol*	Water in national economic planning: Utilization, challenges and valuation. *Dr. Khalid Siddig*
	Use of Earth Observation Data for Monitoring River Basins. *Ms. Milly Mbuliro*	Community Conservation Agreements Model for Sustainable Management of Winam Gulf Wetlands *Ms. Roniance Adhiambo*	Influence of Roseires Dam Heightening on Performance of Al-guneid Irrigation Pumps in Sudan *Prof. Ali Adeeb*	Hydro politics, Hydro-hegemony and the Problem of Egypt's Securitization of the Eastern Nile Basin *Dr. Akwei Benjamin*	Eastern Nile Multipurpose Option Scoping Model *Ms. Azeb Mersha*
	Assessment of ground water of Blue Nile Sudan *Dr. Elmusalami Fadlallah*	How Healthy is the Lake Victoria Ecosystems Goods and Services?: Gender-Ecosystem-Poverty linkage Perspective. *Dr. Aloyce Hepelwa*	Using WEAP Model to Monitor and Manage the Blue Nile River Basin *Eng. Mohamed Mokhtar*	Role of water diplomacy in transboundary cooperation in EN: Application of experimental games *Dr. Mahsa Motlagh*	Projecting downstream impacts of the GERD: the case of irrigated schemes in Sudan *Dr. Shamseddin Ahmed*
	Flood forecasting and early warning *Eng. Surafel Mamo Woldegbrael*	Incentives Based Conservation Approach for Nile Basin Wetlands Wise-use by *Mr. Amos Thiongo*	Mainstreaming value of Ecosystems and Biodiversity in Development Planning: Tana River Basin *Mr. Wamubeyi Brian Jared*	The Emotional River: The Hydro political psychology of the Nile *Mr. Wondwosen Michago Seide*	Updating the hydrology of the Baro-Akobo-Sobat *Dr. Verno Jonker*
	Discussion	Discussion	Discussion	Discussion	Discussion
15:00-15:30	*Coffee Break*				

15:30-17:00	**WA3 - Enhancing water resources supply**	**ECO3 – Environmental Flows**	**WEF3 – Coordinated planning and management**	**GOV3 – Multi-track Hydro- diplomacy**	**ECN3 – Investment and trade: exploring the current landscape**
	Room MH 1	*Room MH 2*	*Room MH 3*	*Room AD 12*	*Room AD 10*
	Scope for diversifying water resources supply in the Nile Basin *Dr. Yassir Abas*	A Framework Model for Strategic Environmental Assessment for River Engineering Development *Mr. Lugard Kaunda Ogaro*	Towards operation of dam cascades, approaches of NBI in the Eastern Nile *Eng. Michael Abebe*	Realizing the water security of the Nile Basin states: exploring the options *Dr. John R. Nyaoro*	Political economy of large scale agricultural investment in the Nile Basin: Exploring opportunities and challenges *Ms. Ramy Hanna*
	Rainfall harvesting projects in Sudan *Dr. Ahmed Adam*	Environmental flow assessment: NBI experience; include case studies (dinder) *Dr. Mohsen Alarabawy*	Challenges facing Atbara Dam Complex (ADC) Operation Management *Prof. Abdalla Abdelsalam Ahmed*	The role of media and science communication in shaping debates and negotiations over the Nile. *Dr. Emanuele Fantini*	Food, Fodder and Flowers: the critical role of global and regional virtual water trade in the Nile Basin *Dr. Ana Elisa Cascão*
	Challenges and success factors to enhancing rural community resilience to drought- Case study Bugesera in Rwanda *Eng. Lazare Nzeyimana*	Environmental flow for the Nile Basin: Framework for regional evaluations and a case study from the Mara river *Dr. Gordon O'Brien*	Seeking compromise with the GERD *Dr. Kevin Wheeler*	Integrated diagnostic approach to understand stakeholders' role and impact on water governance in the Nile Basin *Mr. Mohamedh Tawfik*	Business Corporations in the Eastern Nile Basin: Engine or barrier of effective water governance? *Ms. Abeer Abazeed*
	Groundwater availability and potential in the Nile Basin *Dr. Seifu Kebede*	Evaluation of experiences with e-flow assessments in the East Africa *Prof. Michael McClain*	National Water Projects in the Eastern Nile Basin: Drivers to conflict or cooperation? *Eng. Mina Michel Samaan*	The Nile Project: Culture and education dimensions of water diplomacy *Mr. Mina Girgis*	Climate finance: Opportunities for investment in the water sector *Mr. Herman Kwoba*
	Discussion	Discussion	Discussion	Discussion	Discussion

17:00 – 18:00	*Open Space (Exhibition visits, book launches, side meetings)*

DAY 3 – Wednesday, October 25, 2017

Day 3 aims to pave a way forward for Nile Basin countries to explore joint solutions to river basin management. The Plenary introduces current strategies at the national level, NBI's approach to exploring possible solution pathways and examples of how two other river basins are addressing similar challenges.

08:30 – 10:25	**Plenary Session 2: Coordinated planning and management of shared water resources for enhancing water security in the Nile Basin** *Room MH 1 + 2* • Review of Day 2, introduction to Day 3; *MC* • Country perspectives (4) on future water demands, challenges and strategies for addressing the growing water demands • Keynote 1: Exploring how to address projected growth in water demands, NBI's approach; *Dr. Abdulkarim Seid* • Keynote 2:Planning for Water Secure Futures in the Context of Fragile Water Economies: Reflections from the Zambezi Basin; *Prof. Zebedia Phiri* • Keynote 3: Adapting water governance to emerging needs and challenges, example from the Colorado River Basin; *Prof. Edith Zagona*

10:20 – 10:45	*Coffee Break*

Four parallel panel sessions draw on the vast knowledge collected on day two and begin to explore possible solutions and pathways to the sustainable and cooperative management and development of the Nile Basin's resources. Each panel will feature three short expert inputs to stimulate discussion.

10:45 – 12:15	Panel Sessions: exploring solutions and pathways			
	Thematic Panel 1: Options for conserving and diversifying water source	Thematic Panel 2: Reconciling ecosystem sustainability with water resources investment planning	Thematic Panel 3: Towards a basin approach for efficient water management and food security	Thematic Panel 4: Regional integration through hydraulic infrastructure
	Room MH 1 + 2	*Room MH 3*	*Room AD 12*	*Room AD 10*
	Enhancing and diversifying water sources: scanning the options for the Nile Basin *Dr. Yassir Abbas*	Environmental flows: how to use existing best practice in the Nile Basin region *Prof. Michael McClain*	Food security through basin-wide approaches of agricultural water management *Eng. Bart Hilhorst*	Coordinated operation of cascade of dams, experiences from the Colorado Basin, USA *Prof. Edith Zagona*
	Improved demand side management and use of non-conventional water; *Dr. Mohammed Ahmed Hassan*	Water requirements of Wetlands: Integrating wetland sustainable use and management in basin planning *Dr. Paul Ouédraogo*	Regional agricultural trade and investment in the Nile Basin *Dr. Claudia Ringler*	Power inter-connection and energy trade, NBI's experience. *Eng. Ellicad Nyabeeya*
	Groundwater as complementary water source *Dr. Seifu Kebede*	Integrated watershed management for protection of water source areas and sustainable livelihoods *Dr. Seifu A. Tilahun*		Regional integration through hydraulic infrastructure: The economic arguments *Prof. Marc Jeuland*
	Short interventions by: *Dr. Yilma Sileshi, , Florence Adongo (tbc);*	Short interventions by: *Alier Oka; Laisser Sadiki; Lucy Iyango;*	Short interventions by: *Eng. Innocent Ntabana; Gladys Wekesa ; Dr. Rawiya Tawfik, Prof. Younis Gismalla*	New approaches for regional water-energy integration *Prof. Julien Harou*
				Short interventions by: *Kevin Wheeler, Prof Abdalla Abdussalam; Sowed Sewaggude (tbc); Michael Abebe;*
	Discussion and audience Q&A	Discussion and audience Q&A	Discussion and audience Q&A	Discussion and audience Q&A

12:15 – 13:30	*Lunch Break*

Two parallel synthesis panels seek to further focus the discussions of the previous days and translate them into specific options for Nile Basin countries to move their cooperation forward.

13:30- 15:15	Synthesis Panel Session: How to take it forward	
	Synthesis Panel 1: Nile Cooperation, how to make the qualitative leap forward?	Synthesis Panel 2: Rethinking basin planning and investment in the Nile Basin
	Room MH 1	*Room MH 2*
	Qualitative leap in Nile cooperation, reflecting on the outcomes of the paper and panel sessions	Building blocks for a water secure Nile Basin: reflecting on the outcomes of the paper and panel sessions
	Strengthening the dialogue: structured dialogue as a means for exploring breakthrough options in transboundary cooperation *Prof Jon Martin Trondalen*	NBI's 10 - year Strategy: Re-thinking regional investment and basin planning *Dr. Abdulkarim Seid*
	International water law perspectives *Dr. Salman Salman*	International experience in joint basin planning and investments *Dr. Don Blackmore*
	Short interventions by: *Mr. Imeru Tamrat, Prof. Seifeldin Abdalla; Dr. John Nyaoro; Sylvester Matemu;*	Short interventions by: *Eng. Teferra Beyene; Aly Matano (tbc); Chris Juma, Ellicad Nyabeeya; Hesham A. Ghany (tbc);*
	Discussion: Q and A from audience, panel members reflection	Discussion: Q and A from audience, panel members reflection

15:15 – 16:00	*Coffee Break*

In the High Level Panel, Nile Basin Ministers of Water Affairs will deliberate on the messages and possible solution pathways emerging from the 5th NBDF.

16:00 – 17:00	**High Level Panel – moving the agenda forward together** *Room MH 1 + 2* Reporting back on key issues: *chief rapporteur* Introduction *by Moderator* Ministers in charge of Water Affairs from Nile Basin countries deliberate on issues and solution options synthesized from the sessions Wrap-up of the high level panel deliberations *by Moderator*
17:00 – 17:30	**Closing** *Room MH 1 + 2* Messages from the forum, *by chief rapporteur* Word of thanks, *by Executive Director of NBI* Concluding remarks *by Development Partners* Closing remarks *by Host Country Nile-COM member*

ABSTRACT

The NBDF 5 Abstract Book consists of the abstracts presented at the NBDF 5 held in Kigali, Rwanda during October 23-25, 2017

Session Series I: Ensuring water availability for a growing water demand (WA)

WA1 - Climate change

1. Climate Change projections for the Nile Basin: what do the climate models tell us? *Dr. Bruce Hewston*
2. Analyzing the future climate change of Upper Blue Nile River Basin (UBNRB) using statistical down scaling techniques; *Mr. Dagnenet Fenta Mekonnen*
3. Impact of climate change on precipitation distribution and water availability in the Nile basin; *Mr. Zelalem Mekonnen*
4. The National Impact of 1.5 and 2 Degree Global Warming over Africa, and the Role of Aridity; *Dr. Modathir Zaroug*

WA2 - WR Availability and Variability

5. Surface water availability; variability; climate change impacts; *Prof. Seifeldin H Abdalla*
6. Use of EO Data for Monitoring River Basins. *Ms.Milly Mbuliro*
7. Assessment of GW of Blue Nile Sudan ; *Dr. Elmusalami Fadlallah*
8. Flood forecasting and early warning; *Eng. Surafel Mamo Woldegbrael*

WA3 - Enhancing water resources supply

9. Scope for diversifying water resources supply in the Nile Basin; *Dr. Yassir Abas*
10. Rainfall Harvesting Projects in Sudan ;*Dr. Ahmed Adam*
11. Challenges and success factors to enhancing rural community resilience to drought- Case study Bugesera in Rwanda ; *Eng. Lazare Nzeyimana*
12. Groundwater availability and potential in the Nile Basin ;*Dr. Seifu Kebede*

Session Series II: Sustaining the water ecosystems of the Nile Basin (ECO)

ECO1 - Catchment/Watershed Management

13. Soil and Water conservation, experiences from upper Blue Nile Basin, Ethiopia; *Mr. Adugnaw Tadesse*
14. Assessing impact of land use and land cover change on stream flow response: Dinder and Rahad ; *Eng, Khalid Hassaballah*
15. Livelihood Contribution of landscape restoration; *Mr.Yitbarek Tibebe Welde semaet*
16. Catchment restoration for a sustainable renewable energy production in Upper Nyabarongo Catchment , Rwanda; *Francois Tetero*

ECO2 - Sustainable use and management of Wetlands

17. Supporting Sustainable Management of the Mara Wetlands in the Mara River Basin ;*Mr. Emmanuel Mgimwa*
18. Community Conservation Agreements Model for Sustainable Management of Winam Gulf Wetlands, *Ms.Roniance Adhiambo*
19. How Healthy is the Lake Victoria Ecosystems Goods and Services?: Gender-Ecosystem-Poverty linkage Perspective. *Dr.Aloyce Hepelwa*
20. Incentives Based Conservation Approach for Nile Basin Wetlands Wise-use ;*Amos Thiongo,*

ECO4 - Environmental Flows

21. A Framework Model for Strategic Environmental Assessment for River Engineering Development: NB Case Study; *Mr.Lugard Kaunda Ogaro*
22. Environmental flow assessment: NBI experience; include case studies (dinder); *Dr. Mohsen Alarabawy*
23. Environmental flow for the Nile Basin: Framework for regional evaluations and a case study from the Mara river. ; *Dr. Gordon O'Brien*
24. Evaluation of experiences with e-flow assessments in the East Africa; *Prof Michael McClain*

Session Series III: Water – energy – food nexus (WEF)

WEF1 – Food production and water management

25. Harnessing Water for Food Security: Challenges and options; *Dr. Eltigani Abdelgalil*
26. Technical efficiency of large scale irrigated wheat production in Blue Nile basin, case of Koga irrigation scheme; *Mr. Anteneh Belay*
27. Impacts of irrigation development in the upper blue Nile basin using Nile basin DSS; *Eng. Habtam Achenif*
28. Satellite based ICT for improved crop production in the Gezira Scheme – Sudan; *Prof. Younis Gismalla*

WEF2: Multi-sector planning and tradeoffs

29. Eastern Nile Multi-Sectoral Investment Opportunity Analysis ; *Ms. Azeb Mersha*
30. Influence of Roseires Dam Heightening on Performance of Al-guneid Irrigation Pumps in Sudan; *Prof. Ali Adeeb*
31. Using WEAP Model to Monitor and Manage the Blue Nile River Basin ; *Eng. Mohamed Mokhtar*
32. Mainstreaming value of Ecosystems and Biodiversity in Development Planning: Tana River Basin ; *Ms.Julie Mulonga*

WEF3: Coordinated planning and management

33. Towards operation of dam cascades, approaches of NBI in the Eastern Nile. *Eng. Michael Abebe;*
34. Challenges facing Atbara Dam Complex (ADC) Operation Management ;*Prof. Abdalla Abdelsalam Ahmed*
35. Seeking Compromise with the GERD;Dr. *Kevin Wheeler*
36. National Water Projects in the Eastern Nile Basin: Drivers to Conflict or Cooperation? *Eng.Mina Michel Samaan*

Session Series IV: Governance (GOV

GOV1 - Transboundary cooperation: sharing experiences

37. Beyond legalisms: toward cooperative governance of resource security; *Ms. Belynda Petrie*
38. TB water governance and cooperation through Benefit Opportunities Assessment Dialogue in the Sio-Malaba-Malakisi sub-basin; *Mr. John Owino*
39. Project based transboundary cooperation: the case of GERD-P;Eng. *Gedion Asfaw*
40. GERD and hydro-politics in the Eastern Nile: from water to benefit sharing? *Rawia Tawfik and Ines Dombrowsky*

GOV2 - Hydro-politics of the Nile Basin

41. Collective Action Theory and Nile Basin Cooperation: Past Experience, Future Directions; Dr. Alan Nicol
42. Hydro politics, Hydro-hegemony and the Problem of Egypt's Securitization of the EN Basin ;*Dr. Akwei Benjamin*
43. Role of water diplomacy in TB cooperation in EN: Application of experimental games *;Dr.Mahsa Motlagh*
44. The Emotional River: The Hydro political Psychology of the Nile; *Mr. Wondwosen Michago Seide*

GOV3 – Multi-track Hydro diplomacy;

45. Realizing the water security of the Nile Basin states: exploring the options. *Dr. John R. Nyaoro*
46. The role of media and science communication in shaping debates and negotiations over the Nile. *Dr. Emanuele Fantini*
47. Integrated diagnostic approach to understand stakeholder's role and impact on water governance in NB; *Mr. Mohamedh Tawfik*
48. The Nile Project: culture and education dimensions of water diplomacy; *Mina Girgis*

Session Series V: Economic Perspectives for Basin Management (ECN)

ECN1 - Economic valuation of ecosystem services

49. The Value of the Sudd Wetland: Implications for Integrated Policies in the Nile River Basin; *Dr. Hannes Lang*
50. Applying standardized methodology to value biodiversity and ecosystem services in the Lake Victoria Basin ;*Dr. Brenda Bergman*
51. Rapid Assessment of Ecosystem Service values at Yala Wetland, Kenya ;*Mr. Justus Amayo*
52. Economic Valuation of Wetlands Ecosystems for Wise Use Review and Case Studies from the Nile Basin; *Dr. Amel Azab*

ECN2 - Hydro -economics of water allocation

53. Water in national economic planning: utilization, challenges and valuation. *Dr. Khalid Siddig*
54. Eastern Nile Multipurpose Option Scoping Model ;*Mr Mikiyas Gonfa*
55. Projecting downstream impacts of the GERD: the case of irrigated schemes in Sudan ; *Dr. Shamseddin Ahmed*
56. Updating the hydrology of the Baro-Akobo-Sobat ;*Dr. Verno Jonker*

ECN3 – investment and trade: exploring the current landscape

57. Political economy of large scale agricultural investment in the Nile Basin: exploring opportunities and challenges of private sector financing in land and water resources development. *Ramy Hanna;*
58. Food, Fodder and Flowers: the critical role of global and regional virtual water trade in the Nile Basin; *Dr. Ana Elisa Cascao*
59. Business Corporations in the Eastern Nile Basin: Engine or Barrier of Effective Water Governance? *Ms. Abeer Abazeed*
60. Climate finance: opportunities for investment in the water sector; *Herman Kwoba*.

Thematic Panel Sessions Abstracts

1. Integrated Watershed Management for Protection of Water Source Areas and Sustainable Livelihood, *Seifu A. Tilahun*
2. *Strengthening the dialogue: Structured dialogue as a means for exploring breakthrough options in transboundary cooperation, Prof. Dr. Jon Martin Trondalen,*
3. Food security through basin-wide approaches of agricultural water management*", Bart Hilhorst*
4. Challenges for Adaptive Transboundary Governance in the Nile Basin: Parallels with the Colorado River Basin*, Professor Edith Zagona,*
5. The regional economics of water resources development: Assessing tradeoffs and opportunities for integration*, Marc Jeuland*

Session Series I: Ensuring water availability for a growing water demand (WA)

WA1 - Climate change

1. **Climate Change projections for the Nile Basin: what do the climate models tell us?'**

2. **Analyzing the future climate change of Upper Blue Nile River Basin (UBNRB) using statistical down scaling techniques**; *Dagnenet Fenta Mekonnen,*: dagnfenta@yahoo.com, dagnenet.mekonnen@tum.de

Dagnenet Fenta Mekonnen is passionate to significantly contribute in the development and management of water resources for the well being of the people who are dominantly dependent on subsistence agricultural economy. Professionally, he received BSc Degree in hydraulic Engineering at Arba-Minch University with high honor and MSc in surface hydrology (Geo-information and Earth observation) in International Institute for Geo-Information and Earth Observation Science (ITC), Netherlands.
After graduation, he has been working for more than 15 years in government organizations in leading, coordinating, design & supervision of water supply and irrigation projects at different positions (Design engineer, Department head and deputy Bureau Head) at water sector in the Amhara region, Ethiopia.
Currently, he is studying his PhD at Technical University of Munich, Germany with the topic of " Impacts of climate change and water resource developments on the water resources of Upper Blue Nile River Basin, Ethiopia"

Abstract.

Climate change is becoming one of the most arguable and threatening issues in terms of global context and their responses to environment and socio/economic drivers. Its direct impact becomes critical for water resource development and indirectly for agricultural production, environmental quality, economic development, social well being. However, a large uncertainty between different Global Circulation Models (GCMs) and downscaling methods exist that makes reliable conclusions for a sustainable water management difficult. Hence, we employed a multi model approach from six different GCMs which were used in the IPCC's Fourth Assessment Report (AR4) based on Special Emissions Scenarios SRES B1, A1B and A2 and one CMIP5 GCM used in the IPCC Fifth Assessment Report(AR5) based on RCP2.6, RCP4.5, RCP6 and RCP8.5 scenarios for three time windows 2030s, 2050s and 2080s to appreciate the uncertainty of GCMs. And also, two widely used statistical down scaling techniques Long Ashton Research Station Weather Generator (LARS-WG) and Statistical Down Scaling Model (SDSM) were applied.

The downscaled precipitation results from the six GCMs by LARS WG showed inconsistency and large inter model variability, two GCMs showed decreasing trend while 4 GCMs showed increasing in the range from -7.9% to +43.7% while the ensemble mean of the six GCM result showed increasing trend ranged from 1.0 % to 14.4 %.

Conversely, the result from all GCMs showed a similar continuous increasing trend for maximum temperature (Tmax) and minimum temperature (Tmin) in all three future periods The change for mean annual Tmax may increase from 0.4oc to 4.3oc whereas the change for mean annual Tmin may increase from 0.3oc to 4.1oc

Although, both HadCM3 and canESM2 GCMs using SDSM agree with respect to the direction of 21st century precipitation, minimum and maximum temperature changes, there are considerable variability in magnitude. The relative change of mean annual precipitation range from 2.1 % to 43.8 % while the change for mean annual Tmax and Tmin may increase from 0.4oc to 2.9oc and from 0.3oc to 1.6oc respectively. The change in magnitude for precipitation is higher in RCP8.5 scenarios than the others as expected. The present result illustrate that both down scaling techniques have shown comparable and good ability to simulate the current local climate variables which can be adopted for future climate change study with high confidence for the UBNRB. However, based on the comparative performance evaluation results and because of the well known fact that GCMs are not very reliable in simulating precipitation, SDSM would be more robust and can be applied at higher confidence for downscaling large scale GCMs outputs to finer scales to suit for hydrological models for impact assessment in the UBNRB.

The positive change of precipitation in future can be a good opportunity for the farmers who are engaged in rain fed agriculture to maximize their agricultural production and to change their lively hoods. However, this information cannot be a guarantee for irrigation farming because precipitation is not the only factor contributing to affect the flow of the river, which is the main source of irrigation.

Key words: Climate Change, GCM, statistical down scaling, LARS WG, SDSM

3. Impact of climate change on precipitation distribution and water availability in the Nile basin;

Zelalem T. Mekonnen[1], Mekonnen Gebremichael[1]
[1]*University of California, Los Angeles, Civil and Environmental Engineering, CA, USA*

Zelalem Mekonnen is currently an engineer and researcher in the Water Resources Management Division at Research Triangle Institute (RTI International). Mr. Mekonnen's eight years of experience and research interest include climate change and its impact on water resources management, the application of remote sensing in water resources, hydrology and climate modeling and forecasting, water allocation and optimization, and drought and flood modeling.

Mr. Mekonnen got his BS in Civil Engineering from Addis Ababa Institute of Technology, Ethiopia in 2009 and his MS in Civil and Environmental Engineering from University of California, Los Angeles, in 2015. He is pursuing his PhD at University of California Los Angeles since 2015 focusing on water resources and climate change.

Past experiences include water resources engineer at Eastern Nile Technical and Regional office (ENTRO), Assistant lecturer at Addis Ababa Institute of Technology and National Network Member for the Nile Basin Decision Support System.

ABSTRACT

In a basin like the Nile where millions of people depend on rainfed agriculture and surface water resources for their livelihoods, changes in precipitation will have tremendous social and economic consequences. General circulation models (GCMs) have been associated with high uncertainty in their projection of future precipitation for the Nile basin. Some studies tried to compare performance of different GCMs by doing a Multi-Model comparison for the region. Many indicated that there is no single model that gives the "best estimate" of precipitation for a very complex and large basin like the Nile. In this study, we used a combination of satellite and long term rain gauge precipitation measurements (TRMM and CenTrends) to evaluate the performance of 10 GCMs from the 5th Coupled Model Intercomparison Project (CMIP5) at different spatial and seasonal scales and produce a weighted ensemble projection. Our results confirm that there is no single model that gives best estimate over the region, hence the approach of creating an ensemble depending on how the model performed in specific areas and seasons resulted in an improved estimate of precipitation compared with observed values. Following the same approach, we created an ensemble of future precipitation projections for four different time periods (2000-2024, 2025-2049 and 2050-2100). The analysis showed that all the major sub-basins of the Nile will get will get more precipitation with time, even though the distribution with in the sub basin might be different. Overall the analysis showed a 15 % increase (125 mm/year) by the end of the century averaged over the area up to the Aswan dam.

4. **The National Impact of 1.5 and 2 Degree Global Warming over Africa, and the Role of Aridity;** Modathir A H Zaroug; Mark New; Chris Lennard.

Abstract:
The aim of a 1.5 degree global warming target is to reduce the potential impacts of climate change on the most vulnerable regions and states, most especially Small Island developing states, but also other vulnerable developing countries. The effect of 1.5 and 2 °C global warming on temperature and precipitation over all the African countries were examined by calculating the median of the GCMs, based on 81 RCP8.5 scenario simulations for temperature and 78 for rainfall. The drivers behind differing levels of localised extent of change climate change in Africa were also examined. Of the 49 African countries, 5 show a warming of less than or equal the global mean change of 1.5 and 2 °C. However, 44 countries (~90%) warm at rates higher than the global mean at 1.5 and 2 °C.

Of these 44 countries, 7 warm at a rate 1.33 (1.25) times the global mean at 1.5 (2.0) C warming and 5 at a rate of 1.4 (1.3) times the global mean increase. In general, temperatures in North African countries will increase fastest and in east Africa more slowly. When the rainfall change was calculated for each African country, 20 countries show drying signals compared to the global mean at 1.5 and 2.0 °C warming, 17 show wetting signals and 9 countries show no change signal. All the Southern African countries were projected to have less rainfall when the global mean reaches 1.5 °C and 2 °C. On the contrary, all the East African countries were projected to have more rainfall when the global mean reach 1.5 °C and 2 °C. The West African countries showed mixing signals of diminishing, increasing and no change in rainfall at 1.5 °C and 2 °C. North African countries have little rainfall with little variability due to rainfall scarcity, and they were projected to remain almost the same at 1.5 °C and 2 °C. An analysis of aridity indices revealed warming will be at a faster rate in arid regions which already have high temperature and low precipitation, whereas over humid regional warming rate is less pronounced.

5. **Surface water availability; variability; climate change impacts;** Prof. Sefeldin Hamad Abdalla

Use of Earth Observation Data to Monitor River Basins: The NBI Experience

Milly Mbuliro, Nile Basin Initiative, Entebbe, Uganda

Milly Mbuliro has 13 years of working experience as a GIS and Remote Sensing Specialist with a strong background in water resources management. She graduated from the University of Dar es Salaam, Tanzania with a Masters degree in Integrated Water Resources Management in 2004. She works for the Nile Basin Initiative Secretariat as the GIS and Remote Sensing specialist.

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Abstract:

Keywords: Basin Monitoring, Remote Sensing, GIS, Precipitation, Earth Observation, Satellite data, Nile Basin, River Nile.

The Nile cuts across diverse climatic zones with its sources in the humid regions and encountering arid conditions as it flows downstream across the arid regions in the desert in the northern part of Sudan and further north into Egypt. Traversing South-North of the Sahara desert, the Nile river experiences humid, semi-humid, arid, semi-arid, and Mediterranean climates, an extreme variability that requires state-of-the-art technologies and skills to monitor.

Despite the challenge presented by the complexity of climate variability in the Nile Basin, constant and minimal error basin monitoring is critical to sustainably maintain the Nile water balance considering its high socio-economic value for the populations of the eleven Nile countries.
The amount of water in the River Nile is determined by annual precipitation, run-off and evaporation. Therefore, understanding precipitation patterns is crucial for the sound management of the Nile waters, bearing in mind that higher temperatures will lead to higher evaporation rates and lower run-off. The health of the Nile River watersheds is threatened in certain areas by the degradation of productive agricultural and grazing lands through inadequate cropping and range management practices; erosion and sedimentation due to deforestation and inappropriate land use practices. These changes need to be monitored.

Under the Hydro-Met project, the NBI aims to set up a regionally recognized monitoring system to capture and store readings of key climatic variable. This system was agreed upon by the countries. Funds for implementation of this system are still underway. In the meantime, satellite based products are to be used especially for areas without monitoring systems and for those not easily accessible. The NBI aims to enhance a shared understanding of basin processes, keeping track of changes in the environment and climatic variables and to promote good data management, data sharing and data communication to resource managers in a consistent, harmonized and understandable way.

Satellite products have been recognized globally as most feasible means to provide spatially distributed regional information on land surfaces. Remotely sensed data, especially those from polar-orbiting satellites, provide temporally and spatially continuous information over vegetated surfaces useful for regional measurement and monitoring of surface biophysical variables

The Nile Basin Monitors variables such as Rainfall , Evapotranspiration ,Relative Humidity ,Air Temperature ,River or Lake Stage/ Discharge, Soil erosion Vulnerability, Land-cover /use change, Seasonal Variation of Wetland areas ,Soil Moisture , Vegetation cover and socio economic indicators among others. The NBI is also moving towards ground water monitoring, water quality monitoring and sediment load monitoring.

There are various data sources and remote sensing products globally available in the public domain. All products are released with different spatial and temporal resolutions to meet different needs. The NBI accesses data mainly from NASA and from ESA.

Among the many satellite products that estimate precipitation, the NBI uses NASA's TRMM 3B42 daily accumulated precipitation and 3B43_v7 monthly aggregated products. There is a near-real-time version, 3B42-real-time (3B42RT), that is available with a time lag of about 6 hours. Their spatial resolution is 0.25^{o}. Overall, TRMM 3B43 indicates a wide rainfall variability and spatial distribution in the basin which is also confirmed by ground measurements. Minimum rainfall is seen to be less than 50mm in the arid parts of the basin and maximum estimates observed in the Nile equatorial lakes region and the Ethiopian highlands with over 1200mm/yr. Other reliable Precipitation estimates include NOAA's RFE v 2.0, TAMSAT, CHIRPS products. Such precipitation estimates are very useful especially for small ungauged catchments. Estimated values are extracted using zonal statistics and timeseries used as inputs in numerical models.

Realizing the importance of ET to the water balance of the Nile, and utilizing the available satellite information and advanced algorithms, the Nile Basin Initiative has produced estimates of actual ET over the Nile Basin Countries at a resolution of 1 km2 at 8-day time step, monthly and annually using an improved remote sensing algorithm based on the glob al MOD16ET. The improved algorithm uses daily meteorological data and MODIS land surface dynamic datasets as input for daily ET calculations. Major improvements to the global MOD16 ET include estimating not only over vegetated land surfaces but also over deserts, urban areas, inland water bodies such as rivers and lakes. Generating this dataset aims at establishing more accurate water balances for the various Nile sub-basins especially those with large swamps (e.g the Sudd) and those with inaccessible river gauges. Results show that ET is highest over open water bodies and is almost uniform all year round over lake Victoria sub basin and Blue Nile Sub basin but the trend is different for the other Nile Basin sub basins. In the sub-basins of Lake Victoria, Lake Kyoga and the Ethiopian Plateau, the ration of ET/P is less than one implying that there is potential to generate runoff in these sub-basins unlike in the Bahr el Jebel and Main Nile subbasins where the ET/P ratio is greater than 1. The difference between P- ET gives an indication of how much is lost to the atmosphere and where the loss is beneficial or not calls for a management decision to promote better land use practices.

Monitoring water levels especially in large lakes is a useful element in water balance models and gives an indication of storage. Radar altimetry is another technically viable methodology for acquiring levels of rivers and lakes. Altimetry has the advantage of not being effected by clouds, night time conditions, or even vegetation. Of all the lakes in the Nile Basin region, water levels of four lakes (Lake Victoria, Tana, Nasser and Kyoga) are being monitored using satellite altimetry since 1992. This data should be used in reference to the datum.

Changes in Landcover, forest area, agricultural land, seasonal variation of wetlands is monitored using MODIS, Landsat and Sentinel-B data. Derived products show changes in land cover with an increase in agricultural area and decrease in forest area between 2004 and 2009. Seasonal variation of wetland areas has been monitored using Sentinel B data based on thresholding and retrieval of soil moisture values.

Temporal and spatial variation of biological indicators in lake larges can be monitored using MODIS and previously by MERIS. The results show distinct areas of pollution load especially in areas close to town and trading centers. This is has been observed for lake Victoria based on Chlorophyll concentration.

A huge wealth of knowledge and customized data is achieved in NBI repositories for free access by member states. The NBI aims to enhance a shared understanding of basin processes, keeping track of changes in the environment and climatic variables and to promote good data management, data sharing and data communication to resource managers in a consistent, harmonized and understandable way.

Conclusion

Basin monitoring still remains a useful tool towards sustainable management of the Nile basin considering that it becomes easy to manage what you can measure. With a continuously growing population and climate change becoming a reality, changes in the Nile Basin need to be monitored. The NBI has designed a regional Hydro-met system to be operated by countries in order to monitor the basin continuously. The system supports use of satellite data to compliment ground based measurements. Monitoring and management of Nile Basin resources calls for a cooperative approach and the NBI offers a suitable platform for this.

6. Assessment of ground water resources of the Blue Nile Basin, Sudan

Dr.Elmusalami Yousif Fadlallah, Associated Professor in Groundwater
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1982—1987: B.Sc. (Hons.), Geology, Khartoum University, Sudan
1993—1995: M.Sc. (Geophysical Investigation with reference to groundwater), Khartoum University, Sudan
2000---2004: PhD (Groundwater Modeling and Management) Khartoum University, Sudan.
30 years of teaching and research experience in various aspects of water engineering, simulation and management in addition to geological and geophysical work at undergraduate levels at Faculty of Earth Sciences – Red Sea University

Abstract:

The area occupies about 27000km 2,in the Blue Nile basin between latitudes 12° 45'-15° N ,and longitudes 33° 15' -34° 10 E ,the main objective of this study is to estimate the actual recharge to the aquifer from the Blue Nile and Dinder River ,by using the stable isotopes Oxygen-18 (18O) ,and deuterium (2H), which are normally, not involved in the natural decay. The radioactive isotope Tritium (3H) was used to measure the residence time (there is continuous recharge for more than 50years).The basin is filled with fluvial sediments more t han 1650mthick,.The oldest rocks in the area are the basement complex rocks of (Pre Cambrian age)which underlie the basin and outcrop at its prepheries. The occurrence of the groundwater in these sedimentary units is controlled by structures (faulting), an d the average saturated thickness in the upper 300m depth from the land surface is 75m.The flow direction

of groundwater is regionally towards the north-northwest, but locally from the Blue Nile and the Dinder River (main sources of recharge) towards the c entre of the area under an average hydraulic gradient of (0.00125).

The groundwater of the study area carries the isotopic signature of the headwaters of the Ethiopian highlands (the sources of these rivers).It contains tritiated water, which indicates mod ern recharge to the aquifers (renewable resource).The annual recharge is estimated to be (923 million m3 year-1).

More exploitation of the groundwater resource is thus possible and sustainable, at least for the coming ten years.More simulation technique is recommended.

Keywords:

Sudan, Blue Nile, groundwater, Isotopes, recharge, assessment

7. Eastern Nile Flood Preparedness and Early Warning

Surafel Mamo (M.Sc.), 2Almutaz Abdelkarim (M.Sc.), 3Choul Biel (M.Sc.), 4Azeb Mersha (M.Sc.)

Surafel has more than 15 years of working experiences in the water sector, especially in hydrology and water resources. He has a Master of Science in Water Science and Engineering - specialization in Hydroinformatics in Modeling and Information Systems for Water Management from UNSESCO-IHEInstitute for Water Education, the Netherlands (2011) followed by the research work "Flood Control in Fogera floodplain under Regulatory Operation of Reservoirs, Upper Blue Nile, Ethiopia".
Currently, he is working for the Ministry of Water, Irrigation & Electricity of Ethiopia as senior Hydrologist| Water Resource Engineer

Abstract

The Eastern Nile Flood Preparedness and Early Warning (FPEW) project is one of many projects under ENSAP programs implemented by the Eastern Nile Technical Regional Office (ENTRO). The EN Flood Monitoring Program is one of those activities implemented by ENTRO in the management of floodplain areas; flood mitigation planning; flood forecast and early warning; and emergency responses and preparedness at regional, national and local community levels in EN countries.

The EN Flood Monitoring Program is the processes of flood forecasting and modeling systems and implemented in Lake Tana sub-basin, Blue and Main Nile, and Baro-Akobo-Sobat pilot flood prone areas that are affected by both flash and fluvial floods. This program is aimed to save life by allowing people to have early warning information and provide emergency services to prepare for flooding then to reduce the human sufferings from flooding and its damages. Some of the flood events, for instance, were the 1998 floods in Sudan caused U$D 24.3million the direct

damages, the 2006 floods in Ethiopia caused many to die and hundreds to displaced, and the recent flood events (2013 and 2014) both in South Sudan and Sudan. Thus, ENTRO create a platform for EN countries, FPEW program which is an ongoing program, to collaborate and deal with flooding to reduce flood devastation for about 2.2 million people in the EN region.

FPEW is adopted flood modeling and forecasting systems as a methodology for each flood floodplains (Lake Tana, Blue Nile and Main Nile, Gamebela and Pibor) to produce flood forecast information every flood season. The flood modeling system for Lake Tana was used rainfall from WRF weather model as an input in the configured Hydrologic model (HEC-HMS) and generate the runoff. The Hydraulic model (HEC-RAS) utilized the runoff (as an upstream boundary condition) and Lake Tana water level (as a downstream boundary condition) to route the river flood flows. The simulated results from HEC-RAS are then used to produce flood depths using HEC-GeoRAS mapping. Likewise, the flood forecast for Blue and Main Nile, the estimated average rainfall data obtained from RFE, USGS, TRMM and CMORPH satellites, daily Eddeim and other river gauging stations are used to update the states of hydrologic model component in the Sudan FEWS. Then, the HEC-RAS component in the Sudan FEWS was run to route the flows from Eddeim to Khartoum downstream. Similarly, BAS flood forecast uses hydrological and hydraulic models to generate flood forecast information. Once, the forecast results such as, rainfall forecasts, peak runoff flows, flood inundation maps for 3 days lead-time are obtained using numerical weather model and flood models, they are interpreted and summarized into forecast information. This flood forecast information are then disseminated to different users at different levels using the ENTRO web portal, Email, mobile SMS communication modes.

Generally, as a success story, the EN countries benefit a lot from the EN flood early warnings services to save life and properties since the FPEW program has been operationalized in 2010. There are about 150,000 flood vulnerable communities in Ethiopia, 100,000 people in South Sudan and 700,000 in Sudan benefits from it directly, and nearly 2 million people benefits indirectly in the EN basin. In 2012 flood season, for example, there are about 400 households in Lake Tana flood vulnerable communities were affected by flooding: two deaths, relocation of live-stocks and many hectares of farmlands were impacted. However, the impacts since 2013 to current flood seasons are decreased as a result of increasing of awareness and responses of the local communities to flooding and getting much better and better.

However, many challenges such as data sharing and exchange, real-time data acquisition under possible scenarios of current and future climate projections to address flash flooding among others. In the future such challenges should be addressed to produce good information and raise the confidence of citizens in the Nile system. The citizens can then better understand and prepare for flooding, and the FPEW continues to evolve to decline the flood devastations.

Key words: Numerical weather model, Flood models, Flood inundation maps, Sudan FEWS, Eastern Nile countries,

8. Scope for diversifying water resources supply in the Nile Basin; Dr. Yassir Abas

9. Rainfall Harvesting Projects in Sudan

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Abstract

Limited or lack of access to safe water is the main factor hindering the socio-economic development and environmental conservation in the rural areas in the Sudan away from the Nile corridor. As well, the instability due to conflict over water between pastoralists and farmers is also another factor. Almost two-third of Sudan's population lives in rural areas, with 80% depends on rain-fed traditional farming and livestock rearing for their living earning. Rainfall harvesting projects if developed well will ease the pressure on the scarce Nile waters and achieve the targeted socio-economic development goal for the populace of the Nile Basin.
Scarce water regarded as the root cause of conflict in Darfur when started in 2003. The problem aggravated in 2005 when signing "The Comprehensive Peace Agreement" between the Sudan Government and the Southern rebels. The nomad's pastoralists in West Sudan used to move southwards annually post the rainy season from the States of Darfur, Kordofan, White Nile, Sennar and Blue Nile, fetching for water for their livestock, and now found themselves left without access to their historical grazing lands. The problem becomes between two countries since the secession of South Sudan in 2011. The secession led to loss of natural resources: forestry, grazing lands and 60% decrease of annual amount of rainfall.

This situation necessitated adoption of a strategic program for resettlement of nomads, provision of services, socio-economic development, as well as urgent action program for the provision of drinking water.

Water harvesting projects are recognized by the government as a priority to provide access to safe water as a key element for stability and socio-economic development in the rural areas, where people depend on groundwater and erratic rains as source of water..

Therefore the Government adopted a programme called "Zero Thirsty Programme" which aims at providing water within 2 km to every dweller by 2020. A Water Atlas was developed showing most of the villages and towns with/ without drinking facilities.

Water harvesting techniques proved to be simple, easy to implement with high socio-economic return.

The rainfall decreases northwards from 800 mm in the southern border with South Sudan to less than 20 mm in the North. Variability in rainfall may reach about 50% in the northern half of the country and 30% in the central region. Rains are usually intense with short duration. The rainy season in central Sudan is short extending from July to September.

Water harvesting storage facility has to be of low cost, of simple design, easy to implement, easy to operate and easy to maintain.

The paper gives the objectives of the water harvesting projects, shows the impact of these projects on the lives of the residents in the rural areas. The concept and techniques of water harvesting were illustrated. Problems encountered in construction and operation were discussed. Different types of storage facilities were shown, and proper ways for operation and maintenance are described to increase the efficiency.

The role of the federal, state governments and the NGOs in these projects are shown.

A summary of all the water harvesting project in Sudan up to 2013 are given.

10. **Challenges and success factors to enhancing rural community resilience to drought- Case study Bugesera in Rwanda**; Eng. Lazare Nzeyimana, Linköping University/SWECO Environment AB (lazare.nzeyimana@liu.se)

Mr Lazare Nzeyimana holds an MSc in Water Resources and Livelihood Security with more than 18 years working experience in the water and environmental sector. He is a PhD student at Linköping University (Sweden) focusing on applied robust methods for enhancing resilience to drought in the context of Climate Change with a case study in Bugesera, Rwanda. Areas of expertise are IWRM, Climate Adaptation and Disaster Risk Management and Resilience, Environmental and Social Impact Analysis of physical development infrastructures. As a Senior Consultant, Lazare has an extensive experience in project planning, project appraisal, knowledge gaps analysis and needs in country policies related to livelihood challenges. In previous missions, he has been responsible for the development and coordination of Environmental Impact Assessments, international capacity-building programs in the fields of Climate Change Adaptation and Mitigation, Sustainable Urban Planning, Municipal Solid Waste Management, Integrated Water Resources Management and Urban Environmental Management. Lazare has a vast working experience on climate and environmental projects in Angola, Benin, Burkina Faso, Burundi, Côte d'Ivoire, DR Congo, Ghana, Kenya, Mali, Mozambique, Namibia, Niger, Rwanda, Senegal, Tanzania, Togo, Uganda and Zambia.

Abstract

By 2025, 1.8 billion people will be living in regions with absolute water scarcity and a two-third of population could be living under water stress. At the global scale, agriculture is by far the most important water user and, the need for new approaches to managing those resources is becoming more pressing.

In Sub-Saharan Africa, small-scale rain-fed farming is the main livelihood source. To increase drought resilience, there are some commendable efforts in promoting community-based soil and water conservation by governments and development organizations.

Droughts normally make their entrance quite slowly and signs should be possible to see earlier – *e.g*. from signs in nature, seasonal forecasts or from just comparing monitored soil moisture or other factors against the typical development during a year. But if we have early warnings and water conservations systems like that – how can that information and knowledge be used on local, regional and national level? What is missing to engage rural communities to become drought resilient by developing long-term planning based on future scenarios?

Many successful cases of rainwater harvesting documented in Ethiopia, Kenya, Tanzania and Burkina Faso describe the technical management of water conservation, but little is mentioned on their failures.

In Bugesera district, rainwater harvestings were introduced to improve living conditions by insuring food security.

This case study is analyzing the knowledge gaps in addressing the challenges related to building resilience to drought with focus on water management and other capitals. The challenges to overcome in order to increase resilience to drought with consideration to multi-level actions are highlighted.

Integrated Watershed Management Approaches that promote Community-based Soil and Water Conservation technologies and practices have proven to be successful in cases whereby conducive water institutional framework and arrangement had taken into consideration local needs and capitals. Below are key ways to consider

1. Prior to any intervention aiming to address the local water and soil issues, governments and development organisations should, in a participatory way, assess the existing local communities' defined needs and wants that could result into local initiatives for building capacity in catchment management and storage infrastructure.
2. Promoting women's active involvement in participatory community forums about improved water management priorities and local development.
3. Running applied trainings for women and men in targeted communities on methods for maintaining soil moisture in agriculture, grazing and fodder management and on techniques for regenerating vegetative cover to protect water sources.
4. Local governments, Development Organisations and local communities have to better coordinate integrated watershed management programs, increase local knowledge about good practices and implement activities to boost the resilience of watershed.

Community-based soil and water conservation should therefore be promoted by all stakeholders and its implementation should follow the multi-level governance approach.

Key words: *Climate adaptation, vulnerability, resilience, drought, risks, rural communities, agricultural water management, livelihood security*

11. Groundwater in the Nile Basin and its connection to the Nile River, Seifu Kebede, School of Earth Sciences, Addis Ababa University

Dr Seifu Kebede is a hydrogeologist and authors more than 35 peer reviewed scientific articles and a book entitled 'Groundwater in Ethiopia: features, numbers and opportunities'. He is involved in research related to the multifaceted dimensions of groundwater (rural water supply, groundwater irrigation, groundwater and health, isotope and geochemistry application for water resources mapping, household water economy and groundwater role). Currently and recently he is involved in the following groundwater projects: Climate Risk Screening for Rural Water Supply in Rural Ethiopia (ODI-DFI project); A technical assistant study on Groundwater Development and Management for Ethiopia (World Bank); Capacity building for drought mitigation (UNESCO-Addis Ababa); UPGro's Hidden Crisis research consortium; Developing Adaptive Water Resources Management Strategy for Ethiopia (SCIP-DFID funded); REACH: Improving water security for the poor (DFID funded Oxford University led project). He has been involved in international expert missions (eg Kenya, Sierra Leone, Morocco, Tunisa, Lesotho, Malawi, Uganda), such as for the International Atomic Energy Agency mainly related to isotope hydrology and project management in groundwater sector.

Abstract

Previous authoritative summaries of the Nile hydrology (Shahin 1985; Sutcliffe and Parks 1999) and subsequent studies either neglect the role of groundwater in the Nile hydrologic system or cover the groundwater aspect in limited sub basins of the Nile Basin (Allan 2009). This is partly because of lack of data and/or because of the assumption that groundwater is insignificant in the overall Nile basin water balance. In discussions regarding equitable sharing of the Nile basin water resources among the basin states (Ethiopia, Sudan, Egypt, Uganda, Tanzania, Kenya, Rwanda, Brundi, DR Congo, South Sudan,Eritrea), groundwater is rarely brought into the equation. However interest around consideration of groundwater in the Nile basin resources (Bonsor et al. 2010; IAEA 2010; Zeitoun et al. 2010; Fragaszy and Closas 2015) and in river basins elsewhere (Taylor 2009) is increasing. Three phenomenon calls attention to the increasing importance in considering groundwater resources in the Nile hydrology discussions. First, the role of groundwater in basin water resources may not be negligible as previously thought; second, the groundwater-surface water interaction is gaining attention recently not only from water resources perspective but also in terms of exchange of heat and solute between groundwater and surface waters and thereby affecting the aquatic biology; and third, groundwater has become one of the strategic resources of economic growth and development as well as adapting to impacts of climate change in Africa (Moench et al. 2003; MacAlister et al. 2010).

Since 1990's, the private sector initiative in Egypt has has utilized groundwater to produce high value crops for export to Europe and the Middle East (Allan 2009). With congestion and land scarcity in the Nile valley and the Nile Delta, Egypt strategizes to reclaim new arid land, including the New Valley-Toshka based on groundwater supply and out-of-basin water transfers (Appelgren et al. 2000). In Sudan groundwater based irrigation is expanding and currently estimated at 60,000 ha (MacAlister et al. 2010) and the potential for groundwater irrigation stands at nearly 1.4 million ha. Given high groundwater storage there is huge prospect for expanding groundwater based irrigation in Sudan (Omer 2002). Ethiopia is pushing for bringing about major increase in groundwater based household irrigation (Van Steenbergen et al. 2015). There is a push to develop as much as 2 million ha of land from groundwater abstraction (Van Steenbergen et al. 2015). Groundwater is the main source of drinking water in the Nile Basin countries (Masiyandima and Giordano 2007). Market forces are also leading to farmers initiated rapid groundwater development elsewhere in the Nile basin countries (Van Steenbergen et al. 2015). The intensification in groundwater use and the uncertainties around future impacts of CO_2 induced climate change (Conway and Hulme, 1996) on the amount and direction of change in the flow of the Nile River show there is an urgent need to characterize the groundwater resources of the basin.

Albeit fossil nature, with little connection to the present day recharge (Edmunds et al. 1992; Shohaib et al. 1990; Abdalla 2008; Sultan et al. 2011), the downstream region of the Nile contains one of the most prolific aquifers in the world. The storage in one of the aquifers (the Nubian sandstone) alone is estimated to host a groundwater flow volume commensurate to hundreds of years of flow of the Nile (Thorweihe and Heinl 2002; Thorweihe 1990). In the upper riparian countries (equatorial regions and the highlands in Ethiopia) substantial portion of the River flow comes from groundwater (Kebede 2012) making the groundwater an integral part of the surface water flows.

The infrastructure development has been shown to impact surface water groundwater interaction in Egypt, and the planned additional development (eg. the Grand Ethiopian Renaissance Dam and others) may further perturb these hydrologic exchanges in the vicinity and downstream of the structures. This may be small in terms of the volume of flux. Nevertheless surface water-groundwater interaction is already demonstrated to have impact on the aquatic biota in the Nile (Van Noordwijk 1984). Another effect of the perturbation of the surface water - groundwater interaction in relation to hydraulic infrastructure development is water salinization. For example, with the cessation of the cyclic behavior of groundwater following the construction of the Aswan High Dam (levels rose after a flood wave and gradually sunk afterwards) and the increasing cropping intensities and perennial irrigation, more water seepage occurs that eventually caused a rise in the water table and increased salinity. This has been exacerbated by a lack of effective drainage in some areas of the Nile valley and delta (El Shabrawy 2009). On the other hand the dam has also changed the nutrient and solute load of the water downstream of the dam (Balba 1979).

In view of ongoing and planned accelerated hydraulic infrastructure development in the Nile basin and the anticipated changes in the flow regime and associated changes in water quality, it is imperative to understand the current state of groundwater- surface water interaction in the basin. For example Fragaszy and Closas (2015) argue that at the basin level, interactions of surface water and groundwater represent an additional challenge when it comes to envisaging a new covenant for the allocation and sharing of Nile waters amongst its riparian users.

Considering the lack of data, it is a huge task to give a comprehensive review of the groundwater occurrences, flow, recharge, quality and use at the basin scale. The objective of this paper is to present one aspect of the groundwater resources of the Nile, specifically the surface water-groundwater interaction from the head waters to the Nile delta region. Unlike previous studies which focus on surface water–groundwater interaction regime in specific sectors of the Nile or in specific countries this work attempts to provide a comprehensive review of the regime from the head waters to the Nile delta. Piezometric and isotope hydrology evidences are the tools utilized for characterizing these interactions.

This paper largely reflects the publication made in Journal of Hydrogeology (2016), Seifu Kebede as corresponding author and Osman Abdela, Ahmed Seifalnaser, and Osman Obori as co-authors.

Session Series II: Sustaining the water ecosystems of the Nile Basin (ECO)

12. Impact of soil depth and topography of watersheds on the effectiveness of conservation practices in the Ethiopian highlands;

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Adugnaw Tadesse, Ph.D. Candidate at Bahir Dar University in the institutes of Technology.I have MSC in the field of engineering hydrology/ water resources engineering. I have 10 years of working experience in the area of Water supply and irrigation projects in construction and design of different civil works and research as a fulfill meet of my PhD and MSC study in the fieldof modeling rainfall runoff using SWAT, analysis the groundwater quality, effect of soil and water conservation on sediment budget and runoff response. All the ten years working experience related to water resources development and management with the focus of design and construction supervision of water supply and irrigation projects in the rural areas of Ethiopia. Trained a number of government staffs on water resources management. Conducted odeling and exterminate analysis of watershed hydrology. I have proven experience in the implementation Water supply projects funded by USAID, EU and private donors in the position of infrastructure development team leader and working as a design engineer in Amhara design and supervision works enterprise in the field of irrigation. implemented research projects on watershed hydrology through the fund support of L.Normal Borlaug foundation and higher education for development.

Abstract:

Restoration of degraded landscapes through the implementation of soil and water conservation practices is considered a viable option to increase agricultural production by enhancing ecosystem. However, in the humid Ethiopian highlands, little information is available on the impact of conservation practices despite wide scale implementation. The objective of this research was to document the effect of conservation practices on discharge and sediment concentration and load in watersheds that have different soil depth and topography. Precipitation, discharge and sediment concentration were measured from 2010 to 2012 in two watersheds in close proximity and located in the Lake Tana basin, Ethiopia: Tikur-Wuha and Guale watersheds. The Tikur-Wuha watershed has deep soils and a 5% sloping stream channel. The Guale watershed has shallow soils and a stream channel slope of 11%. In early 2011, the local community installed upland conservation measures consisting of stone and soil bunds, waterways, cutoff drains, infiltration furrows, gully rehabilitation and enclosures. The results show that conservation practices marginally decreases direct runoff in both watersheds and increased base flow in the Tikur-Wuha watershed. Average sediment concentration decreased by 81% in Tikur-Wuha and 45% in Guale. The practices intended to increase infiltration were most effective in the Tikur-Wuha watershed because the deep soil could store the infiltrated water and release for a longer time after the rainy season than the Guale watershed because of the smaller gradient.

Keywords: East Africa; Blue Nile; Lake Tana; runoff; discharge; sediment; erosion; soil depth; soil and water conservation; gully.

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13. Assessing the impact of land use and land cover change on streamflow response: case study of Dinder and Rahad, Ethiopia/Sudan

, Khalid Hassaballah 1, 2, Yasir Mohamed, 3, Stefan Uhlenbrook , 4, Khalid Biro

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Abstract

Keywords: land use land cover, hydrological modelling, streamflow response, WFlow model, Dinder Rahad

1 Background

The Dinder and Rahad basins (DRB) generate around 7% of the Blue Nile basin's annual flow. The Rahad River supplies water to the Rahad Irrigation Scheme (100,000 ha), while the Dinder River supplies water to the diverse ecosystem of the Dinder National Park (DNP). The DNP (10,291 km2) is a vital ecological area in the arid and semi-arid Sudan-Saharan region. The Dinder and Rahad Rivers has experienced significant changes in floodplain hydrology during recent years, claimed to be caused by land use and land cover changes (LULCC) in the upstream catchment that modified the streamflow response. The floodplain hydrology defines the seasonal wetlands (Mayas) which are the only source of water in the DNP during the dry season (8 months). The hydrology of the Mayas has large implications on the ecosystem of the DNP. Understanding the LULCC and its implication on the hydrology of the DRB approximately 77,504 km2is vital for the decision-making process for better management and utilization of water resources in the basins. Although there are many studies on LULCC in the Blue Nile basin, specific studies on LULCC in the DRB are still missing. Hence, its impact on streamflow is unknown. The

objective of this paper is to understand the LULCC in the DRB and its implications on streamflow response using satellite data and hydrological modelling.

2 Data and Methods

2.1 LULC classification:

Multi-temporal Landsat data for the years 1972, 1986, 1998 and 2011 were obtained free of charge from the internet site of the United States Geological Survey (USGS) (source: http://glovis.usgs.gov/). The classification results of the historical images were validated through visual interpretation of the unclassified satellite images and supported by in-depth interview of local elders. The classification of the 2011 image was validated by ground survey during a field visits throughout the study area during the period between 2011 and 2013 assuming no significant change during this period. A Global Positioning System (GPS) device was used to obtain exact location point data for each LULC class included in the classification scheme and for the creation of training sites and for signature generations as well. A supervised Maximum Likelihood Classification (MLC) technique was independently employed to the individual images. The accuracy assessment of the classified images was based on the visual interpretation of the unclassified satellite images.

However, the visual interpretation was conducted by an independent analyst not involved in the classification. Multi-date Post-Classification Comparison (PCC) change detection method described by Yuan et al. (2005) was used to determine the LULCC in three intervals: 1972–1986, 1986–1998 and 1998–2011.

2.2 Satellite-based rainfall estimates (SBRE)

In this study, three open-access satellite-based rainfall estimates (SBRE) products were compared based on their runoff performance. The best product was then used to run the WFlow model using different LULC maps. The SBRE and the evapotranspiration products used are: Rainfall Estimates (RFE 2.0), potential evapotranspiration (PET), Tropical Rainfall Measuring Mission (TRMM) and Climate Hazards Group InfraRed Precipitation with Stations (CHIRPS).

2.3 WFlow hydrological Model

The WFlow distributed hydrological model (Schellekens, 2011) is used to simulate the processes. The WFlow is a state-of-the-art open source distributed catchment model. The model is part of the Deltares OpenStreams project (http://www.openstreams.nl). Understanding the level to which the streamflow has altered is critical for developing an effective management plan for ecosystem restoration and conservation.

Thus, the Indicators of Hydrological Alteration (IHA) approach proposed by Richter et al. (1996), was then applied to analyze the streamflow characteristics are likely to affect the ecological processes in the DRB including: flow magnitude, timing, and rate of change of flow. The hydrological model has been derived by different sets of LULC maps from 1972, 1986, 1998 and 2011. Catchment topography, land cover and soil maps, are derived from satellite images and serve to estimate model parameters.

2.4 Indicators of hydrologic alterations (IHA)

The IHA approach used to assess river ecosystem management objectives defined based on a statistical representation of the most ecologically relevant hydrologic indicators. These indicators describe the essential characteristics of a river flow that have ecological implications. A detailed description of IHA can be found in (Richter et al., 1996 and Poff et al., 1997).

3 Key findings

Results of LULCC detection between 1972 and 2011 indicate a significant decrease of woodland and an increase of cropland. Woodland decreased from 42% to 14% and from 35% to 14% for Dinder and Rahad respectively. Cropland increased from 14% to 47% and from 18% to 68% in Dinder and Rahad respectively.

The model results indicate that streamflow is affected by LULCC in both the Dinder and the Rahad Rivers. The effect of LULCC on streamflow is significant during 1986 and 2011 particularly in Rahad River. This could be attributed to the severe drought during mid 1980s and the recent large expansion in cropland in the Rahad catchment to 68% of the total area.

4 Conclusion and recommendation

For assessing the changes in land cover, four remote sensing images were used for the years 1972, 1986, 1998 and 2011. The accuracy assessment with supervised land cover classification shows that the classification results are reliable. The land cover changes in the DRB are assessed by image comparison and the results showed that the dominant process is the relatively large decrease of woodland and the large increase of cropland. Results of LULCC detection between 1972 and 2011 indicate a significant decrease of woodland and an increase of cropland. Woodland decreased from 42% to 14% and from 35% to 14% for Dinder and Rahad respectively. Cropland increased from 14% to 47% and from 18% to 68% in Dinder and Rahad respectively. The rate of deforestation is high during the period 1972-1986 and probably is due to the severe drought during 1984/1985, expansion in agricultural activities and increased demand for wood for fuel, construction and other human needs due to the increase in population. On the other hand, increasing in woodland during the period between 1986 and 1998 is probably due to reforestation activities in the basin.

Nevertheless, the magnitude of deforestation is still much larger than the reforestation. The cropland expansion over the period 1986 to 1998 is larger than the expansion over the period 1998 to 2011, suggests that most of the areas that are suitable for cultivation have most likely been occupied, or the land tenure regulations have controlled the expansion of cultivation by local communities.

The IHA analysis indicated that the flow of the Dinder and the Rahad Rivers was associated with significant upward and downward alterations in magnitude, timing and rate of change of river flows, as a result of LULCC. These alterations in the streamflow characteristics are likely to have significant effects on a range of species that depend on the seasonal patterns of flow. Therefore, alterations in the magnitude of the annual floods that decrease the water flowing to the Mayas wetlands may reduce the production of native river floodplain fauna and flora, and migration of animals that may be connected to Mayas inundation. In absence of ecological data, we assessed the impact of LULCC on hydrology, further study for assessing the impact of hydrological alterations on ecological processes is recommended.

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14. Livelihood Contribution of landscape restoration; ecosystem services valuation from the Upper Blue Nile

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MSc in Environmental Sciences with over 10 years' professional experience as a researcher, coordinator, and advisor of projects/programmes on environmental governance and economics, ecosystem based Disaster Risk Reduction, biodiversity conservation and climate change;

Researched and advised on several environmental themes and communicated results through refereed journals, proceedings, reports and presentations on several International events;

I have certified consultant proficiency in in conducting Environmental Impact Assessment (EIA) Forest related assessments, Land Use Management, and Climate Change Studies

Abstract

Nile Basin countries governments and their partner Non-Governmental Organizations had long started committing billions of dollars every year to the ecosystem restoration of degraded landscapes. Despite this hefty capital investment, success in terms of adoption, scale up and

sustainable management of restored ecosystems has been limited. This is thought to be due to the poor understanding of stakeholders about the potential benefits of restoring landscapes. As of recently, several stakeholders viewed restoration as an expense with few tangible economic benefits. Often this is because of erroneous accounting practices and a conventional cost-benefit analysis which exclude the socio-ecological benefits. This is also true in academic literature, where the economic and socio ecological benefits of restoring landscapes, has only recently begun on the science and practice of landscape restoration. This means that landscape restoration efforts in the Nile Basin Countries and specifically in Ethiopia have not been adequately justified in terms of their true economic, social and ecological benefits. This study, therefore, quantified the economic contribution of restoring a degraded landscape to dependent community livelihoods. The study also evaluated how the restoration's social aspect further ensured the sustainability of the ecological and livelihood benefits. However, it should be noted here that the study's economic quantification is based to some extent on assumptions and estimates than precise figures which are currently unattainable to approximate. Moreover, the ecosystems services valuation is conducted only on some of the provisioning (trees for fuel wood and construction, grass for fodder), regulating (sequestered carbon payment), and supporting (soil fertility nutrients) ecosystem services; because of the many difficulties in valuing all ecosystem goods and services.

This case study is conducted in one of the Upper Blue Nile catchment watersheds, where a program by the Ethiopian government and its development partner the German Development Cooperation restored communally owned landscape patches. These restored landscape patches have an area of 133ha and are owned by a community of 2,300 dependent households. These community households are mostly agrarian with family number of 5 and 2.9% annual population growth rate on an average 1.4ha land holding size and average per capita income of USD 335. The program also organized this community into legal watershed organizations with effective legal bylaws and statutes for sustainable use and management of the restored landscape ecosystem services. Since then, these households have been benefiting from the provisioning ecosystem services delivered by the restored landscape, while also protecting and managing the restored landscape through their legal watershed organization.

This case study quantified the net benefit of restoring a degraded landscape; by comparing the cost of restoration inputs; with the monetary benefits generated from valuing the restored landscape ecosystem services. Moreover, this net benefit is projected temporally and spatially, estimating the maximum net benefit that can be generated from scaling up this restoration effort to agro-ecologically comparable large-scale landscapes. The study further assessed how the organisational setup of the dependent community ensured continuity of the net livelihood and ecosystem service benefits. Data were obtained from primary as well as secondary sources. The primary data was obtained through a biophysical assessment of the restored landscape's outputs (trees, soil and grass). While secondary data (on the use and price of outputs, temporal and spatial outputs) was obtained from the literature, program implementers and community. In analysing the primary data different ecological models were used in estimating volume, biomass and carbon sequestration from the restored landscape. While secondary data was analysed by estimating the restoration cost, the monetary value of the restoration outputs and the net benefit estimated using simple econometric cost-benefit models.

The study findings indicated that in restoring this degraded landscape, implementers including community have spent a cost of USD 1,006,950 considering all costs from inception to phase out of the program. While this restored landscape accumulated a net monetary benefit of USD 364,320 yr^{-1} in just four years after the restoration program. This means each dependent household shared a

restoration output that amounts to USD158 yr^{-1} from the restored landscape's provisioning ecosystem services. The maximum net monetary benefit estimated to be obtained from valuing the restored landscape's maximum projected ecosystem services yield will be about, USD 2,369,360^{-yr}. This maximum ecosystem services yield will at the same time increase the households share to USD 1,030^{-yr}. Since the Upper Blue Nile eco-region has about 338,600 ha of agro-ecologically comparable degraded landscapes, which harbours about 132,069 households depending on its resource. Restoring this large scale degraded landscape will cost about USD 3 Billion and its ecosystem services can produce a maximum net economic benefit of about USD 1 Billion^{-yr}. This means, dependent households can increase their income to USD 7,600^{-yr} by sustainably harvesting the ecosystem services produced by the large-scale restored landscape. If this is further projected to the Nile basin countries, area in the basin, there will be about 4 million hectares of the degraded landscape in agro-ecologically comparable environment, which supports about a million households. This means that the effective restoration and sustainable management of this landscape will provide the households with about USD 12,000^{-yr}.

The case study results suggest that instead of initiating small-scale restoration initiatives, as in the past; economically viable large-scale landscape restoration initiatives are better, especially when patchy large-scale communal land holdings are widely available. The livelihood net benefit anticipated to be attained from the large-scale restoration is significant enough to motivate dependent community, their governments, or financial intermediaries (banks, microfinance institutions, governments, etc) investment; providing a potential indemnity to extend credit to restoration activities. Moreover, this large-scale livelihood net benefit, if realized, surpasses what the Nile Basin Countries governments planned to achieve as their 2030 GDP of the Sustainable Development Goal. This rationalizes why governments should focus on restoration and its sustainable protection and management. This restoration contribution is fail safe because the program organised dependent households into legal organisations with recognized protection, management and utilisation rules and regulations. This legal infrastructure, its institutional framework and the process of mandating legitimate beneficiaries by involving them fosters ownership, responsibility and accountability which should lead to sustainable livelihood benefit. However, in maximising the realisation of this benefit, it will require thorough research for the development of markets for different bio-geographic zones. While at the same time, the possibilities of linking these services to international protocols in the conservation of natural resources, global warming, and world trade have to be explored. Moreover, such economic return can be sustained if restoration efforts are complemented with evolving appropriate working plan prescriptions.

Key words: ecosystem services valuation restoration, livelihood, degraded landscape, Upper Blue Nile Basin

15. Catchment restoration for a sustainable renewable energy production in Upper Nyabarongo Catchment, Rwanda, Francois Tetero

Abstract

Rwanda is subdivided into two main river basins(Nile and Congo) and nine level one catchments of which Upper Nyabarongo is part of, and being the most upstream in the Nile basin part. The catchment has an area of 3, 348 km² and is entirely located in Rwanda starting from the Nyungwe National park.

The Nyabarongo River is the main tributary of the AkageraRiver. However, the Upper Nyabarongo catchment ends at the confluence with Nyabarongo river with its major tributary, Mukungwa river.

Its other key tributaries located in the Upper Nyabarongo catchment are Mwogo(81.1 Km), Rukarara(47.4 Km), Mbirurume(51.6 Km) and Satinsyi(59.7 Km).

Over the last 60 years, the water quality of Nyabarongo river and its tributaries has significantly been altered mainly due to poor agriculture practices, poor mining practices, deforestation mainly for firewood, and this in addition to the natural landscape of the catchment characterized with very high slopes. This resulted in a progressive high siltation of the river making it very difficult to be used for various purposes.

On the other side, a part of being the water tower of Rwanda, the catchment is highly potential for hydropower development and currently accommodates various hydropower reservoirs with a total production capacity of around 50 MW. Nevertheless, the progressive accumulation of sediments in the river and ultimately in the hydropower reservoirs has been a serious threat to the sustainability of the hydro-energy production.

In order to reverse the trend, the Ministry of Environment has initiated a comprehensive program to restore the catchment so as to be able to provide its full potential functions and services. The program included many elements among which:

(i) A sediment fingerprinting exercise; this being a technology helping to identify the sources of sediments in a particular catchment. The technology involves the collection of samples representing a range of possible sources of sediments (source samples) as well as receiving water samples (downstream samples) and this followed by a laboratory analysis and a statistical analysis. The exercise was supported by USAID.

(ii) Development of a restoration plan of the catchment with a combination of various land husbandry techniques based on the land use, land cover and land characteristics. The development of the plan involved a wide stakeholder's consultation within the catchment.

(iii) Implementation of the catchment restoration measures as proposed in the restoration plan and the priority intervention areas being those identified under the sediment fingerprinting exercise as the most contributing to the sedimentation of the river. The implementation is being done through various projects funded by FONERWA and a program funded by the Kingdom of Netherlands.The total catchment area that needs to be restored is around 220km² (about 6.5 % of the total catchment area).The involvement of the community in catchment restoration will be also strengthened through introduction of Payment for Ecosystems services in which the Private sector mainly mining operators will play a significant role.

The restoration of the catchment is expected to be beneficial not only for hydro-development within the catchment but also, being the country's water tower, for securing water of adequate quality for downstream uses mainly drinking water for the City of Kigali which is currently relying by almost 80 % to Nyabarongo river.

16. Supporting Sustainable Management of the Mara Wetlands in the Mara River Basin

Mr. Emmanuel Mgimwa

My name is Emmanuel Fidelis Mgimwa and I'm currently working for BirdLife International Africa Partnership Secretariat as a Project Manager for the Lake Natron Eco-tourism project in the Lake Natron, Arusha Tanzania. I have a Bsc. in Wildlife Science and Conservation from the University of Dar es Salaam and I'm currently studying Msc. in Wildlife Ecology at the University of Dar es Salaam, Tanzania.

I have 4 years of working experience specializing on project implementation, management and scientific research with extensive experience on freshwater ecosystems and tropical forests of the Eastern Arc Mountains where I worked for 2 years as researcher.

From August 2016 to August 2017 I was supporting implementation of the project for promoting sustainable management of the Mara wetlands funded by the USAID-PREPARED to BirdLife International. The project has supported Mara wetlands stakeholders in drafting and validating the Mara Wetlands Integrated Management Plan (IMP).

Abstract

Keywords;
Mara Wetlands, Mara River Basin, Nile River Basin, Integrated Management Plan

A short background
The Mara Wetlands is an important watershed of the Mara River Basin (MRB) on the Tanzanian side. The Mara River Basin originates from Mau forest in Kenya and pour its water on the Lake Victoria, Tanzania which is an important source of water of the Nile River and therefore, the Mara River Basin is an important basin to the Nile River Basin.

A growing population in the Mara River Basin (MRB) and with it an increasing demand of natural resources has led to expansive riverine cultivation, upstream deforestation and incompatible land use, resulting in increased water runoff, soil erosion and sediment loads that have altered the seasonal flow of water resulting in extreme incidences of droughts and floods within the lower basin and the wetlands. Increasing human population has also resulted in increased livestock and farming activities conducted on the Mara River and wetland, papyrus clearance for handcrafts which are threatening the integrity of biodiversity and natural resources within the Mara wetland and diminishes its ability to sustain the ecosystem services and functions (Mayo, Muraza, & Norbert,

2013)[1]. Over-dependence of the local communities on the MRB and wetlands resources in support their basic needs threaten the River Basin and wetland sustainability.

BirdLife International received a simplified grant award to implement a project on promoting the sustainable management of the Mara Wetlands in Tanzania from Planning for Resilience through Policy Adaptation, Research and Economic Development (PREPARED) Project. The project is addressing the issues of increasing demand of natural resources that has led to expansive riverine cultivation, upstream deforestation and incompatible land use, resulting in increased water runoff, soil erosion and sediment loads that have altered the seasonal flow of water resulting in extreme incidences of droughts and floods within the lower basin. The goal of the project is to conserve and protect the Mara Wetlands Biologically Significant Area (BSA) in Tanzania by strengthening the governance of institutions for sustainable transboundary wetland management and increasing the awareness of the value of the Mara Wetlands and promoting sustainable alternative livelihood approaches. The main outputs of the project are Integrated Management Plan (IMP), Communication Plan and Community Action Plans.

Methodology and approach

Intensive engagement and consultations of the key Mara Wetlands stakeholders corroborated with wetland inventory and mapping by UNESCO-IHE-project partners. The key stakeholders include; local communities in the North and South of the Mara River and Wetlands, North and South Mara Water Users Association (WUA), Village government councils, Ward government Councils, Tarime and Rorya District government Councils, Mara Regional Secretariat, key ministries i.e. Ministry of Natural Resources and Tourism, Ministry of Water and Irrigation, Ministry of Health, Community Development, Gender, Seniors and Children, Ministry of State in the Vice President's Office Union Affairs and Environment. Moreover, we engaged the Lake Victoria Basin Water Board (LVBWB), National Land Use Planning Commission (NLUPC) as well as key local and national non-governmental organizations. We used Participatory Rural Appraisal (PRA) and Focused Group Discussion in consultations and meetings with the local communities and (WUA)

The development of the Integrated Management Plan (IMP) is being led by the Institute of Water Resources, Delft – UNESCO-IHE and fed by information from local communities and institutions collated by BirdLife on the ground and by receiving information, technical and legal advice from the Interagency Technical Committee (IATC) for the development of the Mara Wetlands which was developed on the project commencement with recommendations from the National stakeholders and with composition from key National, Regional and local representatives and the chair of the committee is the National Environment Management Council (NEMC). The IATC members include; National Land Use Planning Commission (NLUPC), Lake Victoria Basin Water Board (LVBWB), Mara Regional Administrative Secretary (RAS) office, Tarime, Rorya and Butiama District Councils, Nile Basin Initiative - The Nile Equatorial Lakes Subsidiary Action (NELSAP) Program, Mara Regional Lands Office, World Wildlife Fund for Nature (WWF) and local community representatives.

Key findings

The major threats and challenges of the Mara Wetlands developed after consultation with local communities in PRA, meetings, field visits, wetland inventory and mapping include; poor capacity of the local conservation groups i.e. WUA and of the village council government in the conservation and management of the Mara River and wetland resources. Increase in the number of livestock and on the farming activities near the wetland which increase the rate of soil erosion and thus sedimentation in the wetlands which is the important root for wetland expansion and flooding. Unsustainable mining activities upstream (Nyamongo area) is compromising with water quality downstream affecting livestock and human health and their socio-economy. Limited government budget allocation for the conservation and management of the MRB and wetlands as well as poor flow of information and communication between WUA and Village council leaders was also

[1] Mayo, A. W., Muraza, M., & Norbert, J. (2013). The Role of Mara River Basin Wetland in Reduction of Nitrogen Load to Lake Victoria. International Journal for Water Resources and Environmental Engineering, 659-669.

mentioned as the major drawback to effective conservation of the Mara Wetlands. Together with the above, proliferation of invasive species (water hyacinth), poverty resulting into intensive charcoal burning, unsustainable fishing and climate change threaten the MRB and Wetlands sustainability.

The main output of this project is an Integrated Management Plan (IMP) for Mara Wetlands which will incorporate information on the challenges/threats, opportunities, proposed interventions/actions as well as resources needed. Moreover, the project has developed North Mara Community Action Plan. This Action Plan will be implemented back to back with the IMP. Communication Plan for the Mara Wetlands has also been developed. We have also conducted Institutional Capacity Assessment for the key stakeholders responsible for management and conservation of the Mara Wetland as well as Ecosystem Services Valuation training to the key civil societies, government institutions and to decision and policy makers.

Conclusions and recommendation.
The Mara River Basin and Wetlands plays critical role in supporting wildlife and communities as well as contributing to water into the Nile River Basin. Together with other threats and challenges, the basin now also faces threats from development projects. There is an increase on the number of proposed development initiatives on the lower MRB especially wetlands which could increase the pressure as well as degradation of the ecosystems and increase conflicts amongst water users.

Communities, stakeholders and government institutions has shown positive commitment in wetland and basin conservation and they showed good support in the IMP development and promised the same in the implementation of the Plan. With that there is an important need to start securing for funds and resources to enable the implementation of the activities and actions proposed in the IMP. The IMP will also improve multi-sectoral coordination of stakeholders at the National level in the management of the MRB and wetlands.

17. Community Conservation Agreements Model for Sustainable Management of Winam Gulf Wetlands, Lake Victoria, Kenya

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Roniance holds a BSc in Wildlife Enterprise and Management from Egerton University, Kenya and postgraduate professional certificate course in Wetlands, Integrated Water resource Management and Food Security from Wageningen Centre for Development Innovation, Wageningen University, Netherlands. She is the current Environment Officer at Ecofinder Kenya. Roniance has over 5 years' working experience undertaking research and conservation work on the Lake Victoria Winam Gulf Wetlands Resilience Project which aims to enable rural riparian communities to conserve and benefit from wetlands in the Winam Gulf of Lake Victoria, Kenya; Coordinating Kenya Lake Victoria Waterkeeper's portfolio that works with numerous stakeholders in fighting and advocating for clean water and mobilizes grass root conservation corps as wetland Keepers for wetlands zonation and restoration. Additionally involved in wetlands sustainability research and interventions such Wetlands valuation, Local Community Climate Change Adaptation Action Planning, Conservation Agriculture for Climate Change Resilience, Conservation Agreements Design and Implementation, Developing Ecotourism Ventures and enabling off-grid renewable energy technologies to ensure wise use of natural resources and sustainable development.

Abstract

Key Words

Wetlands, Sustainability, Conservation Agreements, Incentives, Restoration, Moni toring, Enforcement, Community.

Background Information

Lake Victoria is the largest Lake in the Nile Basin, mainly bordering Kenya Uganda and Tanzania. Along the Lake Victoria region of Kenya, there occurs the Winam Gulf Wetlands which have all been designated as Important Bird Areas by Bird Life International and they are Dunga Wetland IBA KE037, Yala Wetland Complex IBA KE041, Kusa Wetland KE039 and Koguta Wetland KE038. These wetlands are ecologically important for their buffering effects, water purification and flood c ontrol. They are also endowed with a rich biodiversity of flora and fauna including both the East African endemic bird species and a variety of migrants like the Palearctic Great Snipes. They also provide different forms of ecosystem goods and services like wood fuel, fisheries products, traditional medicine, construction materials like sand and ballast. In addition, the Winam Gulf Wetlands also have attached cultural and economic values from both consumptive utilizatio n of the goods and nonconsumptive utilization in the forms of recreation and ecotourism.

A greater population of the wetland communities depend wholly on these wetlands for their livelihoods and while this is not wrong, the continued indiscriminate harvesting and unsustainable utilization has contributed to the current degraded state of the wetlands. The pressures of poverty, over population, inadequate education and awareness, ignorance, unappreciation and climatic conditions have also had massive negative impacts on the wetlands. Hence the resultant challenges facing the wetlands like encroachment for settlement and farming, overgrazing and papyrus over harvesting leading to loss of the wetlands' biodiversity; Pollution from both agricultural and industrial discharge; Clearing of the wetlands through burning for large scale commercial farming and as a means of poaching and hunting of wild game; Introduction of alien and invasive species; Lack of political good will and poor governance of the wetland despite there being a wildlife reserve in Yala and the swamps being designated as Important Bird Area by Bird Life International. These challenges have resulted into the continued loss of up to 50% of the wetlands over the last decade. Fish stock in the Lake has greatly decreased and the level of eutrophication in the lake is also high affecting the associated lake biodiversity. The commercialization of the wetlands by farming corporations is restricting environmental flow and the poor coordination among relevant government bodies and stakeholders only works to worsen the state of the wetlands over time. This situation necessitated the need for strong and feasible actions to be taken in an effort to save the Winam Gulf Wetlands.

Methodology and Approach

Our approach was therefore anchored on incentive based models of conservation for interventions. We conducted Participatory Wetlands Assessments involving citizen science, tapping into traditional knowledge and scientific studies to generate enough information for the development of feasible change making solutions. We then mobilized local community members and

conducted education and awareness programs on Nature Based Enterprises, environmental monitoring, surveillance and advocacy and Environmental and Economic Sustainability Concepts in an effort to capitalize on the value of the wetlands while instilling respect for them and the associated resources to the locals in order to promote their wise use, protection and conservation. Lastly we launched a Model Farmer and Wetland Keepers programme using a set of well-defined selection criteria to recruit the most conservation enthusiastic locals and train them on community conservation, alternative livelihoods innovation, wetlands advocacy, monitoring and surveillance for the pur pose of promoting sustainable management and improving the value of the Winam Gulf Wetlands to perpetuity.

Key Findings

The Wetlands Assessments surveys, uncovered the land use and land cover statistics for the wetlands, the current and past status of the wetlands and rate of degradation. We then used this information to deduce the best solutions for the wetlands to ensure their restoration and conservation. We recruited Model Farmers who are charged with the responsibility of promoting the adoption and use of green technologies among the wetland communities at the grass roots level. These green technologies include Ecological Sanitation toilets for compost manure production, hybrid feed biogas digesters for energy and organic manure production, efficient cook stoves and solar lamps. We also recruited Wetland Keepers who use their advocacy, monitoring and surveillance training in reaching out to their entire communities and stakeholders and advocating for action against the threats to the wetlands through the use of bulk instant messaging. This also led to the development of an adopt a wetland scheme whereby the wetland keepers adopt portions of the wetland and are responsible for their restoration through either active or passive regeneration and are offered Nature based products and services as incentives.

The Implementation of these model was made possible by the development of a Conservation Scheme Agreement targeting restoration, sustainability, protection and wise use of the wetlands. This was in the form of a contract between the Model Farmers and Ecofinder Kenya as the Implementing body in the presence of a neutral third party in the case Alternative livelihoods innovation and the Wetland keepers, Ecofinder Kenya and a neutral third party in the case of wetlands restoration and protection. These Conservation Agreement contracts details the roles and responsibilities of all the parties involved. This approach aims towards greening the livelihoods of local community members through giving the Model farmers and wetland keepers incentives in the form of pilots for the green technologies we promote, to help boost their morale in advocating for wise use, restoration, positive action orientation and sustainable management of the Winam Gulf Wetlands among both locals and the relevant stakeholders.

Contribution to Restoring E-Flows of the Wetlands and Lake Victoria

This project on sustainable Management of Winam Gulf wetlands has been ongoing for three years now and as such, this has allowed us to see some of the expected outcomes come to light in the four Winam Gulf Wetlands. In terms of water quality as an indicator for e-flow, we have observed an improvement in the turbidity of water passing through the restoration sites in the wetlands. We attribute this to the improved density of wetland vegetation which has enhanced the water purification service of the wetland. Using IBA monitoring Protocol we were able to measure the increased vegetation density and height, with respect to ambatch trees and Papyrus reeds.

This was done through transects and point sampling methods and through physical observation, identifying endemic plant and bird species. In addition to this, we also used voice call

for birds which were indications of restored habitats and the repopulation of birds to the sites they had previously abandoned due to habitat degradation.

We have also seen an improvement in the livelihoods of people who depend on the Lake and the wetlands and this has gone hand in hand with sustainable utilization of the wetland resources coupled with adhering to the regulations instituted by the communities in the Wetland Wise Use bylaws instigated by them. In discriminate harvesting of papyrus reeds has seized and there is practice of paddock harvesting which allows for regeneration of the reeds. There has been reduced cases of cutting down of ambatch trees in these wetlands. Ambatch trees and known breeding grounds for fish and their continued existence leads to better survival and hence restocking of fish in the Lake. The aspect of increased fish stock was assessed through catch assessments at specific fishing grounds which benefit from the restoration sites. Due to the efforts of the wetland keepers to reduce wetlands encroachment, there has been wetlands edge farming where the locals now benefit from the clean water from the wetlands as opposed to clearing of the wetlands for farming. Their animals also graze on the soft vegetation around these parts as opposed to trampling inside the wetlands. The protection and restoration of the habitats has contributed improving the health and integrity of these ecosystems. We believe that this trend will continue and in the future we test for and record an elaborate boost in the ecosystem services to the lake even better environmental flow in the wetlands and the Lake Victoria.

Conclusion

Encroachment and over utilization of the wetlands is a major contributor to their current states. The wetlands are however part of the communities they are in and they provide a base for livelihoods provision in those local villages. It is therefore paramount to find ways of striking a balance between economic and environmental sustainability as this will save our wetlands. Our approach is the restoration, conservation and sustainable management of the wetlands ecosystems and through these Incentive Based Solutions, we are confident in restoring the E-flow of the wetlands and the Lake which have since been blocked by all the anthropogenic factors.

Empowering community members to take charge of their wetlands and have formally recognized alternative livelihoods and monitoring and enforcement systems works to build the sustainability and re silience of the Nile basin’s water ways.

Recommendations

Promoting large scale community conservation initiatives through the use of conservation agreements as a means of encouraging win-win scenarios for both the natural environment and the local communities.

18. How Healthy is the Lake Victoria Ecosystems Goods and Services?: Gender-Ecosystem-Poverty linkage Perspective.

By Aloyce S. Hepelwa

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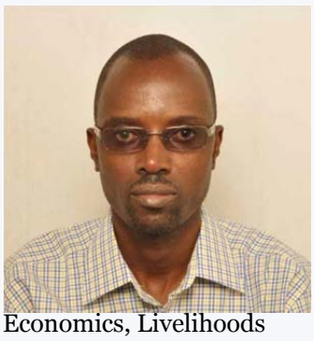

Dr. Aloyce Hepelwa is working with the the University of Dares Salaam as Senior lecturer and Head of the Department of Agricultural Economics and Business. Dr. Aloyce Hepelwa has 15 years of experience in sector of Economic Research and Consultancy. He is specialized in Environmental and Natural Resource Economics, Livelihoods and Welfare Development, Econometrics, Integrated Assessment of the Natural Resources and efficiency Use of Natural Resources and the Sustainability Indicators in the sprit of Sustainable Development. He has a BA(Statistics) degree from the University of Dar es Salaam,MA (Economic Policy Management) degree from Makerere University, Kampala. He is a holder of Regional Master Degree Courses in Environmental Economics and Policy from Center for Environmental Economics and Policy (CEEPA) at the University of Pretoria. He completed his PhD studies at Vrije Universiteit Brussel (VUB) in Belgium and researched"Environmental Resources Sustainability Indicators: An Integrated Assessment Model for Tanzania". The PhD research focused on the definition and analysis of quantitative indicators for sustainable use of water and forest resources in Tanzania.

Abstract

Water ecosystems provide vital functions and direct contribution to people. The functionality and sustainability of water ecosystems are contingent on conservation and human development plans in existence. Conservation investment planning for water resources is paramount for the sustainability of human development. However, to achieve the dual objectives of conservation and development pose a greater challenge and hence endangers the sustainability of most water resources. A study on how community adjacent to Lake Victoria depends on lake ecosystems goods and services was conducted. The purpose of this study was to argue the case for a new strategy for poverty eradication and sustainable natural resource management by using the local ecosystem – based income generation initiative. Specifically the study aimed to establish households dependence on the lake basin ecosystems goods and services; Investigate the contribution of ecosystem services on household livelihood outcomes such as crop productivity, rural income and food security; and to identify relevant investment opportunities to address directly the poverty and the over exploitation of environmental resources. In this study we undertook quantitative and qualitative data collection around the Lake zone. From the three regions (Mwanza, Mara and Kagera), a total of 8 administrative districts were purposively sampled, from which 42 villages were selected from each of the districts. On average 25 households were randomly selected for interview from each village and a total 1050 households were interviewed using a structured questionnaire. We also conducted the focus group discussions (FGDs) at the village level and with other community groups that benefit either directly or indirectly from the Lake Victoria ecosystem in order to validate the information collected from the household level.

Key study finding is that, the plight of rural households that depend on the natural resources for the livelihood in the Lake Victoria basin is characterized by both urgency and opportunity. Most of the ecosystems goods and services are on the decline and rural communities in the study areas

also experienced a variety of social and economic challenges, including widespread poverty. These create the conditions of increasing uncertainty, risk and insecurity across the rural landscape. In general, evidence indicates that the Lake Basin resources and other ecosystems are experiencing threats that are negatively impacting the socio-economic development and the natural resource base. Most of these resources are under increasing pressure and consequently are deteriorating due to over use.

This study identifies actual and potential local ecosystem based activities that can provide solutions to environmental and poverty problems in the Tanzania side of the Lake Victoria basin.

The activities identified include those related to the following resources: crop farming, Land, livestock, Forest, Beekeeping, wetlands, water bodies, fishery and minerals. The level of investment in agriculture is also small in terms of the purchase of inputs such as fertilizers, improved seeds and other farm implements such as tractors and plough. In the area, crop cultivation is dominated by the use of hand hoe. More than 85% households reported that hand hoe as the most means of cultivation used. About 27% use ox-plough and very few, 2% and 1% reported to use tractor and power tillers as the main means of land cultivation respectively. The evidence from the current survey is that out of 1051 surveyed households, only 1.4% reported to irrigate. The main constraint facing irrigation farming in the study area is the absence of the irrigation infrastructures and capital inadequacy. The lack of financial resources limits farmers to develop the necessary infrastructure that could support irrigation. It has been observed that few farmers that have tried to practice irrigation; they are able to get significant benefit in terms of bumper harvests. Fish catch has been declining both in size and quantity for the past two decades. This is believed to be due to overfishing and increasing use of illegal and destructive fishing gears. Majority households have shown that they are not aware and knowledgeable about fish farming.

The study would recommend the promotion of fish farming. Beekeeping provides opportunities to the people in Lake Region, however, there are unsatisfied market of honey and other related products both domestically and external market. With extensive forest cover in the regions like Mara and Kagera, is important that the culture of beekeeping is promoted. It is observed financing is a major constraint facing majority of the households. It is high time that financial institution and other microfinance units extend their loan schemes to the rural community. To curb deforestation and forest degradation is important that the culture of tree planting is promoted among the households. It is important that alternative energy sources, like solar, biogas, the use of energy saving stove, planting trees for charcoal are promoted.

Keywords: Water ecosystems; local ecosystem–based income generation initiative; Sustainability

19. Incentives Based Conservation Approach for Nile Basin Wetlands Wise-use by

Amos Thiongo

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Amos Thiongo oversees the implementation of incentive-based conservation agreements across Africa for Conservation International. Most of his work involves supporting communities living in high value or fragile ecosystems adopt ecologically friendly livelihood activities. He believes in mainstreaming rural enterprises development approaches in building environmental sustainability. Before joining CI, Amos worked with

various organizations facilitating producer organizations and agribusinesses attain the triple bottom-line of People, Profits and Planet. Amos holds a Masters of Arts (Rural Sociology) degree from University of Nairobi and is also a Certified Financial Accountant.

Abstract

Background

Incentive based conservation models have been evolving for over three decades now. Before the advent of incentive based approaches, many conservation efforts involved protecting important biodiversity areas and fragile ecosystems from human activities that posed a threat. Fences and other manner of barriers (including legislative barriers) were erected to ensure that human beings were kept off and the target areas remained protected. In extreme cases, communities were involuntarily relocated to other areas. This protective approach had mixed results. In certain cases, it led to very well protected islands of biodiversity/ecosystem services, but in many cases, it alienated communities.

Over time, there has been growing recognition of communities as conservation partners not as passive onlookers of conservation efforts. Various community conservation approaches have developed. Today, NGOs, governments, private sector and other conservation investors have mainstreamed participatory approaches to conservation. The approaches share the same goal of making communities stewards – but differ in the actual shape and form.

Methodology and Approach

Conservation International's Conservation Agreements are an incentive based model that aim at making communities stewards of their ecosystems in return for a negotiated benefit package based on performance. Communities and conservation investors enter into a **written voluntary agreement** that clearly outlines the conservation commitments by the community as well as the incentive package from the conservation investor. In addition, the conservation agreement outlines how performance will be monitored as well as sanctions for non-compliance to the agreement.

Conservation Agreements are built on **incentivizing** long-term **behavior change** based on **verified performance**. Incentives are only channeled to the community based on satisfactory performance of the conservation commitments. In case of default, a **sanction** mechanism is in-built into the agreement. Being voluntary agreements, they are renegotiated periodically to ensure ownership of results and challenges.

Key Findings

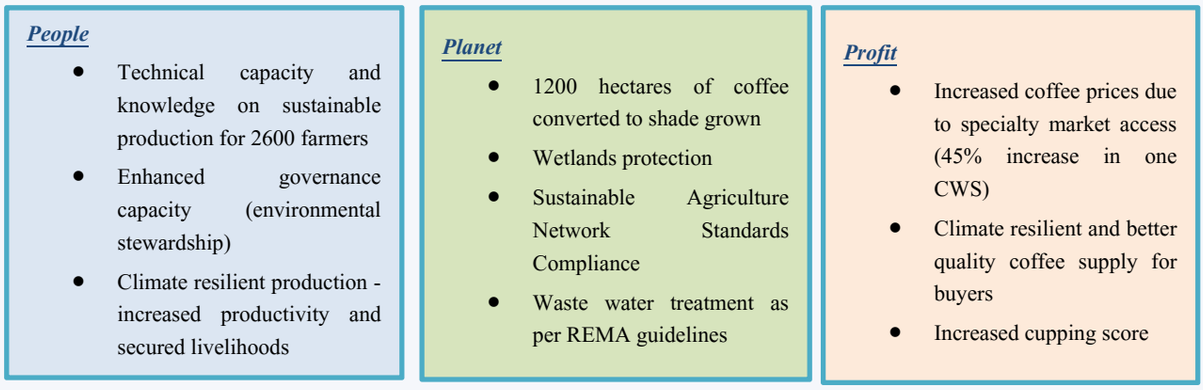
Rwanda

Conservation International (CI) and partners have applied the conservation agreements model in both Uganda and Rwanda on conservation of important wetlands. In Rwanda, CI worked with three coffee washing stations (CWS) and their members in three sub-landscapes (Muhanga, Karongi and Nyamasheke districts). The key objective of the project was to address wetlands degradation and river pollution as a result of coffee production. Prior feasibility studies had shown massive soil erosion resulting to water pollution and silting, cultivation on riverbanks and other wetlands, as well as dumping of raw waste water from coffee processing. The soil erosion coupled with the impacts of climate change was having a negative impact on coffee productivity across the three coffee washing stations.

To address these challenges, CI worked with local service providers to support farmers adopt Sustainable Agriculture Network (SAN) standards, undertake conversion from sun-grown to shade grown coffee, conserve riverbanks and other wetlands, and construct waste water treatment plants. In return for these commitments by the farmers, CI channeled a range of incentives including Rainforest Alliance Audit fees support, credit facilities guarantee, technical capacity support,

premium market linkages, infrastructure improvement with CWS, and part payment for waste water treatment plants. The incentives were channeled to the communities upon meeting agreed deliverables

Key Results of the Rwanda



Conservation Agreements;

Uganda

In Uganda, International Crane Foundation (ICF) is using the conservation agreements model for restoration and conservation of several wetlands in Western and Central regions. For example, in Mugandu wetland in Kabale district, the community has agreed to gradually move away from cultivating certain parts of the wetland. Already, the community has stopped cultivation on about 80 hectares of the wetland with ambition of exiting another 400 hectares in the next 2 years. In return, ICF is supporting communities rehabilitate the farms on hill slopes and establish intensive dairy farming as a viable enterprise. The community can access credit to purchase improved dairy cattle breeds from a revolving fund set up by ICF.

The community has also selected wetland custodians who patrol the area to ensure no illegal activities are taking place e.g. hunting of cranes. The wetland custodians earn a stipend thus this becomes a source of employment for community members. The wetland custodians work closely with the wildlife authorities and can report any illegal activities to the enforcing authorities. As a result, a 14% increase of crane population has been recorded in the Mugandu wetland over the past one year. This can be considered as an indicator of recovery of the wetland quality.

Other examples include the use of conservation agreements by Albertine Rift Conservation Society (ARCOS) in the Kagera river basin and ICF's conservation agreements in Rugezi Marsh in Rwanda.

Conclusion

Incentive based conservation models are powerful mechanisms for making communities partners of conservation efforts. In the Nile Basin, the health of wetlands is largely dependent on making local communities stewards of the wetlands.

20. A Framework Model for Carrying Out Strategic Environmental Assessment for River Engineering Development: Case Study of Nile Basin

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ABSTRACT

The Nile Basin Initiative (NBI), launched in February 1999, is a regional partnership within which the 10 countries in the Nile Basin have united in common pursuit of the long-term development and management of Nile waters. They formulated a 'Shared Vision' whose aim is to achieve sustainable socio-economic development through the equitable utilization of, and benefit from, the common Nile Basin water resources. This in essence calls for recognition of the multisectoral nature of water resources development in the context of socio-economic development, as well as the multi-interest utilization of water resources for water supply and sanitation, agriculture, industry, urban development, hydropower generation, inland fisheries, transportation, recreation, low and flat lands management and other activities. While the underlying factor here is sustainable development, the challenge that NBI faces is lack of strategic frameworks that integrate the three pillars of sustainable development (i.e., social, economic and environment) at higher levels of decision-making, i.e., policy, plan and programme (PPP). While Environmental Impact Assessment (EIA) has been widely used for assessing environmental and socio-economic impacts at project level, it has a limited scope since it cannot be applied at PPP levels. The Business-As-Usual scenario will mean that development continues to suffer since there is less integration of environmental, social and economic issues at higher levels of decision-making.

Strategic Environmental Assessment (SEA) methodology promotes the principles of sustainable development ensuring that the three pillars of sustainable development, that is, social, economic and the environment are considered at policy, plan and program levels.

This study focused on the Nile Basin Initiative (NBI), as a regional partnership within which the 10 countries of the Nile Basin united in common pursuit of the long-term development and management of Nile waters.

The main objective of this research was to develop a framework model for carrying out SEA for River Engineering related PPPs for the Nile Basin Countries. To achieve the main objective, three specific objectives were sought: To analyse, through case studies, how a selected number of countries in the Nile Basin have applied or used SEA in various proposals (or PPPs); to test for sustainability

3
4

equilibrium of various SEA methodologies from case studies, using set theory, Venn-diagram model; and eventually to develop a framework model for carrying out SEA for River Engineering (RE) development proposals at PPPs in the NBCs.

To realise these objectives, the study took the premise that, mutual inclusiveness of social, economic and environmental factors at PPP, could lead to achievement of sustainable development. This premise was represented in a Venn diagram providing for a pictorial presentation of how social, economic and environment variables are interdependent on one another. The process of developing the model involved definition of the variables by representing them in a set theory. Ten process levels forming the framework model for an SEA were identified and analysed to generate a Sustainability Equilibrium Index.

The developed framework model was then applied on five samples of SEAs undertaken within the NBCs to test on their suitability. In the application of the model, the study made two assumptions, one that the PLs have got equal weight and two, that a sustainable process was achieved when the sustainability index was above 0.8. Therefore in the research outcome, a score of less than 0.8 meant that a number of key PLs were ignored during an SEA exercise. Accordingly, out of the five (5) samples of SEAs undertaken in the NBCs, only one (1), an SEA for the Kenya Forests Act 2005, fulfilled this requirement by achieving Sustainability Equilibrium Index of 0.83.

It is anticipated that, development of this sustainability index in SEA will lead to a process of integrating social, economic and environmental factors at PPPs providing for what is usefully be referred in this research as 'sustainability equilibrium'.

Key words: *Strategic environmental assessment, Nile Basin, River Engineering, Model*

21. NILE BASIN ENVIRONMENTAL FLOW ASSESSMENT: NBI EXPERIENCE

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Dr. Mohsen Alarabawy is a PHD professional water resources expert with more than 25 years of practical experience in water resources planning, management and development related fields. Dr. Alarabawy is the Water and Natural Resources Policy Specilaist with NBI. He is knowledgeable of trans-boundary water resources issues and challenges, policy instruments, legal and institutional frameworks, safeguards and standard procedures, conflict mitigation and resolution, arbitration and negotiation, outreach and advocacy, communication and stakeholders engagement. He is familiar with trans-boundary water resources strategic assessments, development of water resources Atlas, river basin "hydromet" monitoring, environmental flows, showcases and means of informing and enriching the riparian dialogue. He has experience in socio-economic development and environmental health. His experience in water resources numerical and physical modeling, sediment transport and hydro-morphology, decentralized water management, training and coaching, stakeholders' scan and analysis as well as stakeholders' mapping and involvement is coherent. He is also experienced in irrigation, drainage, mechanical and electrical public works, shore protection, research and development, water studies and capacity building programmes.

Abstract

Environmental flows are essential for river health, delivery and sustainability. Reliable estimate and consideration of environmental flow requirements are prerequisite for effective water resources

planning and management. Environmental flow assessment is undertaken within the identification, preparation, design, implementation and operation of the NBI investment projects. Similarly, most Nile Basin countries consider environmental flow as one of the key elements of water resources 'infrastructural' development projects. Sound water management strongly links with E-Flows.

Nevertheless, adhoc and heuristic approaches are mostly adopted to determine the environmental flows; the e-flows are assumed within a range of 3% to 20% of the maximum, average, or minimum flows. This leads to over- or under estimation of the minimum environmental flow and consequently untapping or exploiting vital resources and seriously restricting development potentials besides compromising basin health and quality of natural resources, adversely affecting the conditions of vital ecosystems and consequently the wellbeing of their dependent people; basin-wide.

NBI is currently pursuing with an ambitious water resources management program that includes Nile water resources strategic analysis, diagnostic analysis and integrated management plans for wetlands of transboundary significance, development of the second issue of NB state of the basin report, and transboundary water resources management policy instruments. Environmental flows assessment and management is a pivotal component of all the afore-mentioned working areas.

Moreover, national water resources management plans, water-related negotiations and joint planning, and water resources development programmes call for credible quantification of environmental flow requirements for the main Nile sub-basins.

However, accurate definition of environmental flows for the entire Nile Basin is both time and resources demanding; extensive data collection and modeling are typically involved. Furthermore, correlating aquatic and ecological conditions to both resource objectives and socio-economic aspects require intensive stakeholders' scan, mapping, consultations, awareness, feedback and involvement.

Therefore, NBI has accomplished considerable progress in the field of environmental flows' assessment. Knowledge as well as application cases together with policy tools is required to gear the process towards environmental flows management within the entire Nile Basin. A survey, classification and categorization of the NB ecosystems were completed; degree of alteration and deterioration was determined. Assessment of the past and current practices for NB e-flows and consequently identifying gaps and weaknesses was done; highlighting strengths and advantageous aspects. Stock-taking from best international practices, the Nile Environmental Flows' Management Framework was developed. The demonstration of the Framework in four E-flows establishment and management case studies was undertaken in the Mara, Dinder, Sio-Malaba and Kagera Rivers; with different methodologies and approaches. The application cases covered a variety of data rich to data scarce examples.

Moreover, NBI is initiating a process of coarse “rapid” assessment of environmental flows for the entire Nile Basin. This will adequately serve the national immediate purposes and needs on one hand and assist NBI in operationalizing the Environmental and Social Policy (2013), climate change strategy (2013), and the environmental flow management strategy (2016). Further, downstream, work includes more exhaustive eco-systems’ classifications, updating the NB E-Flow repository, and determine more accurate – fine “detailed” assessment methods – e-flows for selected reaches of the Nile River.

This paper describes the NBI experience in environmental flows’ assessment; it provides a summary of the NBI experience and practice. The paper presents the following:

- A review of global practices and experiences on Environmental Flow Assessment.
- Nile Basin aquatic ecosystems; wellbeing and response to flow alterations.
- Practices and experiences of environmental flows management in the Nile River Basin.
- Policy instruments developed for managing E-Flows within the Nile Basin.
- The Nile Environmental Flows Management Framework and associated strategic actions.
- The case studies undertaken for parts of the Nile Basin; selected sub-basins.
- Scientific and institutional aspects, Show cases and limitations.

The prime aim of this paper is to trigger discussions and sharing experiences on creating and maintaining the critical balance between *ensuring water security* and *sustaining the water ecosystems of the Nile basin*. The enhanced knowledge and expertise on E-Flows will definitely support the analysis and decision making with regard to master planning, adaptation of ecosystem services, and strengthening transboundary ‘cooperative’ water resources management.

22. FRAMEWORK FOR REGIONAL EVALUATIONS OF E-FLOWS IN THE NILE BASIN.

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Abstract

Keywords: Environmental flows (E-flows), Nile Basin, Trans-boundary, Multiple spatial scales, Holistic, Socio-ecological considerations.

Background

For the holistic management of Environmental flows (E-flows) in the Nile Basin an E-flow Framework that meets best practice E-flow management principles within a regional context has been established. The framework directs the application of holistic E-flow assessments on meaningful regional scales, with multiple transboundary social and ecological considerations. This framework established by the Nile Basin Initiative with stakeholders of the use and protection of the water resources of the basin, conforms to the principles of trans-boundary collaboration and benefit sharing, sustainable water resource use and protection using evidence based, transparent and adaptable tools. The framework has been the foundation of the establishment of transboundary policy instruments for transboundary E-flow assessments on regional scales in the basin.

Methodology

The study initially included a reviews of: (1) global practices and experiences of E-flow assessment methods (2) aquatic ecosystems of the Nile Basin, their wellbeing and response to flow alterations, and (3) management of environmental flows in the Nile River Basin: practices and experiences. These reviews with a series of specialist workshops in the Nile basin with stakeholders resulted in the formation of the Nile E-flows Framework. The Nile E-flows Framework established in the study (Figure 1) addresses the requirements of a robust E-flows Framework for the Nile Basin and the use of current best practice E-flows assessment methods into an adaptable, scientifically valid E-flows management framework for the Nile Basin. The framework, loosely based on the Ecological Limits of Hydrologic Alteration framework (Poff et al. 2010) with local considerations, includes seven phases including: (1) Situation Assessment and Alignment, (2) Governance and Resource Quality Objectives Setting, (3) Hydrological Foundation, (4) Ecosystem Type Classification, (5) Flow Alterations, (6) Flow-Ecological-Ecosystem Services Linkages and (7) E-Flows Setting and Monitoring.

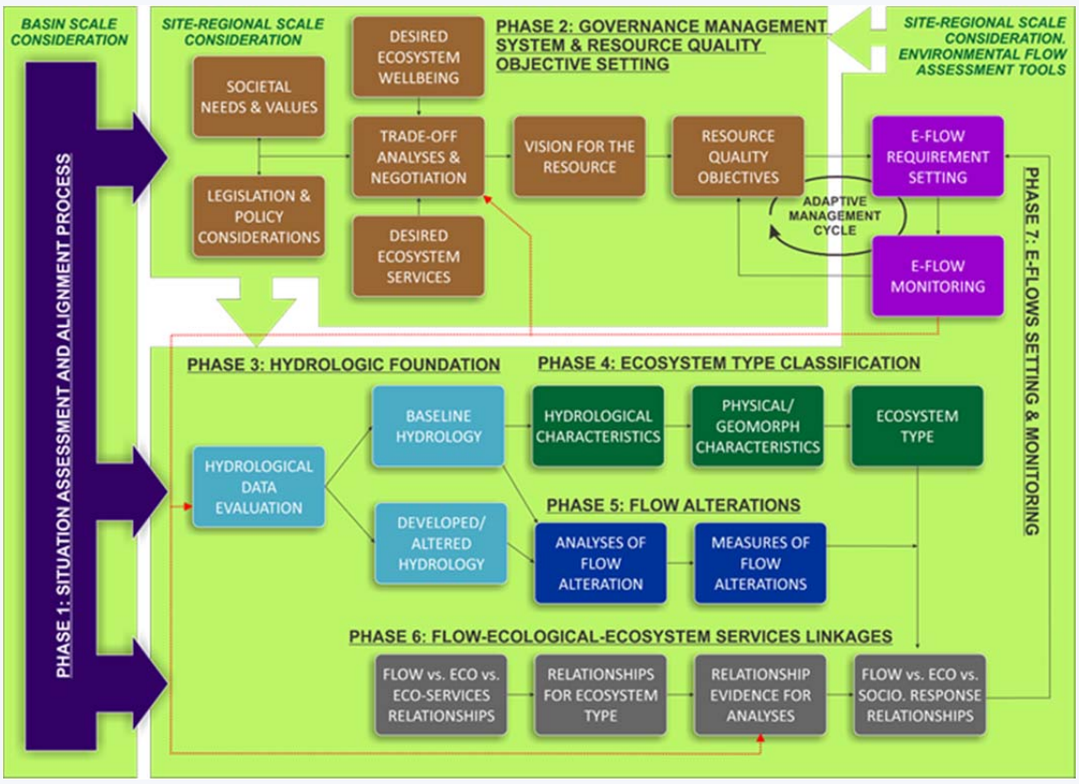

Figure 1: Expanded seven phase Nile E-flows Framework for the coordinated assessment of E-flows on multiple spatial scales in the Nile Basin with the adaptive management cycle emphasised.

Findings

The framework has been developed and tested through four trans-boundary case studies in the Nile Basin namely; the Dinder River (Ethiopia/Sudan), the Malaba River (Kenya/Uganda), Mara River (Kenya/Tanzania) and Kagera River (Burundi/Rwanda/Tanzania). The results reveal the scientific robustness of the framework, its adaptability and the type and value of outcomes.

Conclusions and recommendation

The Nile E-flows Framework will contribute to the future aim of managing resources on a regional, ultimately a Nile Basin scale, using information derived from sub-basin scale E-flow management activities. Although this basin scale E-flows assessment process requires the future establishment of scale relevant E-flow management objectives, and a better understanding of the flow-ecology and flow-ecosystem service relationships on a basin scale, the Framework allows for larger regional scale assessments to be undertaken immediately and highlights information needs for larger regional/basin scale assessments.

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23. Demonstration of the Nile E-flows Framework in the Mara River, Lake Victoria Basin.

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Abstract

Keywords: Environmental flows (E-flows), Mara River, Kenya, Tanzania, PROBFLO, Risk Assessment.

Background

For the holistic management of Environmental flows (E-flows) in the Nile Basin an E-flow Framework that meets best practice E-flow management principles within a regional context has been established. The framework has been implemented in the Mara River to demonstrate the application of the framework and its flexibility. The Mara River in Kenya and Tanzania, Lake Victoria Basin Region of the Upper Nile Basin, is a socio-ecologically important river ecosystem which maintains a large diversity of aquatic and terrestrial animals, includes the ecologically important Masai Mara National Reserve and Serengeti National Park and supports a diverse range of ecosystem services upon which many Kenyans and Tanzanians depend. Increasing use and degradation of water resources in the Mara River Basin threatens the integrity of the Mara ecosystem and the services it provides to local and regional communities. Successful water management depends on the establishment of a balance between use and protection of resources for the benefit of all stakeholders. The Mara River and its tributaries are an essential source of water for domestic needs, agriculture, pastoralism and wildlife in Kenya and Tanzania, but the river also has enormous instream conservation values . Although extensive research has been undertaken into the environmental management of the game reserves in the Basin and land use threats, limited consideration has been given to regional flow management, therefore an integrated Mara River Basin wide environmental flow assessment is required.

Methodology

In this study the seven procedural phases of the Nile E-flows Framework were implemented on a regional Mara River Basin scale (O'Brien et al., 2016) including: (1) Situation Assessment and Alignment, (2) Governance and Resource Quality Objectives Setting, (3) Hydrological Foundation, (4) Ecosystem Type Classification, (5) Flow Alterations, (6) Flow-Ecological-Ecosystem Services Linkages and (7) E-Flows Setting and Monitoring. The holistic PROBFLO EFM (O'Brien et al, 2017) was selected for this assessment which included a field survey to seven sites in the Mara River by a team of E-flow and socio-ecological system experts.

Findings

The vision evaluation established a high ecological importance, high livelihoods value and low commercial value vision for the upper Mara River Basin and a high ecological importance, moderate livelihoods value and moderate commercial value vision for the lower Mara River Basin. In this context numerous socio-ecological endpoints were selected for the study. Regions were established based on socio-ecological land use scenarios in the basin. Historical data describing flow-ecosystem and flow ecosystem services were reviewed and used in the assessment. The surveys resulted the identification of new ecological and social indicators of the ecosystem that were used to evaluate the holistic consequences of altered flows in the study area. Outcomes of the assessment included moderate to high risks to selected ecological endpoints during low flows in the middle and lower reaches of the study area which were verified with real instream ecosystem wellbeing data. Although the risk to the social endpoints fluctuated results demonstrate that supply of ecosystem resources generally exceeds supply. Scenarios considered in the assessment demonstrated the robustness of the risk model used, and the probable consequences of elevated use of resources without the establishment of protection measures. The ecological water requirements (EWR) results include 366.61 million m^3 per annum (31.01% of the total Mean Annual Runoff) in the catchment. Monthly flow requirements including recommendations for wet and drought phases have been established for the protection of the ecosystem. Current flows generally exceed the EWR but provide important guidance for managers during drought and low flow conditions.

Conclusions and recommendation

The holistic application of the PROBFLO EFM in the Mara River resulted in the proposal of EWRs for ten sites, with consideration of their associated regional geographic areas, in the Mara Basin. The assessment demonstrated that EWRs can be generated from the PROBFLO approach that will maintain the overall wellbeing of the socio-ecological endpoints considered in an acceptable state. Although low probabilities of unacceptably high risk of endpoints not being achieved were observed, they are unlikely but need to be monitored to ensure that they are achieved. The probability of high risk associated with the initial EWR to the ecological endpoints in the lower Mara River were revised through the hypotheses testing and adaptive management phase of the PROBFLO process.

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24. Harnessing Nile Water for Food Security in the Eastern Nile Basin: Challenges and Options

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Abstract

Keywords: Nile water, food security, challenges, options

Background

Food insecurity is a major challenge in the Eastern Nile Basin (ENB) countries. The ENB countries are endowed with vast resources (land, water and climate) suitable for agriculture, livestock production, and forestry and fisheries development, among others. However, agriculture is characterized byrelatively low productivity. FAO 2010 estimated that there were some 680 million hungry people in the world, more than 250 million of whom in sub-Saharan Africa. Currently there is real famine in some of the ENB countries (e.g South Sudan) because of war and less food production. Food imports is increasing, while agricultural productivity is stable and or decreasing despite huge potential. There is potentiality - given the huge amount of water – for the ENB region to feed its population and maybe the world. UN, MDG progress reports on to halve the number of hunger people by the year 2015 showed big gap in most of the Nile Basin countries. The main problem of food insecurity in the region is not scarce resources but poor policies, poor strategic planning, mismanagement, traditional practices (absence of technology), crop failure, droughts and civil war. Other reasons complicated the situation is the lack of coordination and cooperation between ENB countries.

Methodology and approach

This paper discusses the issue of harnessing water in the Eastern Nile Basin (Ethiopia, Sudan, South Sudan and Egypt) for food security. The paper reviewed the availability and distribution of water resources in the ENB. The ENB community food need was estimated. The available water was tested against the community needs for food. Current and future challenges

of food insecurity were discussed and classified to countries and regional challenges. Options of food security improvement

were discussed versus existing challenges. Results are summarized in tables, graphs and figures.

Ways and means to face food insecurity challenges were reported and prioritized.

Key findings

The available water in the region is more than enough to feed the ENB community and beyond. The total renewable water resource in the ENB is about 153.8 BCM. This is huge water to feed about 215 million people (total estimated population). It has been found that the current and future regional food needs can be covered by small percentage from the available Nile water. The main regional challenges of food insecurity are climate change, mismanagement of water, lack of cooperation, lack of vision and strategic planning. Other challenges are various depending on each country, but low productivity and civil war constitutes the main challenge to achieve food security.

Conclusions and recommendation

Food security issue should be at the top of the region agenda. Some food insecurity challenges are country specific (eg. civil war in Sudan and South Sudan, low productivity in Sudan and Ethiopia) andclimate change is regional challenge. I think it is high time for the ENB to decide how and where to produce food?

25. Technical efficiency of large scale irrigated wheat production in the blue Nile basin: the case of Koga irrigation scheme

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ABSTRACT

The Ethiopian economy is heavily dependent on agriculture, although the food production could not be able to feed the ever-increasing population. Agriculture accounts for 44% of the country's GDP and serves as source of employment for about 80% of the total employed labor and 70% of export earnings. Ethiopia is one of the SSA countries, where poverty and food insecurity remains a big challenge. In Ethiopia, more than 30% of the population is below the poverty line and is incapable of getting the minimum calorie intake to survive. Domestic per capita food supply in Ethiopia has decreased year after year, and the remaining balance has been covered mainly by food aid. Wheat is the main crop, which has been also imported to fill the food deficit in the country. Food self-sufficiency in Ethiopia can be achieved by improving productivity either through the introduction of new technologies or improving the efficiency of production of major food crops such as wheat. Given a good knowledge of the efficiency of various production units, output can be increased by improving production efficiency. Among the dominant crops which is grown in koga irrigation scheme, wheat production is profitable and requires less amount of irrigation water (i.e. in terms of water use and frequency of irrigation). Economic efficiency of water as well as irrigation water productivity of wheat is better than potato and green maize. To use water resource more efficiently the water resource association should start water pricing in terms of volume use.

This study was aimed to analyze the efficiency level of wheat production under Koga large-scale irrigation scheme together with factors determining it; and to explain the possibility of productivity gains by improving efficiency of wheat producers, in 180 selected farmers in 2016-irrigation season. Stochastic production frontier model was used to estimate technical, allocative and economic efficiency estimates, whereas Tobit model was used to identify factors affecting the efficiency level of the sampled farmers. The coefficient of the Cobb-Douglas production function interpreted as elasticity and summing the individual elasticity, yields a scale elasticity of 1.20. This indicates that farmers' scale of production belongs to increasing returns to scale. This mean that a 1 percent increase in all inputs within the same time at the sample mean, will increases wheat output by 1.2 percent. The estimated results showed that mean technical efficiency (TE), allocative efficiency (AE) and economic efficiency (EE) were 86, 46,and 38 percent, respectively, which indicates the significant inefficiency of wheat production in the study area. Thus, output can be increased by 14% or cost can be reduced by 54%, respectively with in the current level of technology and resource. The result of the Tobit model revealed that household sex, improved seed and extension visit contributed significantly and positively to TE and AE, whereas wheat cultivated land was inversely related to AE. Livestock ownership and wheat cultivated land significantly and inversely affected the level of EE of wheat producer. The study recommends that access to extension

services, capacity building and access to credit for women to use agricultural inputs, and accessing improved agricultural inputs can help to improve efficiency and productivity of wheat.

Keywords: Allocative efficiency, Developing countries, Food security, Irrigation, Technical Efficiency

26. Impact of Irrigation Development on Water Resource Management and its Trans Boundary Implications in Ethiopia, Upper Blue Nile Basin

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Abstract

Introduction:
The Blue Nile River is an important shared resource of Ethiopia, Sudan and also, because it is the major contributor of water to the main Nile River, Egypt. Under the auspices of the Nile Basin Initiative (NBI) the riparian countries have agreed to collaborate in principle, but formal mechanisms to develop the basins water resources cooperatively are currently limited and tensions remain (Metawie, 2004). Despite the potential benefits of regional cooperation and integrated joint basin management, all three countries continue to pursue unilateral plans for development (Whittington et al., 2005; Cascao, 2009).

There are plans for significant expansion of hydropower and irrigation in the Ethiopian portion of the Blue Nile River Basin. However, the possible consequences of water management on the performance of existing and planned schemes have not previously been evaluated.

Challenges with food security, poverty, climate change, ecosystem degradation and biodiversity loss are highly interlinked. These interconnections are increasingly apparent in Ethiopia's growing economy, where ecosystem degradation enhances food insecurity and poverty, and poverty and food insecurity exacerbate the pressure on scarce natural resources. Furthermore, many of these interactions occur at a scale that spans multiple water uses and socio-ecological systems. Integrated solutions that sustain vital ecosystem services, enhance food production, and improve human health and well-being simultaneously and operate at a Basin scale are required to address these complex challenges.

Given existence of high hydrological variability, climate change and un-coordinated water resource management, it is vital to appreciate to what extent it is possible to internalize those problems by

creating potential collaboration among water use sectors. However, despite a clear understanding of the role of policy and institutional capacities in promoting sustainable development, only little research has been done to understand how to support the importance that institution and policy can play on optimal use of this limited resource (Hagos et at., 2011). In addition to that, modeling efforts specific to Ethiopia much more limited to water resource simulation model with a particular focus on the effects of new infrastructure proposals GIRD, 2010; SMEC, 2008).

Background:
Ethiopia is located between approximately 3° to 15° N latitude and 33° to 48°Elongitude. The country covers a land area of about 1.12 million km2, occupying a significant portion of the Horn of Africa. It shares boundaries to the east and south east with Djibouti and Somalia, to the north with Eritrea, to the south with Kenya, to the west with Sudan and to the southwest with South-Sudan. The altitude ranges from the highest peak at Ras Dashen (4620 m a.s.l.), in Gonder, down to the Danakil depression(120 meters below sea level), one of the lowest dry land points on the earth, in the Northeast part of the country.

The climate of Ethiopia is mainly controlled by the seasonal migration of the Intertropical Convergence Zone and associated atmospheric circulations as well as by the complex topography of the country. It has a diversified climate ranging from semi arid desert type in the lowlands to humid and warm (temperate) type in the southwest. Mean annual rainfall distribution has maxima (>2000 mm) over the South-western highlands and minima (<300 mm) over the South-eastern and North-eastern lowlands. In terms of rainfall occurrence one can generally identify three seasons in Ethiopia namely; Bega: - dry season (October- January), Belg: - short rainy season(February- May) and Kiremt: - long rainy season (June- September). Mean annual temperature ranges from < 150C over the highlands to > 250C in the lowlands. Although Ethiopia is endowed with large amount of water resource potential, between80-90 % of its water resources is found in the four river basins namely, Abay (BlueNile), Tekeze, Baro-Akobo and Omo-Gibe. More than 60 % of the populations are residing in the east and central river basin system where the availability of the water resources is only 10-20 % and much of the river systems are transboundary in nature.

Purpose of the study:
The purpose of the work was to evaluate the impact of irrigation developments on multi sectoral water users and its Tran boundary implications at upper Blue Nile basin.

Methodology:
The NB DSS is considered to comprise (i) a knowledge base, and (ii) modeling tools. These two elements are to have in-built internal interfaces and the DSS as a whole, through input and output systems, is to have strong linkages with the separately developed BIS and WIS and Ethiopia is carrying out a study using the Nile Basin Decision Support System (NB-DSS) to providing the inputs needed for a water resources management and planning.

Mike Hydro was used for simulation (1960 to 2005) and following six steps have been well under taken: Definitions of problems/Key Water Management Issues, Clarifications of Objectives, Development of scenarios, Definitions of Indicators and Evaluation of Criterion, Simulation and Quantification of Indicators and Evaluation/Interpretations of Results and Tradeoffs.

Findings and Arguments:
We have found that, during the worst case scenario the hydropower and fish productions tends to be declining with a minimum amount where as will have a significant influence on the navigation sector in the upper part of the Blue Nile basin. Upstream who benefit from future irrigation development will expected to refuse or resist the effort towards collaboratively managing the water resource towards economical optimality unless there is compensation for the lost benefit. On the other hand, downstream water use sectors estate may show interest cooperation for full supply of irrigation demand.

Nile Basin DSS showed implicitly and explicitly how existing institutional collaboration gaps reduce the interaction between involved water use sectors towards reaching informed decision in solving water management issues. Clearly defined operation rule under different hydrological conditions or a responsible body that creates a discussion platform for involved stakeholders to collaboratively manage the reservoir to reduce high social and economic impact, Sectorial dynamics.

27. Satellite based ICT for improved crop production in the Gezira Scheme - Sudan

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Project leader for the Smart ICT for Weather and Water information and advice to smallholders in the Gash & Satellite based ICT for improved crop production in Gezira.
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Abstract

The competition over water in the Nile basin is increasing because of high population growth and diversified uses. Given the low water productivity level in the basin, improved agricultural water management, i.e., more crop per drop is seen as a potential opportunity to close the yield gap. Satellite based ICT can play a vital role towards increasing agricultural productivity of small holders farmers in the basin.

The satellite based ICT for improving crop production was tested in Gezira irrigation scheme (880,000 ha) in Sudan, during the winter season of 2014/2015. The water management at the field level in the scheme is undertaken by the farmers and Water Users Associations. Irrigation scheduling is fixed at two weeks irrespectively of the weather conditions. One of the key water management issues is to advice farmers on when to irrigate and how much water to apply.

The ICT is an innovative project that conveys to the farmers satellite based information on crop growth and agricultural water use via mobile phone text-messages. The developed tool can monitor field specific information by measuring nine parameters that cover crop growth (biomass production, leaf area index, and vegetation index), moisture (actual evapotranspiration, evaporation deficit, crop factor, and biomass water use efficiency) and minerals (nitrogen in upper leaf and total plant nitrogen). The data is derived using the Surface Energy Balance Algorithm for Land (SEBAL) applied to high-resolution satellite images from Disaster Monitoring Constellation (DMC) and

Landsat8. A web portal irrigation planner is run twice a week to advice farmers on the irrigation date in advance.
44 farmers representing Gezira scheme geographically viz. north, middle, south and west were selected for the pilot testing. The selected pilot farmers receive weekly text-messages through mobile phone that give a summary of these measured parameters and a separate message on "*when to irrigate*". The collected information is presented numerically and via maps in the web portal www.fieldlook.com.sd.
The outcome of the pilot experiment showed promising results. Wheat production of the pilot farmers has increased by an average of 67 %, varying from 3% to 270%, compared to the previous season. The irrigation interval varied between 8 and 17 days and the total number of watering was increased from (5-7) to (7-9). The total volume of water supplied per irrigation was relatively less. Farmers had better on-farm management, as they receive the advice via SMS messages regardless of their location. The farmers accepted the new technology because it is easy, truthful and saved them both time and effort. All stakeholders, famers, Gezira administration and minister of irrigation officials expressed their willingness to replicate the same techniques over larger areas of the scheme.

Keywords: ICT in agriculture; satellite images; biomass, irrigation planner; Fieldlook; Gezira Scheme; Sudan

KEY WORDS: Climate Change, CMIP5, Nile, East Africa, CenTrends, Precipitation, Weighted Ensembles

28. Eastern Nile Multi-Secoral Investment Opportunity Analysis (EN MSIOA)

Eastern Nile Technical Regional Office (ENTRO)
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Azeb Mersha: M.Sc in Surface Water Hydrology from UNESCO-IHE and B.Sc in Civil Engineering from Addis Ababa University Worked as a water resources modeler, hydrologist, lecturer and civil engineer for more than ten years. Experience in developing models for water resources planning and management, water allocation, reservoir simulation, optimization of resources and flood forecasting. Currently working for Eastern Nile Technical Regional Office(ENTRO) as a water resource modeller dealing with large scale multi-national and regional projects, system analysis for optimization of water resources of transboundary river basin and contributing in knowledge product development.

Abstract:

The Eastern Nile Multi-Sectoral Investment Opportunities (EN-MSIOA) study is one of several specific studies being undertaken by ENSAP to achieve the general objective of the NCORE from the Eastern Nile perspective. of the seven IDEN Projects ENTRO completed, have made the earliest contribution in terms of alerting decision makers the need for integrating water resources planning across sectors and across the EN basin if we are to learn to do more with less and less per capita available water. Their findings have never been integrated across sectors to provide direction for wider basin level water resource optimization and efficiency. The EN MSIOA draws from and/or updating earlier ENSAP studies as needed, the EN MSIOA aims to undertake water resources

analysis that would promote (a) sustainable management of common Eastern Nile water resources; (b) cooperative investment planning that takes into account the water scarcity of the basin and the social and environmental and economic implications of such investments.

The EN MSIOA started by identifying key EN basin-wide water resources development and management challenges that indicates the current situation of the basin in respect ot its water resource, key environmental issues and social issues. The core analysis involved the definition and analysis of different combinations of water resources management (termed Development States)twelve of them, and the analysis of the economic, social and environmental implications of each of these Development States defined, using a three-step process: water demand satisfaction, availability of water at various location and economic assessment. The study used the Muliti-Criteria Analysis to compare the impacts of each Development State, especially in terms of how they meet the water resource and sustainable development expectations of the ENB countries. The MCA has captured the interest of the countries by selection of evaluation criteria and weighting them according to their national and regional priorities.

As the study proceeded to the final phase, it became clear that all development states needed to respect one overriding criteria, i.e. the limits imposed by the water resources of the ENB, the violation of which would risk the Nile itself. The water resource implication of each Development State was thus analyzed with respect to water availability in the ENB. The fact that there is only a finite amount of water in the ENB (which is going to be increasingly variable and unreliable) places environmental limits to water resources development in the ENB. There are also social limits to water resources development, i.e., a limit as to how many people can be displaced or otherwise affected by water resources investments and the priority to be accorded to social needs in water resources investments. The desired Development State of the ENB has thus to fit within hydrological, social and environmental prerequisites limits that will enable it to sustain for future generations.

The MSIOA yielded fundamental insights into the challenges, complexities and possibilities of water resources investment planning while adopting a regional or ENB-wide and hydrology-based perspective. The analysis pointed out that business as usual, i.e., water resources planning and investment strategies that do not consider the basin as a whole will not lead to sustainable outcomes. For one, regionally uncoordinated planning and investment lacks consideration of inevitable upstream and downstream impacts which affect other countries within the same Basin. It also pointed out a regional, whole-basin perspective, orientation and modus operandi in investment planning is a must, if adverse impacts are to be avoided, minimized or managed successfully. In the long run, the only option is a regionally optimized investment portfolio for the basin as a whole. The MSIOA study shows that there is scope for new irrigation, but in the longer-term, there is not enough water to fulfill the development plans of all countries. Unchecked or unilateral expansion of planned irrigation will lead to major water shortages and/or the abandonment of some irrigation schemes. While regionally planned hydropower development has minimal impact on regional water resources, once the dams are filled. Although the study did not analyze the filling of dams and this needs further investigation, the study established that, being non-consumptive water use, new hydropower can be managed in a trans-boundary context while working to reduce evaporative losses from reservoirs, and coordinating filling and operation. As combine use where reservoirs are used for hydro-power and irrigation, water availability may be impacted. But if well-planned, there are win-win-win development opportunities. The other insight is on choice of crops, agricultural water use efficiency improvements and a regional approach to food security and agricultural markets should be explored further and developed . Moreover other areas to further explored to

reach favorable win-win development outcomes for all include watershed management, groundwater management, salinity control, flood forecasting, wetland preservation – and climate change across all sectors and the basin. The study also have some limitations which direction for future improvement.

Keywords: Eastern Nile Basin, ENTRO, ENSAP, NCORE, MSIOA, investment, development, tradeoff

29. Influence of Upstream Intervention of Roseires Dam Heightening on the Performance of Alguneid Irrigation Pumps in Sudan

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Abstract

Key words: Roseires Dam, Blue Nile, Alguneid, upstream intervention.

The Roseires Dam is located near the town of Aldamazin on the Blue Nile River in the south east of the Sudan, approximately 100 km downstream from the Ethiopian border, up to which the storage extends by means of the Roseires Dam Heightening Project (RDHP). Initially the dam project was designed for two stages with the first stage completed in 1967. That stage was comprised of a central concrete buttress dam one kilometer in length with integral spillway, deep sluice gates, power station and flanking earthen embankments of eight and four kilometers length. The second stage was designed for construction at a later date after the first stage was in operation and with minimal disruption to operation. This second stage is to raise the dam and the top water level by ten meters, with the earthen embankments now extending to a distance of over fifteen and eight kilometers west and east, respectively, producing a total crest length approaching twenty five kilometers.

The existing deep sluice gates, spillway and power station turbines were to be retained as they had originally been designed to serve the heightened dam. The flow of the Blue Nile reflects the seasonality of rainfall over the Ethiopian highlands where the two flow periods are distinct. The flood period or wet season extends from July to October, with the maximum in August – September, and low flow or dry season from November to June. Therefore, the annual Blue Nile hydrograph has a constant bell-shaped pattern, regardless of variation in the annual flow volumes. The objective of The Roseires Dam Heightening Project is to increase the size of the reservoir and thus the storage and regulation capacity. This will enable existing agricultural activities to continue and increase the production through expansion of current schemes. It will also offer future opportunities for irrigated schemes and further agricultural development. It will also allow for improved management of water resources in a manner that better meets the demands of downstream consumers while ensuring a continuous supply of water for irrigation of existing schemes. Since the 1950s, the government has installed a number of large pump projects, mostly on the Blue Nile. Al Guneid project on the right bank of the Blue Nile east of the Gezira Scheme is one. This project, with an

irrigated area of about 36,000 hectares, went into operation in 1955 to provide an alternative livelihood for nomadic pastoralists in the area. It produced cotton until 1960, when about 8,400 hectares were converted to sugarcane under the corporate and farmer management. Normally, water level increases during the year reaching the highest level in August during the rainy season and lowest in May and April. The main problems encountered by pump stations before the heightening due to low water levels are the fear of cavitation at low river water level, extended priming time if the pumps stop for any reason. Reverse circulation of pumps at the time of stoppage of the electromotor causes damage in many parts of the structure of the pump and gearbox in addition to the loss of a large amount of water to the Blue Nile before closing the valve; sudden closure of the system may cause surge pressure which may lead to water hummer. Cavitation causes great damage to the pumps. Low water levels reduced rate of flow from pumps, lowered efficiency and increases energy consumed and increased operating hours to meet demand. Guneid scheme suffered from the low level of the Blue Nile during the recession period. Since 2013 the situation was relieved with reduced complaints. The study was carried out with the objectives of quantifying the impact of Roseires heightening on the head, operating hours, energy consumption and satisfaction of the agricultural crops needs by 2 comparing the water level at the pump station before and after dam heightening, evaluation of discharge before and after dam heightening, evaluation of pumps efficiency and calculation of energy consumed before and after Roseiris dam heightening . The study was conducted in Alguneid pumps irrigation scheme at Gezira State, downstream Sennar reservoir in a reach which suffered from the low Blue Nile water levels during winter and summer. Alguneid lies in arid area with mean temperatures range of 32oC and 26oC, average annual rainfall of 112

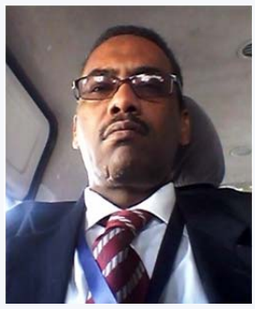
mm within the study area, 90% of which falls in July, August and September; emphasizing the necessity of secure and sustained river flow for perennial irrigation of sugarcane.

The soil of Algunied sugar scheme is clay loam low in organic matter and nutrient demanding addition of chemical fertilizers conaining nitrogen and phosphorus elements with organic materials provided by the cane residuals. Data were collected for two years before and two years after Roseires dam heightening. The data collected included the daily river water level in the Blue Nile at Algunied irrigation pumps two

years before and two years after Roseires dam heightening, the corresponding Pump operation hours and pump discharge, sugarcane crop rotation and climatic data.

Results show that water level after Roseires Dam heightening was greater than the water level before heightening at an average rise of 1.3 m. The highest difference of 2.55 m occurred during May; the hottest month in Sudan. The discharge after heightening is greater than the discharge before heightening by about 6.5% due to the rise of the Blue Nile water levels, with the greatest improvement occurring in April and May, the period that the sugarcane required large amount of irrigation water during summer. Before heightening the pumps required large number of hours to provide the requested water. The pumps operation hours decreased by about 10% after the heightening. This will result in more reliable and sustainable water supply for the sugarcane growers. After heightening the water level of the Blue Nile rose at the pump sites and the pumps operated without loading and heating, thus improving the energy consumption which after heightening decreased by about 25%. Sugarcane in Alguneid is a perennial crop with high irrigation water demand which was not met easily before Roseires Dam heightening. When interviewing the local operator, it was found that before the heightening there was continuous requests made to the Resident Engineer at Sennar Dam, upstream of Alguneid, to raise the water levels in the river, particularly during summer months. Such requests were no longer made after the heightening as the releases from Roseires Dam are greater than upstream Sennar uses which functions as a regulator as it has a small storage capacity. Crop water requirements calculations using CROPWAT software has shown that the heightening has resulted in meeting the demand without stress periods. Considering the fact that sugarcane irrigation continues even during the rainy season which is short, low and not reliable, the rise in water levels has improved the energy consumption, reduced the number of operating units, reduced the operation hours and improved the overall management. The heightening is considered an upstream intervention which has improved the performance of the pumps in Alguneid leading to a more reliable and sustainable water delivery to the irrigated area. Continuous monitoring and probing in extra benefits of the heightening in the form of new extensions of the sugarcane estate are recommended.

30. Using WEAP Model to Monitor and Manage the Blue Nile River Basin



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Abstract

The Blue Nile River Basin (BNRB) is a transboundary water source shared by Ethiopia and Sudan; nonetheless Egypt is the most benefiting country from its water resources. The importance of the BNRB can be represented in the huge percentage of its water contribution to the mean Main Nile River flow (51.61%) for the period (1980-2010), while it is also unique on its wide seasonal variation in its discharge and problems of erosion upstream (i.e. lost more than 250 million m3of topsoil) and sedimentation downstream (i.e. silt accumulation in the reservoirs).

The main objective of the research is to contribute to the sustainable development of the BNRB through the fostering and identifying best development and management options using the appropriate river basin modeling tools. As well as to create a modified rainfall data for the Blue Nile sub-basins and to manage the Blue Nile Transboundary water system in an equitable and sustainable manner.

Within the Water Evaluation And Planning (WEAP) model, the simplified rainfall runoff option has been adopted to determine the runoff of the Blue Nile River Basin, as well as the calibrated satellite rainfall data and adjusted monthly evapotranspiration factors for the Blue Nile sub-basins have been estimated to identify trends and performance measured.

The research builds baseline and alternative future scenarios for BNRB to evaluate and assess water resources projects situation under different assumptions, such as reservoirs filling; hydropower generation; and flow requirements priorities orders. As well as the research used the adjusted satellite rainfall data for the Blue Nile subbasins as a key input data.

- 2 -The WEAP model has been calibrated for the period (1980-1995) and validated for the period (1996-2010) where the simulated and observed flows have been compared at selected stations in a monthly time step yielding reasonable values. The results have effectively showed that

the simulated flows are reasonable depending on the NashSutcliffe efficiency (r2) and the Coefficient of Determination (d) of the model performance.

The research found that there were unmet demands for irrigation water projects in Blue Nile River Basin; the justification of this is attributed to the differences in priorities order for reservoirs filling; hydropower generation; and flow requirements in the BNRB. The priority order process for future reservoirs filling and irrigation water requirements have direct effects in the results of managing irrigation water projects in the BNRB.

To meet future water demands, the research proposed establishing of a joint technical committee to reach an agreed priority orders in each month through determining the optimum operation for water resources projects that satisfied the U/S and D/S water requirements and to guarantee sustainable safeguarding of water security.

For sustainable management of the Blue Nile River Basin, it's required to define the priority orders in the whole systems together to determine allocations from supplies to demand sites (for irrigation), and for filling reservoirs and generating hydropower, to reach an agreed management for all water resources projects in the Blue Nile River Basin.

To determine the pathways toward transboundary cooperation between BNRB countries for better future, the research recommend a wide cooperation between the shared countries through establishing a joint technical committee to determine the optimum operation rules and to guarantee sustainable safeguarding of downstream water security.

Key words: WEAP model, Blue Nile River Basin, Satellite Rainfall, Evaluation.

31. Mainstreaming the value of Ecosytems and Biodiversity in Development Planning: The Economics of Ecosystem Services for Major Rivers a Lake Basins in Africa: A Case study of the Tana River Basin, Ms.Julie Mulonga; Mr. Brian Wamubey

Mr. Brian Wamubey work for Wetlands International Kenya as a Project Manager under: the Protracted Crises Horn of Africa (PCHA) Programme that seeks to strengthen community resilience and enhance disaster risk reduction through ecosystem-based adaptation; and the Satellite-based Wetlands Observation Service (SWOS) that seeks to inventorize and monitor wetland ecosystems through its automated toolbox over time and feed its products to the various players and programmes. I have an academic background in Geography (BA), Geographical Information Science (PgD), Computer Engineering (Dip.), as well as various applications of GIS technology in Natural Resources Management (ESRI and ITC), including GEOSS, IWRM and, and Entrepreneurship. I have 11 years of work experience in Natural Resources Management, ecosystem services mapping, community livelihoods enhancement, capacity building as well as stakeholder networking and engagement. I believe in applying multi-disciplinary and multi-stakeholder approaches towards achieving sustainable societal solutions, and above all link and harmonize human livelihoods with healthy nature.

Abstract

Introduction

A case study is presented of the "*The Economics of Ecosystems and Biodiversity*" (TEEB) study for the Tana Basin study, which highlights the importance of mainstreaming the values of ecosystem services in developments in basins. This study demonstrates that appreciating the relationship between development goals, human well-being and ecosystem services is crucial. It can mean the difference between a successful development strategy and one that falls short because of the unexamined consequences or changes in the flow of ecosystem services.

The integrated assessment of the Tana River Basin evolves around an extended cost benefit analysis taking into account the environmental and societal changes in river basin regimes. In valuing ecosystem services provided by the Tana River Basin, various aspects are taken into account such as the large diversity of ecosystem services affected throughout the river basin, the spatial variation in changes in ecosystem services with the main differences between upstream and downstream effects, and the temporal dynamics of the changes varying between short time and long term effect, as well as season fluctuations. The study builds around four scenarios, which resemble the most important developments that are currently planned in the Tana River Basin. These include:

• Scenario 0 – No Dams: The naturalized state of the river, without any interventions.

• Scenario 1 – Masinga+ dams: This baseline scenario represents the current situation. In total five hydropower dams (Masinga, Kamburu, Kindaruma, Gitaru and Kiambere) have been constructed in the Tana River (upper basin), providing almost three quarters of the national energy demand. Additionally, two dams have been constructed in the Chania (Sasumua) and Thika (Thika) rivers, which supply water to Nairobi (Nippon Koei, 2013).

• Scenario 2a - HGFD: This policy scenario represents a future situation in which the High Grand Falls Dam (HGFD) is completed and additional irrigation in Bura, Hola and the Delta is established.

• Scenario 2b – Million Acres: This additional policy scenario is similar to scenario 2a, with the addition of one million acres (~400.000 ha) of irrigated land for which water is extracted from the HGFD reservoir.

Methodology for Valuation of Ecosystem services

Dose-response functions, also known as factor income functions (Korsgaard & Schou,2010) or production functions (Zwarts et al., 2005) are a method used to "assess the effects of changes in quality/quantity of ecosystem services on the profitability/size of related productions/outputs". In this study a slightly different definition is used in which the quality/quantity of ecosystem services refers to the hydrological regime and the related productions/outputs are the ecosystem end services or beneficial ecosystem processes (Balmford et al., 2008). By this definition the river's hydrological regime is considered a supporting ecosystem service which is essential for the supply of a range of benefits. By just considering end-services and benefits, double counting is avoided (Balmford et al., 2008).

Methodology for Extended cost benefits analysis

The extended cost benefit analysis (CBA) combines the costs side (i.e. the financial inputs resulting from the interventions) and the benefits side (i.e. the socio-economic consequences that result from these interventions). Combining information generated in the previous sub-studies, predictions of costs and benefits were made for a period of 25 years for the three scenarios (1, 2a and 2b) relative to the baseline scenario (0) of the naturalised state of the Tana River without dams. A sensitivity analysis of the CBA results was carried out for varying climate change scenarios.

Key findings

The Tana River provides various services to people and their livelihood options strongly depend on them. For example, the seasonal flooding of the Tana River deposits a fertile layer of silt on the plain and oxbow lakes, supporting agriculture and pastoralism. The seasonal flooding also support fish rejuvenation in the Tana. Storage and purification capacities of the river system allow people to abstract water for multiple purposes, including drinking water and water for agriculture and livestock. Especially in the upper montane parts and the Tana Delta, the ecosystems provide a habitat to diverse and rich biodiversity, creating huge ecotourism possibilities. The potential to deliver ecosystem goods and services depends on the amount of water available to the ecosystems and on the hydrological regime. This may prove to be a challenge as development plans, which includes plans to utilize the waters of the Tana River for water supply for Nairobi City and for the proposed and on-going Lamu port/city, to produce food using irrigation and to develop hydropower change this water availability and hydrological regime.

For the dose-response functions, significant results were obtained for rice production, beef cattle population and health in Tana River County and Garissa County, which are all strongly correlated to changes in water flow. In literature and from interviews it was found that the Tana River, while vital for the health of the people living in the Basin, can cause lethal floods in extremely wet years. Supporting the literature study, a clear statistical relation was established between the average discharge in Garissa during the rainy seasons and the mortality rate in the Lower Tana (Garissa and Tana River counties). Mortality rates tend to increase both when the water flow is low and when it is high. Additionally, the benefits of irrigation schemes and hydropower were calculated. Irrigated agriculture currently has the potential to produce 64,000 tons of rice and maize per year. The benefits of hydropower total an annual US$ 25-43 when compared to an alternative of natural gas and geothermal generation, yet the cost of generating hydropower is also significant, as shown in the cost benefit analysis below.

The extended cost benefit analysis (CBA) combines the costs side (i.e. the financial inputs resulting from the interventions) and the benefits side (i.e. the socio-economic consequences that result from these interventions). Combining information generated in the previous sub-studies, predictions of costs and benefits were made for a period of 25 years for the three scenarios (1, 2a and 2b) relative to the baseline scenario (0) of the naturalised state of the Tana River without dams. A sensitivity analysis of the CBA results was carried out for varying climate change scenarios. The extended CBA draws a number of conclusions. First, the construction of the existing dams (i.e. Masinga and others) has generated abundant welfare for the upstream region in terms of electricity, potable water and agricultural outputs. The downstream region lost slightly more benefits than it gained. This loss mainly resulted from reduced agricultural productivity and increased health issues. The benefits of scenario 1 for downstream counties come from an increase in power supply and flood prevention. Second, the positive change that occurs as a result of the HGF dam compared is especially the increase in electricity supply. The downstream positive and negative effects show a similar but less pronounced pattern as occurred with the Masinga dam addressed in Scenario 1. Third, the million acres scenario seems to create significant agricultural benefits in the downstream

region (i.e. Tana River County) yet the large water demand of the irrigation schemes is likely to cause serious water shortages in this same region which will lead to substantial declines in health, potable water availability, fisheries and livestock. When looking at the distribution of costs and benefits at the county level, the winners and losers of the three interventions are more specifically revealed. Clearly, upstream counties such as Nairobi and Kirinyaga benefit most from the interventions. For each dollar invested in the current dams, eight dollars were returned in terms of electricity and water benefits within the county. These positive effects in the upstream counties are less pronounced in scenario 2a and 2b, yet the benefits still outweigh the costs (measured proportional to the population share in the Tana Basin). The "losers" of the current dams are the counties Kitui, Tana River and Isiolo. All downstream counties suffer from the million acres project, except for the Tana River county where most of the planned irrigation is scheduled to take place. The TEEB study demonstrates that if you want to maximally reap benefits from various interventions in the Tana Basin then you need to carefully plan the allocation of water resources. An integrated assessment which values all the costs and benefits (both direct and indirect) of current and future economic activities and the use of nature shows that past interventions like the hydropower generation brought welfare to the basin with a high benefit costs ration. However, additional planned interventions' contribution to welfare-building will be considerably less. This shows the effect of what is called a closing basin which means that water resources are becoming scarce and becoming a limiting factor in enlarging the economy and welfare. In such cases trade-offs start developing with new economic activities seeming to bring benefits when looked upon narrowly but actually creating costs elsewhere or in future when looked form a broader perspective.

Key Messages

1. Ecosystems in the Tana River Basin vital for human wellbeing and economic development, such as drinking water, hydro-electric power, fisheries, agriculture and biodiversity depends on the amount of water available to the ecosystems and hence on the hydrological regime of the Tana River.

2. Water resource developments (e.g. dams, flow diversions) have dampened the "original" hydrological regime in the Tana. High flow discharges have reduced while the low flows have increased.

3. Further reductions of the river discharge and the moderate (desirable) flooding will have considerable adverse effects on the benefits provided by ecosystem services downstream.

4. The existing dams have generated abundant welfare skewed towards the upstream region in terms of electricity, potable water and agricultural outputs.

5. Positive change will occur as a result of the HGF dam, especially the increase in electricity supply and the regulation of extreme flood events. Benefits accrue mostly upstream.

6. Large water extraction due to the so-called million acres irrigation project, will reduce overall water resources in the lower Tana to an almost constant level of natural minimum flow.

7. The million acres scenario creates significant agricultural benefits in Tana River County and Kilifi County yet its large water demand is likely to cause serious water shortages in the downstream Tana river basin resulting in an economically non-feasible benefit cost ratio of minus 4.

32. Towards operation of dam cascades, approaches of NBI in the Eastern Nile.

Michael Abebe, Regional Dam Safety Coordinator, Eastern Nile Technical Regional Office (ENTRO)

Mr. Michael Abebe holds B.Sc. degree in Hydraulic Engineering and M.Sc in Hydropower Development. He has over 25 years experience in the water and energy sectors in national, Sub-basin and Nile Basin scales. Most recently he served as Regional Coordinator of the First Eastern Nile Joint Multipurpose Program Identification studies (JMP-1 ID Studies) in ENTRO (2009-2012).

At present Michael is Regional Coordinator of Dam Safety in the Eastern Nile Technical Regional Office (ENTRO). He is responsible for the overall implementation of dam safety management in the Eastern Nile.

Abstract

Eastern Nile Water storage dams provide significant opportunities for sustainable economic development of the EN dams contribute to the creation of enabling conditions for food, energy, water security and to cope with climate change associated risks.

International experience demonstrates that riparian countries could achieve short- and long-term benefits through coordinated operation of existing and planned storage dam facilities. The benefit includes; boosting of hydropower generated, enhanced flood and drought management, climate change mitigation and cooperative irrigation development.

The Eastern Nile is home to number of large and complex storage dams. There are four existing cascade dams along the Abay/Blue Nile-Main Nile (Roseires, Sennar, Merowe, and High Aswan Dam) with an aggregate storage capacity of 182 BCM. Further the Grand Ethiopian Renaissance dam (GERD) in Ethiopia, with a storage capacity of 74 BCM will be commissioned soon. There are also three cascade dams along the Tekeze-Atbara Rivers (Tekeze, The Upper Atbara complex (Rumela and Burdana dam), Kashim Al Girba). Other dams are also in the pipeline in the subbasin.

At present, those dams in Egypt, Ethiopia and Sudan that are operating are managed without any coordination. However, uncoordinated operations of these large dams, compounded with climate seasonality, variability and/or rainfall variability, would bring changes to the river system, alter water use and management of dams and thus potentially create tensions among riparian countries. As of now, even if the countries chose to coordinate the management of these dams, they cannot simply because the technical (e.g. water release and operation rules), the institutional (e.g. responsible and accountable entity for coordinated management) and the legal (e.g. treaties encoding coordination) are not there.

Recognizing lack of coordinated reservoir operation framework at sub basin level and that coordinated operation of dams has great potential for enhancing efficient and more optimal use of water; ENTRO has developed a Road Map towards the establishment of coordinated cascade reservoir operation mechanism for Eastern Nile countries. The Road Map has outlined the steps

countries could take together to develop joint operating rules and accompanying institutional mechanisms for coordinated operation of dams in Eastern Nile.

Recently ENTRO in collaboration with Nile Sec, as part of the Nile-Sec strategic water resources analysis, has initiated a preparatory study of Coordinated Operation of Transboundary Cascade Dams in Eastern Nile: The presentation attempts to highlight the objectives, processes, scope of work and expected results of the study.

33. Challenges facing Atbara Dam Complex (ADC) Operation Management

Prof. Abdalla Abdelsalam Ahmed

Prof. Dr. Abdalla Abdelsalam Ahmed has more than 39 years of experience. He is the Director General of ShouraConsult, Khartoum. He is also a UNESCO Professor and Professor of Water Resources of Omdurman Islamic University.
Prof. Abdalla is registered as "***Consultant Engineer***" with Sudan Engineering Council – number EC/ER/CE/279.
Prof. Abdalla is basically a Civil Engineer graduated in 1978- Khartoum Univ. and obtained his PhD from Glasgow Univ. – UK (1984) in Hydraulic Engineering. He has a wide experience in various fields of water resources issues, e.g. Policies, Planning and Management, Irrigation Managements, Water Harvesting, Reservoirs and Irrigation Canals Sedimentation, River Basin Management, River Bank Protection, Water Supply and Sanitation, Water Pollution, Environment and related fields, etc.
Being Deputy Commissioner of Gezira Irrigated Scheme and a Minister of Agriculture, Animal Wealth and Natural Resources, *Prof. Abdalla* chaired many Board of Directors and National Committees in the field of Agriculture Production, Animal Wealth and Water Management.
Prof. Abdalla gained a comprehensive experience through his work as an international, regional and national Consultant in various fields of water resources projects. He also worked as an instructor, a lecturer and a facilitator for several training courses e.g. PhD, M.Sc. and Higher Diploma programmes, in addition to the short training courses.
Prof. Abdalla as a Consultant and an Expert works with international organization e.g. UNESCO, UNICEF, IFAD, FAO, USAID, OFDA and others. He worked with several Nile Basin Initiative (NBI) programmes (in particular ENTRO) as a consultant, e.g. Shared Vision Programme e.g. Applied Training Programme, and Water Resources Planning and Management programme ---- etc.. Moreover, he participated as a consultant in many Subsidiary Action Programmes, e.g. Eastern Nile Projects, Watershed Management, Flood Risk Mapping, IWRM, DSS ... etc.
Prof. Abdalla is a fellow and a member in many international, regional and national Associations. He published more than 100 technical and scientific papers, in addition to several books and technical reports.

Abstract:
Atbara River is one of the tributaries of the Nile River. It is the most northerly tributary of the Nile flowing from the Ethiopian Highlands. It has two branches Setit River (called in Ethiopia Tekeze) and Upper Atbara River. The total catchment area of Setit and Upper Atbara rivers is about 97000 km² (68000 km² and 29000 km² respectively).
ElGirba Dam (KED) was constructed on Atbara River in 1964 with a storage capacity of 1.3 bcm. Since then the KED lost about 65% of its storage capacity due to sedimentation. Currently there are two dams (DCUA) under construction, each on one of the two branches (Setit, Upper Atbara) with total storage capacity about 3.700 bcm (2.52 bcm for Burdana reservoir on Setit River and 1.18 bcm for Rumela one on Upper Atbara river). The two reservoirs are linked by a channel flowing from Burdana to Rumela. Several recommendations are provided by a Consultant to operate the Atbara Dam Complex (ADC) - (the two reservoirs plus KED). The main objective of the project is irrigation, drinking water supply and hydropower generation.
The ADC is KED, Burdana and Rumela reservoirs, Figs (1a, 1b and 1c). Operation of the three reservoirs needs strictly coordination to facilitate effective water resources management and satisfy the needs of all the stakeholders in a balanced manner. Therefore, ADC should serve the following water users:-

• Irrigation requirements for the existing New Wadi Halfa Scheme plus - in the future – Upper Atbara Irrigation Project (UAIP)
• Hydropower generation,
• Domestic water supplies for New Halfa and ElGadarif cities.
• Environmental flow D/S of DCUA and further D/S of KED.

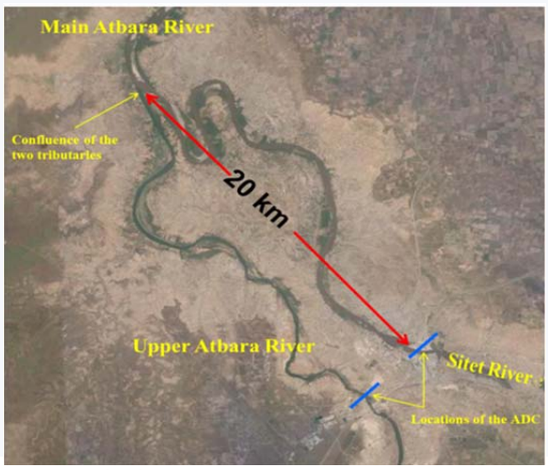

Fig (1a) Layout of ADC and the Confluence

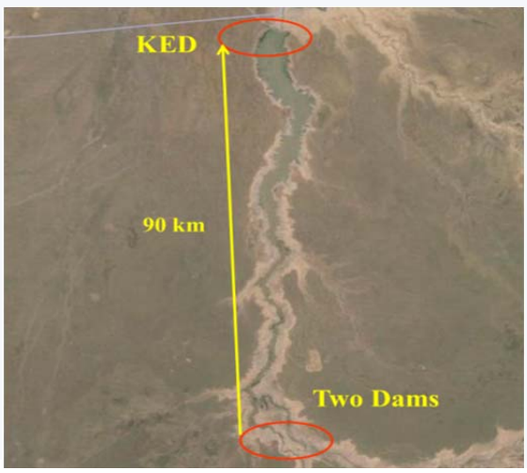

Fig (1b) Layout of ADC

In addition, the sediment should be managed in a manner to satisfy the effective use of the reservoir capacity over a longer period of time.

Fig (1c) Rumela, Burdana Reservoirs and the Linking Channel

Challenges facing ADC Operation

The three reservoirs need to be operated in conjunction at all times and coordination with the U/S TK5 in Ethiopia. From KED, the existing irrigation systems are commanded and also UAIP will be provided with water from these reservoirs. Sediment management operations like flushing need to be synchronized for both reservoirs.

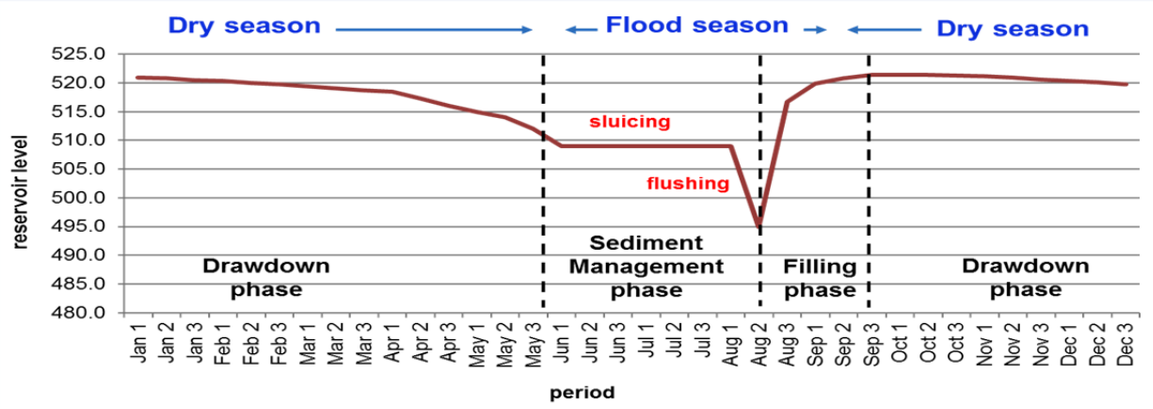

Fig (2) ADC Operation Rules Curve, Mohamed et al 2014

Fig (2) represents the proposed operation mode of the ADC reservoir. The river is expected to carry less sediment due to trapping in the U/S reservoirs (TK5 (Exist), TK6 and TK7 (planned) along Tekeze river). On the other hand, the water availability will be highly affected which will lead to negative impact on all the development activities D/S in the near future. Although TK5 has been operated since 2010, however the Sudanese side has no information what so ever about its operation rules, a situation which puts ADC at *RISK*.

The experience gained from the reservoirs management in Sudan, in particular KED will be reviewed and discussed. Sediment management will be the core of the operation rules which will govern ADC. This means that the sustainability of the reservoir to serve its purposes, on which the feasibility study is conducted, mainly depends on how ADC will be operated. The impact of the upstream development on the ADC operation (i.e. Ethiopia Tekeze Dam – called TK5) will be examined.

ADC Operation and U/S Tekeze Dams

Tekeze river (8.2 bcm at TK5 dam location) is considered the main branch of Atbara river; therefore its impact on ADC operation mode is significant. Besides, what is mentioned previously regarding the sediment management, cooperation in operating the U/S dams on Tekeze river in Ethiopia in harmony with ADC will increase the benefits out of it, in particular, hydropower generation and irrigation potential. The latter is attributed to the fact that the U/S dams will regulate the river flow throughout the year and there will be no peak during the rainy season (July, August and Sept.). Moreover, Tekeze river is a seasonal river runs at TK5 Dam location 6 to 7 months, but it is expected after construction of these dams (TK6 and TK7) it will provides a regular flow throughout the year which will increase the benefits out ADC significantly. Although both Sudan and Ethiopia encourage cooperation in water resources management, however, up to this moment there is no data and/or information exchange or linkage between ADC and TK5 authorities in operation of the two dams..

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Concluding Remarks

1. The general set up of the two dams (Rumela and Burdana) together with the KED regarding locations and flow characteristics is very complex.

2- Although the Hydropower generation comes in second order, however in seasonal river coupled with high sediment flows, the operation of ADC will be more complex. In case the reservoir inflow is lower than the power requirement at Rumela, power generation will rapidly halt. On the other hand, the irrigation and water supply needs will be in jeopardy. One of the solutions adopted to manage the sediment in the three reservoirs is *Flushing*. However, flushing has a limited added value in terms of lowering the annual sediment trapping ratio but has still a positive effect. The main challenge in ADC is that the three reservoirs should be operated in the same time. This means in the near future KED reservoir will no longer store any water due the high sediment concentration released from the two upper reservoirs, Fig (1b). There is no available new irrigated scheme UAIP at

present and the old New Wadi Halfa is not ready to consume additional water. Therefore, the ADC will be operated to generate Hydropower for some time (or years to come) before we have new irrigation projects.
3- The Author of this paper believes that the governing factor in operation of ADC should be the sediment management to protect the reservoir storage capacity against sedimentation. This is the only way to keep the reservoir life span reasonable and acceptable.
4- It is a fact that the sluicing, when practiced at relatively high water levels, and short time flushing are not successful in sedimentation management. The practice in KED resulted in about 65% loss of reservoir capacity and the effectiveness is limited to the river valley only and for very limited upstream distance (< 5 km).
5- The uncontrolled Connection Channel (CC) linking Rumela and Burdana reservoirs is adding further complications to the sedimentation management issue. The two river branches differ in many ways regarding discharges means and peaks, timing, sediment loads, filling and emptying, structural facilities and U/S developments.
a- The CC is prone to annual sedimentation and may be filled up in few years.
b- At the same time depending on filling/emptying rates the CC is prone to scour especially the recently deposited sediment. This will generate lateral inflow of huge sediment load which may threaten the Hydropower intakes and turbines as well.
6- The delta formation in the active zone, propagation rates, and rates of both active and live storage loss in the two reservoirs are not well investigated, since the data available is rare (sediment deposition distribution)?
7- The operation rules of ADC identified so far are not convincing, since it is clear that they give Hydropower generation an upper priority regardless of the reservoirs sustainability. There is no doubt ADC using the suggested operating rules will lose significant part of its storage capacity in the first few years.
8- The flow current from Burdana reservoir through the linking channel (CC) to Rumela reservoir in front of the turbines will create a large loop, high flow circles and hence high sediment deposition, taking into consideration that the bed level of Burdana reservoir is higher than that of Rumela by 3 m. This might lead to frequent blockage of the Turbines Intakes, which means hydropower reduction or stoppage.
9- The future proper operation of ADC is dependent mainly on the cooperation between Ethiopia and Sudan. This is necessary to run all dams reservoirs in Atbara Basin System in harmony. Therefore, operating these dams based on data and/or information exchange between the two countries will facilitate an effective and efficient use of the available water resources.

34. SEEKING COMPROMISE WITH THE GRAND ETHIOPIAN RENAISSANCE DAM

Kevin Wheeler PhD, PE, University of Oxford, Water Balance Consulting

Eng. Kevin Wheeler is professional engineer, PhD candidate in the Environmental Change Institute at the University of Oxford and recent Research Fellow in Sustainability Science at the Harvard Kennedy School of Government. His work focuses on trans-boundary rivers and increasing water security through cooperation, specifically through collaborative risk-based modelling within negotiation contexts. His work explores incrementally coordinated development and management strategies. With over 15 years of consulting experience, Mr. Wheeler has worked on a variety of water-related issues ranging from community-based water development to trans-boundary disputes, including the successful negotiations between the USA and Mexico over the Colorado River. For the last 5 years, he has focused on the Nile River by exploring potential cooperative development between Ethiopia, Sudan and Egypt.

He holds an MSc in Water Science, Management and Policy from Oxford, an MSc in Water Resource Engineering, and BSc in Civil/Environmental Engineering from the University of Colorado.

Abstract

Keywords: Renaissance Dam, GERD, hydropower, modelling, coordination, RiverWare, Ethiopia

Background

The Grand Ethiopian Renaissance Dam offers both a risk and an opportunity for the countries of the Eastern Nile Basin. The benefits of cooperation have been acknowledged by the leaders of Egypt, Sudan, and Ethiopia through the declaration of principles, however the dam is scheduled to be completed in the coming months, and if downstream risks are to be minimized, the concepts of cooperation must soon translate into tangible actions of coordination. The process of filling the reservoir provides the first opportunity to demonstrate this willingness. This research first focuses on exploring potential cooperative solutions to fill the reservoir and evaluates the benefits and risks to all three countries (Wheeler et al., 2016). The second part builds upon this analytical framework to evaluate the long-term technical efficacy of possible agreements in the light of the potential effects of climate changes and increases in upstream development.

Methodology and approach

Cooperation is not a binary phenomenon and can be conceptualized as a continuum ranging from unilateral actions to full integration of decision making. Reservoir coordination can also be mapped onto this spectrum with varying degrees of joint planning, communication, and operations. This work builds upon an effort that began at ENTRO in 2012 to construct a RiverWare model of the Eastern Nile that would have the flexibility to explore and test essentially any joint operation strategy that can be envisaged by the countries under a multitude of hydrologic scenarios. The Eastern Nile RiverWare Model (ENRM) has continued to develop with the participation of ministries and universities across the basin, and contains an accurate representation of current multi-objective operations for most reservoirs. Using a reconstruction of the 1900-2002 basin-wide hydrologic flows performed by Deltares (van der Krogt & Ogink, 2013), 103 different scenarios could be tested using the index sequential method (Kendall & Dracup, 1991) therefore allowing potential policies of the GERD to be stochastically evaluated throughout the transient filling period. Concurrently, operations of the Sudanese and Egyptian reservoirs were incrementally modified to simulate cooperative planning and operation with the releases from the GERD. These releases can be simulated using any logical combination of objectives including hydropower generation demands, meeting negotiated delivery volumes, or meeting specific downstream needs. Highly cooperative solutions include releases that are dependent on the state of the downstream reservoirs.

The critical components included in potential operational policies, and the factors that influence their implications on current water uses, were identified and evaluated using the RiverWare hydro-policy modelling framework. First, the principal cooperative policy examined is an agreed annual release from the GERD throughout the filling period which both provides water security to downstream users and allows the GERD to fill faster under high flow conditions. With a historical annual flow of 49.4 BCM at the dam location, agreed annual releases ranging from 25 BCM to 50 BCM were examined. Second, the effects of various initial pool elevations of the High Aswan Dam ranging from 165 m to 180 m were examined. Third, adaptations to Sudanese reservoir operations during the filling period are simulated which demonstrate the need for such measures to be taken to protect Sudanese water supplies.

Fourth, implementation of the current drought management policy for the High Aswan Dam was examined. Finally, the concept of a 'safeguard release' was evaluated that would allow additional releases from the GERD if the pool elevation of the High Aswan Dam is projected to approach the minimum power generation elevation. Using the GERD to protect the High Aswan Dam in critical conditions represents a strongly cooperative agreement.

The second phase of this work extended the principles of coordination described above into long-term operations. Using the objectives of maximizing energy generation and minimizing the risk of shortages to water supply for each of the three countries, a multi-objective evolutionary algorithm (MOEA) was applied to sample alternative agreed annual releases while refining the variables that define the current drought management policy of the High Aswan Dam. A non-dominated suite of potential management guidelines using a multi-dimensional Pareto front could then be identified to inform policy negotiations. Various optimal solutions are developed using an ensemble of synthetically generated flows from a simulated annealing technique that match historical statistical characteristics

(Wheeler, Simpson, Borgomeo, & Hall, 2017). The resilience of these policies could then be evaluated under scenarios of increasingly altered climate conditions by perturbing the annealing algorithm to simulate higher occurrences and longer persistence of droughts.

Key findings and recommendations

The results of all scenarios demonstrate that a substantial amount of hydropower will be available from the GERD, however if a cooperative filling arrangement is not reached, risks to downstream users do increase during the filling period of the reservoir. It is also clear that these risks can be minimized or eliminated if the countries can agree on a coordinated filling strategy. The modelled effects on water availability and energy generation demonstrate that water diversions in Sudan can be largely assured through adaptations to Sudanese reservoir operations. The risks to

Egyptian users and energy generation can be minimized through combinations of sufficient agreed annual releases from the GERD, a drought management policy for the High Aswan Dam, and a basin-wide cooperative agreement that protects the elevation of Lake Nasser. Longer-term agreements must consider the potential for increased sequential droughts that are similar to 2015 when a seasonal flood didn't occur. The storage of the GERD can be a mitigating factor for such risks.

Moving beyond the concepts of cooperation to implementing practical coordination is not a trivial task and the groundwork to allow this to be possible can begin immediately. Information must flow both upstream and downstream throughout the filling process and reservoir coordination will require data sharing procedures, quality assurance protocols, and dispute resolution mechanisms. The immediate electricity that the GERD will generate will benefit much of Africa, but the courage of the countries to find a compromise will be written into history and determine its future.

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35. National Water Projects in the Eastern Nile Basin: Drivers to Conflict or Cooperation?

Mina Michel Samaan PhD Candidate, Department of International Relations, Technical University of Braunschweig, Germany

Mina Michel Samaan has been working in the Department of International Relations at the Technical University of Braunschweig, Germany, since November 2013 through a full PhD scholarship funded by the DAAD. In August 2017, he defended his PhD thesis successfully, examining the process and mechanisms through which conflictive and cooperative outcomes have been generated over large-scale developmental schemes in the Nile Basin along the past 150 years. His research work has been presented in several international conferences, as MPSA 2016, SWWW 2016 and ISA 2017. Mina's home institution is Mansoura University, Egypt, where he had accomplished his undergraduate and masters studies in architecture in 2008 and 2013 respectively and worked as a lecturer assistant for five years. During those years, Mina had participated in multiple research projects and summer schools in Egypt, Germany and the USA, all of which focused on sustainable development and energy efficiency in hot arid regions.

Abstract

The Eastern Nile Basin (ENB) embodies the dilemma of common-pool resources that crosscut borders of sovereign states. Such transboundary resources may either catalyze cooperation or provoke conflict among the riparian states sharing them.

The asymmetric configuration of the ENB and the growing needs of its populations put heavy burdens on the basin's resources. Egypt—the downstream state—has been fully dependent for millennia on the Nile; its lifeline and sole source of freshwater. This is evident in the fact that about 95% of Egyptians settle in the Nile Valley and Delta, which represent about 5% of the country's total land area. Ethiopia—the upstream state that contributes to about 85% of the Nile flow reaching downstream—relies mainly on rainfalls that are unevenly distributed across the country in space and time, which makes it highly vulnerable to frequent floods and droughts. In addition, Ethiopia faces severe challenges in meeting its energy demands and in alleviating poverty. Sudan—the midstream state—suffers also from serious shortages in its energy sector, particularly after the separation of South Sudan; the territory where most of the oil resources exist.

Aiming at boosting their national water-energy-food security nexus, each of the three countries has developed ambitious national water projects to exploit the basin's resources located on their territories for hydropower and irrigation purposes. Each of these projects has multiple benefits and costs of local, national and international dimensions. Synergies and tradeoffs generated by these national projects may drive the riparian states either to conflict or to cooperation. Yet, the history of mistrust and the uncertainties of climate change substantially increase the complexity of achieving cooperation over these projects.

This study investigates the extent to which the national water projects adopted by Egypt, Ethiopia, and Sudan are compatible with one another. In specific, the investigated projects include the desert reclamation plan in Egypt, the Merowe Dam, the heightening of the Roseires Dam, and the Atbara-Setet Dam in Sudan, and the Tekeze Dam, the Tana-Beles project, and the Grand Ethiopian Renaissance Dam (GERD) in Ethiopia. Three compatibility criteria are used, covering the intrastate, interstate, and regional perspectives. This is done through analyzing the distribution of benefits and costs respectively among different sectors across each country, among the three riparian countries, and among neighboring countries in the MENA and East African regions.

The main finding of the study indicates that the most complex criterion is the compatibility of projects from the interstate perspective, in which the national projects adopted by Ethiopia and Sudan are highly compatible with one another, while they are together incompatible with the Egyptian plan. The study emphasizes that the historical and recent political backgrounds have led all the investigated projects to be planned from a national perspective rather than a basin-wide perspective. The key message of the study is that the only way to achieve regional prosperity in the basin is revising and managing those projects multilaterally rather than unilaterally based on maximizing net benefits for all riparians with particular emphasis on fair distribution of benefits and costs among them. Recently, the three riparian states have taken a significant step in dealing cooperatively with the GERD dispute. However, this should be complemented with further efforts to reach a win-win outcome over all the other projects in addition to the GERD. Obviously, the governmental actors alone cannot accomplish this ambitious goal, but transnational scientific networks and civil societies should be more active in raising the public awareness about the vitality of achieving regional integration through providing multidisciplinary studies that present feasible solutions for fairly rewarding cooperative projects.

Keywords: The Eastern Nile Basin, national projects, water-energy-food security, compatibility, conflict, and cooperation

36. Beyond legalisms: toward cooperative governance of resource security in contested transboundary spaces, Belynda Petrie,

Belynda Petrie *is the CEO of OneWorld Sustainable Investments, with 16+ years of experience in international water governance, energy and climate change. She is instrumental in facilitating transformative pathways for climate-adapted development. Ms Petrie is leading a water law equivalence assessment for the Zambezi Watercourse Commission and recently completed a discussion paper on the Okavango Basin Agreement, in terms of prevailing water, climate and development issues. Ms Petrie led the development of the Green Economy scenarios chapter for the UN Economic Commission for Africa's Economic Report on Green Industrialisation in 2016, analysing continental green growth and business as usual development pathways, drawing on country case studies while modelling co benefits.*

Ms Petrie has led the implementation and methodology development for several water, climate and development risk and vulnerability assessments across Africa's river basins. She is a PhD candidate at the University of Cape Town and a frequent advisor on large scale water, climate and development programmes in Africa.

Abstract

The paper should present innovative ideas and policy insights of social, political and cultural factors, governance frameworks towards regional cooperation and means of achieving integration and equitably shared benefits..

Keywords
Regional integration, transboundary governance, water security, sovereignty, political economy, social capital, cultural factors, equitable benefit sharing

Background
Until recently, regional integration has been mostly about trade and trade relations. However, recent trends in the management of environmental resources and related investments, particularly water resources, points to the necessity of regional integration across other spheres of transboundary governance (UNECA, 2016). Climate changes, which occur across country boundaries and regions (albeit with different levels of impact) heighten the urgency for integrated approaches to managing and benefitting from shared resources, and promoting their security for populations and economies (Petrie et al, 2014, Midgley et al, 2012). Sharply rising demand for the resource is threatening water resource security around the world as populations increase and urbanisation accelerates, further exacerbated by climate change. Water is the stress multiplier – climate change and development decisions manifest in stressed water resources (Spalding-fecher, et al, 2014; OneWorld and FCO, 2010) - and in developing regions such as Africa, poor governance further undermines water security (UNECA, 2016, Morck-Jansen et al, 2013).

In Africa, natural resource security is increasingly reliant on transboundary governance and regional integration and cooperation. Many of Africa's river basins are shared by two or more countries, a function of colonial divides and topography. Some are shared by as many as eight or ten countries,

creating complex transboundary governance contexts across divergent social structures and cultures. For instance, the Nile River Basin (NRB) is shared by ten countries and the Zambezi by eight.

At the same time, shared watercourses generate economic benefits that are and can be shared across boundaries, with the potential to benefit populations. These include water transfers, energy generation (e.g. from hydro-electric power), irrigation, and food and livelihoods. Few, if any industrial developments, including mining, operate effectively without reliable energy and water access; in fact, many pollute water and over-use both water and energy. Furthermore, the globally acknowledged threat of climate change has negative impacts that are seldom confined to political boundaries - for example, the effects of the recent drought in southern Africa have been felt across borders, particularly for water, food and energy provisioning. Investments in mitigating these threats is rapidly increasing in the form of international climate finance, which in Africa, is primarily needed to protect already scarce natural resources such as water. The growing number of transboundary legal agreements and related policy and strategy instruments at river basin and regional levels suggests that countries are joining forces to coherently manage and protect natural resources, as if those resources belonged to multiple countries. However, there are few, if any, examples of this sharing actually happening. At the moment, most countries prefer to stick to historic and colonial approaches of protecting their sovereign interests.

This situation is however starting to shift. Collaborative policy instruments, rather than legal agreements with mandatory requirements, are increasingly being developed through consensus building approaches that make deviation from the resultant mechanism difficult for the riparian countries involved. Because most African countries are desirous of shared benefits from shared watercourses, and because the legal instruments at their disposal are typically an inadequate enabler, river basins are seeking innovative use of alternative, but related policy and governance mechanisms. The Okavango, Zambezi and Senegal River Basins provide useful examples and are in direct contrast to some of the more legalistic instruments available as international best practice, such as the Israel Jordan Peace Treaty, which has a chapter on water governance.

This paper elaborates on the underlying governance issues and the social and political economy interests that block or advance transitions to regionally integrated resource management and benefit sharing, and demonstrates examples of evolving good practice and trends. The paper highlights that although sovereign interests prevail in Africa (and other regions), water resource security is a common objective among most nations. Continuous reference is made to evolving international good practice and to the nature and efficacy of existing regional agreements, protocols, policies and practices as well as to emerging good practice resultant of innovative approaches. The research paper builds on the hypothesis that regional integration, cooperative governance and benefit sharing approaches are cornerstones of effective resource security, noting the transboundary nature and risks of natural resources and their development.

Approach and Methodology

The paper will draw lessons from current and recent developments in other large African river basins, such as the Zambezi, the Okavango and Lake Chad. The hypothesis is that embedding the dimensions of water security (e.g. equitable resource use, planned development, regional integration, dispute resolution, benefit sharing, climate change planning, etc.) in transboundary governance mechanisms and systems, and harmonizing these will promote cooperation. The approach is built on the premise that political economy issues and social and cultural practices and beliefs, advance or obstruct transitions toward regional cooperation and integration in

transboundary water resource management, arguing that legalisms alone will not ensure desired transitions.

The research and policy framework consists of research methodology to provide the necessary evidence, with the following elements: desktop research and literature reviews; quantitative methods and stakeholder interviews and dialogues (participatory analysis) in the Zambezi and Nile Basins (as a basis for indicative comparative analysis).

The purpose of the analysis is to provide evidence-based policy insights in a highly political-economy charged context. Policy is not typically derived from a theoretically-based framework and therefore, participatory analysis is a critical component of the methodological framework. This is particularly important in the context of transboundary resource governance, a highly-contested terrain where some countries seek to exercise hegemonic power.

The research will draw on literature available on approaches that successfully drive regional integration in other sectors, with a view to learning important governance lessons from these. Dani Rodrik's observations from engaging in industrial policy processes are highly relevant for example. He describes industrial policy as being a discovery process where governments (and firms) "...learn about underlying costs and opportunities and engage in strategic coordination" (Rodrik, 2004). He proposes that the right model is one of strategic collaboration to reveal "...where the most significant obstacles to restructuring lie and what type of interventions are most likely to remove them..." (Rodrik 2004). He emphasises the necessity for designing and building institutions that have the capacity to allow governments to let go of losers, given that they can never pick the winners, stating "..that's a much less demanding requirement on the system than simply presuming that government can pick winners, because it allows that the government will make mistakes. In fact, from this perspective, making zero mistakes is surely suboptimal" (Rodrik, 2009).

Key findings

Cultural, social and political issues impede the implementation of legal instruments – at national and transboundary levels and slow the pace of change. In fact, it is suggested that legal instruments can be used to disadvantage transitions, when not properly contextualised and/or clarified. Formal legal vehicles, such as the International Court of Justice are seldom used to resolve disputes on the Continent over water and development (or other issues), primarily for cultural reasons; few African leaders are prepared to publicise their disputes with fellow leaders in an international court setting, preferring rather to resolve these differences or disputes quietly and bilaterally. At the country level, many policy makers recognize that change is not only necessary, but urgent. They want regional integration but they also want this on their own terms. The combination of cultural, socio-economic and political factors in countries that are dependent on the cooperation of their neighbours for water security, is driving innovation in policy development – and this is starting to change the game. Understanding, and dealing with these terms is the critical success factor.

Conclusions and recommendations

Cooperative and sustainable transboundary governance is underpinned by governance frameworks which promote regional integration that is responsive to both the winners and losers in the transition process. Using insights of social, political and cultural factors, these governance frameworks ideally apply strategies for identifying the obstacles to transition and for removing these. Adaptive management, or learning by doing, is the foundational principle of these frameworks, recognising that mistakes will be made and that learning from these is preferable to not making any at all. Regional integration is the primary objective, and equitably shared benefits is the means to achieving this. Ultimately, equitable sharing of benefits will promote water security.

The political economy of water management in shared river basins needs to be well understood, pinpointing the entry points for change. Governance mechanisms and systems need to be clearly and visibly contexutualised by social capital and cultural factors to ensure that transboundary governance is inclusive of political, civil society and private sector actors rather than creating adversaries.

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37. Transboundary water governance and cooperation through a Benefit Opportunities Assessment Dialogue in the Sio-Malaba-Malakisi Sub-Basin in the IGAD region[6]

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Abstract

Keywords: transboundary cooperation; stakeholder dialogue; benefits assessment; joint decision-making.

Summary. In many countries, scarce water resources are shared between different stakeholders for multiple uses. These stakeholders often represent varied interests, drawn from different sectors[11] and levels[12] from local to national to regional scales in transboundary settings. How can joint decision-making processes for shared water resources management yield better and more sustainable benefits across different scales and stakeholders? This paper presents a benefit opportunities assessment methodology being piloted in the Sio-Malaba-Malakisi sub-basin, shared between Kenya and Uganda as part of the wider Nile Basin. The methodology helps to facilitate cooperation through deliberate steps engaging multiple stakeholders at multiple levels in jointly identifying benefit sharing scenarios. The approach expands upon existing guidance provided to countries to identify how benefits can be improved through inclusive dialogue and cooperation, leading to jointly prioritized investment opportunities for development.

[6] This paper will be presented under Sub-theme 5: Water Governance: Addressing Emerging Nile Basin Issues, during the 5th Nile Basin Development Forum 2017 whose theme is "Investing in Nile cooperation for a water secure future", October 23rd-25th, 2017, Kigali Rwanda
[7] IUCN ESARO, Nairobi
[8] IUCN Global Water Programme, Geneva
[9] UNECE, Geneva
[5] Inter-Governmental Authority on Development (IGAD) Secretariat, Djibouti
[6] Agriculture, Land, Environment and Natural Resources, Forestry, Water, Mining, Fisheries, Energy, Foreign Affairs, CBOs/NGOs etc.
[7] Regional, National, County, Districts, Catchments etc.

Background. This paper presents a benefit opportunities assessment methodology being piloted in the **Sio-Malaba-Malakisi (SMM) sub-basin, which is part of the wider Nile Basin and shared between Kenya and Uganda.** The SMM sub-basin has a population of about 4 million people and a wide variety of ecosystems including lakes, rivers, forests, game reserves, and national parks that are home to a rich variety of fauna and flora of high tourism value. These provide opportunities and tremendous potential for socio-economic development and investment. Despite this potential, the sub-basin faces constraints primarily from deteriorating water quality and increasing water scarcity. Agriculture is the major socio-economic activity in the sub-basin, employing about 85% of the working population. Poor agricultural practices have resulted in extensive catchment degradation. Intensive land cultivation up to the riverbanks and indiscriminate sand harvesting of river banks and river beds are causing excessive sediment loads and resulting in water quality decline.

Cooperation among the two riparian countries has evolved to formal establishment of a Memorandum of Understanding, which is managed under the Nile Basin Initiative Nile Equatorial Lakes Subsidiary Action Program (NELSAP) framework through the SMM River Basin Management Project. Strengthening transboundary cooperation in the SMM basin has the potential to accelerate socio-economic development and reverse environmental degradation.

To build on this, the International Union for Conservation of Nature (IUCN) and UNECE's Water Convention Secretariat are supporting the IGAD Secretariat and its Member States in implementing a project titled "Strengthening transboundary water governance and cooperation in the IGAD region", which aims to improve trans-boundary cooperation between riparian countries by facilitating application of hydrodiplomacy at multiple levels and strengthening capacities for the governance of shared waters resources.

At the SMM basin level, the project seeks to answer the following question: how can joint decision-making processes for shared water resources management and development yield better and more sustainable benefits across different scales and stakeholders? The project is supporting Kenya and Uganda to undertake a Benefit Opportunities Assessment Dialogue with the aim of identifying opportunities for enhanced benefits for stakeholders across sectors and levels.

Methodology. The methodology helps to **facilitate cooperation through deliberate steps engaging multiple stakeholders at multiple levels in jointly identifying benefit sharing scenarios**. The Benefit Opportunities Assessment Dialogue is structured as follows: **1]** A 1st SMM stakeholders' consultative workshop to engage in an SMM basin visioning process – analysis of challenges and opportunities for joint basin management and development. Through interactive joint assessment within a basin context, stakeholders are able to identify different types of existing benefits as well as opportunities for additional benefits from cooperation. **2]** A 2nd SMM basin interactive stakeholders' workshop for joint qualitative exploration of specific collaborative water management scenarios using the Benefit Opportunity Assessment Tool (BOAT) developed by IUCN. This will include identification of potential trade-offs for the water-energy-food-ecosystems nexus, distributional effects across stakeholder groups and possible compensation mechanisms, identification of preferred scenarios and additional data needed for the quantification of preferred scenarios; **3]** An analysis and establishment of the institutional mechanisms most conducive to transboundary water governance, cooperation and development at SMM basin level as well as for the sustained implementation of benefit-sharing solutions in the basin; **4]** A 3rd SMM basin workshop with key stakeholders and development partners for the discussion and prioritisation of improved water management, investment, and development opportunities for the enhancement of

shared benefits. The Dialogue series will result in a step-by-step roadmap for building cooperation through future investments and development opportunities. In addition, SMM basin key stakeholder representatives will engage in learning and exchange by visiting the International Sava River Basin Commission and the Rhine River Commission and participating in a special session of the IUCN-BRIDGE[13] Academy, to learn about institutional mechanisms for multi-sectoral and multi-stakeholders cooperation and engagement on water.

The approach expands upon existing guidance provided to countries to identify how benefits can be improved through inclusive dialogue and cooperation, leading to jointly prioritized investment opportunities for development. In conclusion, it is expected that the lessons learnt from the SMM sub-basin will in turn inform both regional level processes and cooperation efforts in other sub-basins in the Nile basin and in the IGAD region by demonstrating how inclusive dialogue processes among stakeholders can enhance benefit opportunities through collaborative management and development of water resources, leading to greater basin-level and regional stability.

38. Project based transboundary cooperation: the case of the Grand Ethiopian Renaissance Dam project (GERDP)., Eng. Gedion Asfaw

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Abstract

Keywords: cooperation, panel of experts, GERD,

Background

The inauguration of the Grand Ethiopian Renaissance Dam Project (GERDP) took place on April 2, 2011. The dam site is located in Guba woreda (district) in Benshangul-Gumuz Regional state about 700km north western of Addis Ababa and some 20 km upstream of the

[13] BRIDGE: Building River Dialogue and Governance, an IUCN programme supporting transboundary water governance and cooperation in 6 regions and 14 basins across Africa, Asia and Latin America.

Ethio-Sudan border. The dam is located at the same site identified by United States Department of the Interior Bureau of Reclamation (USBR) in the study entitled Land and Water Resources of the Blue Nile Basin of Ethiopia conducted during 1958 and August 7, 1964.
The GERD Project comprises a 145 m high dam (170 m in correspondence of the River Gorge) and creates a reservoir with a surface of some 1,874 km2 and a total storage of some 74 Bm3. It has a surface Power House equipped with 16 power generating units, two units for early generation 375 MW each and 14 units with nameplate capacity of 410MW, for a total installed capacity of 6490MW (originally 5250 and later 6000MW). At the GERD site, the catchment area is some 172,250km2.. The long term mean flow at dam site is estimated to be 1,547m3/s. Seasonal variations are extreme, with monthly mean flow ranging from around 131 m3/s in April to more than 5,678 m3/s in August. The plant will produce 15,128 GWh annually, generating more than 750 M€ per year in revenue, and it has been estimated that it will cost approximately 0.63 M€/MW to construct.(Ref 1, p.2).
Such a huge project under construction on a transboundary river (the Nile) necessarily requires close cooperation among the three countries of Egypt, Ethiopia and Sudan. Currently the three countries are consulting on the conduct of the two IPoE recommended studies.

Methodology and approach
The methodology followed included literature review and the author's direct involvement in the process of the tripartite negotiations of Egypt, Ethiopia and Sudan during the last six years, including being a lead member of the International Panel of Experts and chair of the Tripartite National Committee of Egypt, Ethiopia and Sudan**.**

Key issues and findings,
The Ethiopian government expressed its desire to cooperate with Egypt and Sudan on the GERDP by inviting the two countries to join it in establishing an International Panel of Experts (IPoE) to examine the impacts of the project on downstream countries. Subsequently, a tripartite ministerial meeting of Ethiopia, Egypt and Sudan, which was held in Addis Ababa in November 2011, approved the terms of reference and rules of procedure of the IPoE.
The mandate of the IPoE was *"to review the design documents of the GERD, provide transparent information sharing and to solicit understanding of the benefits and costs accrued to the three countries and impacts, if any, of the GERD on the two downstream countries so as to build trust and confidence among all parties."*
On May 31st 2013 the IPoE submitted its final report to the governments of Ethiopia, Egypt and Sudan. The report enjoyed a mixed reception from the three countries, international community, regional organizations and civil society. This particularly emanated from pre-conceived ideas and expectations held by various stakeholders regarding the outcomes of the IPoE.

Following the submission of the final report, excerpts from the report were used by different actors in ways that suited their respective political perspectives and orientation. Extreme views such as proposing to halt the construction of the GERD were observed in the international media, including a threat of war by some elements in the previous government of Egypt.
Over three years after the submission of the final IPoE report, dialogue among the three countries has continued, centered on the recommendations of the panel. A Tripartite National Committee composed of four experts from each of the three countries is now making the necessary follow up on the conduct of the two IPoE recommended studies. Visits from leaders, ministers and experts from the three countries to the GERDP have continued, while technical meetings have been conducted in each of the three countries on a rotational basis thereby fostering greater opportunities for understanding. This process culminated in the signing of the Declaration of Principles (DoP) by the Heads of States of Egypt, Ethiopia and Sudan in March 2015. The significance of the DoP lies in the fact that the three countries agreed for the first time in the *"equitable utilization and causing no significant harm "* principles in the use of the Nile waters. This was misinterpreted as if Ethiopia has abandoned the CFA process, overlooking the fact that this is a project based sub regional cooperation envisaged in the CFA.

Future water availability and use scenarios in the eastern Nile basin show huge imbalance between availability and demand and negotiating countries realizing this fact tend to argue for consideration of their future demand in the impact study.
In the course of the tripartite consultations related to the conduct of the downstream impact studies, thorny issues such as the current water use and what baseline to utilize for impact assessment studies have transpired and still remain sources of disagreement. As indicated by many researched studies the key and common concerns of the three countries are the filling and long term operation of the GERD which will be among the outputs the ongoing study.

Conclusions and recommendations

- Although the three countries are striving to promote their cooperation on the GERDP, the complexity of issues related to the project, and the Nile in general, require continued collaboration and negotiation based on scientific knowledge and compromise.
- The huge storage capacity of the dam (74BMC) created apprehension and with frequent negative media reporting the public opinion in the downstream countries made cooperative efforts difficult. Thus the role of media in promoting cooperation needs to be recognized and cooperating parties should have media strategy that encourages constructive engagement of the media through transparent information sharing about the project and status of the negotiation process.
- Negotiating countries should recognize the most obvious advantages of GERD in the provision of stored water during drought and cheap renewable energy for the region and transparently discus on all impacts of the GERD with the aim of enhancing the positive impacts and avoiding and mitigating the adverse impacts..
- The cooperating countries' negotiators are not expected to compromise their respective national interests, however they need to recognize the importance of:- engaging in transparent manner, reexamining their long held and entrenched positions, learning from international experience and when faced with difficulties not to shy away from requesting third party assistance.
- Finally, if the negotiations on the GERD among the three countries were conducted under the umbrella of the CFA and the NBI, the author of this abstract believes the negotiations would have been smoother and may have resulted in a more fruitful cooperation. The existence of a cooperative framework, mature institution with experienced staff, the CFA negotiation process experience, the NBI governance that could support the tripartite process are some of the factors for such an assumption (note the two downstream countries are not currently CFA signatories).

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39. GERD and hydro-politics in the Eastern Nile: from water to benefit sharing? Rawia Tawfik and Ines Dombrowsky ,

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Abstract

The GERD is presented by Ethiopia and by a number of scholars as a benefit-sharing project in the Nile basin in general, and the Eastern Nile in particular. The resumption of talks in August 2014 and signing of the DoP in March 2015 have reduced the tensions over the project and have paved the way for arrangements to share benefits, especially power produced by the dam, and compensate for potential negative impacts. The continuation of the talks in spite of difficulties indicates that the three governments believe that they will be better off with cooperation on the project than without. However, hydro-political interactions around the project have not moved from a dispute around sharing water to the discussion of sharing benefits, but rather to discussing both issues simultaneously. An uneven distribution of benefits and different expectations on the project have led the three countries to adopt divergent approaches towards the GERD. Ethiopia and Sudan expect, and are moving jointly to reap, the GERD's benefits accruing from increased power production and power trade for Ethiopia, and expanding irrigated agriculture for Sudan. Given the increased size of the dam and its storage capacity compared to earlier plans and the long talks over conducting the required studies on the transboundary impacts of the project, Egypt currently foresees more risks than rewards from the project. Not only is Egypt concerned about the impact of the project on its current use of the Nile water, but it is also aware of the geo-political significance of the project, making it vulnerable to Ethiopia and Sudan's Nile policies, which is perhaps the highest cost of the project.

With the GERD near completion, negotiations over the first filling and operation are expected to face crucial questions that would define the sharing of the benefits and costs of the project. These questions relate to: 1) whether Ethiopia is ready to accept the current uses as a starting point and to adapt the filling and operation to downstream demands defined in terms of these uses; 2) adequate compensation for Egypt for a significant harm; and 3) whether the coordination mechanism would commit the three countries, especially Ethiopia and Sudan, to respect their obligations. These questions confirm the suggestion that in cases where potential negative impacts are expected from a water use or hydraulic project, sharing water remains at stake.

In light of these contentious issues, strong incentives are needed to induce the three countries to reach compromises. Broadening the ranges of benefits and considering splitting the benefits and costs as suggested by benefit-sharing scholars may be more effective in influencing negotiating positions. This may include sharing the annual operation and maintenance costs of the GERD or future projects or coordination to mobilise international funding for these projects, marketing the power produced by the project, and striking deals in other fields. Increasing trade relations, especially virtual water trade imports in livestock and crops from Ethiopia and Sudan to Egypt, and Egyptian investments in the agricultural sector in the two upstream countries have long been proposed, with little progress on the ground.

To achieve progress on these fronts and provide an enabling environment for negotiations, communications between the three countries need not to be confined to the Tripartite National Committee. The regular convening of the tripartite summit proposed by Egypt, and the continuation of the six-party meetings of the ministers of irrigation and foreign affairs of the three countries which helped transcend the difficulties of talks since their resumption in August 2014, are important to back technical negotiations. A parallel effort to adapt water policies in Egypt and Sudan to the post-GERD era, achieve progress in ongoing attempts to convince Egypt to resume its membership in the NBI, and prepare the public in the three countries to compromises in future negotiations could reduce the intensity of disagreement.

Finally, these negotiations should not be considered as an alternative to a more holistic cooperative process that balances the different uses of riparian states, optimises the development of water resources in the basin, addresses long-term challenges in the river, and fosters regional integration beyond the river.

40. Collective Action Theory and Nile Basin Cooperation: Past Experience, Future Directions, Dr. Alan Nicol, Sustainable Growth Program Lead, International Water Management Institution

Dr. Alan Nicol is the Strategic Program Leader - Promoting Sustainable Growth, at the International Water Management Institute (IWMI).

A political scientist by training, Dr. Nicol has more than 20 years of experience in research, policy advice, consulting and program development across Asia, Africa and the Middle East. He is a specialist in a range of water and development issues from transboundary water resources management to catchment management and community-level water supply and sanitation. He has advanced analytical, project leadership and program implementation skills, including experience of leading multinational programs at director level in Africa, working closely with government and other policy influencers on water and climate change and delivering research for development that supports the livelihoods of local beneficiaries. He continues to engage in fieldwork and has recently completed assignments on refugees and water and IWRM and pastoral development in northern Uganda. He is currently based in Addis Ababa.

Abstract

The Nile Basin has been the centre of shifting political structures and spheres of influence for centuries. Since the latter half of the 20th Century, the river has come under unprecedented pressure for control in order to meet rapidly-growing societal and economic demand. The pace of development by countries sharing different portions of the basin yet with widely differing dependency on the river's resources has left a variegated landscape of 'stakes' in governance of the whole basin. Increasingly, however, as climate change adds uncertainty to future hydrological systemic behaviour (Wagena et al, 2016; World Bank 2015), interest has increased in multilateral cooperation and using collective action between states to manage and develop the basin's resources.

This represents an approach to collective action (Olson, 1965) that resonates with the work of Elinor Ostrom (1990) and others, who argue that shared commons, such as major river basins, can be managed in a cooperative manner, sharing commonly-generated benefits and avoiding the so-called 'tragedy of the commons' where individual actions lead to resource depletion and degradation. Recent efforts at cooperation on the Nile Basin reflect this idea of common management and development of a shared resource at multilateral scale, and also, to some extent, support wider notions of collective management as performing a regional public good function (see Nicol et al., 2001), which builds on the idea of public goods (Kaul, Grunberg, and Stern, 1999) as non-excludable and non-rival in consumption and providing a means to other goods such as

greater regional peace and security. In the case of the Nile, this is often referred as benefits 'because of the river' and benefits 'beyond the river' (Sadoff and Grey, 2002),

What constitutes the 'collective' in the Nile Basin is not a constant over time. Changes in the nature of states, in their affiliations to superpowers, and even the number of states entities that constitutes the collective has changed many times in the last half century; and at any given time, the range of staeks and starting points varies considerably. The current 11 countries sharing the basin represent a range of geographical, cultural, political and socio-economic ties to basin resources. The population of Nile countries ranges from over 90 million in each of Egypt and Ethiopia, to just under seven million in Eritrea and just over 10 million in Burundi. Moreover, the economic and social relevance of the water, land and environmental resources of the basin varies widely. Uganda lies almost wholly within, whilst DRC has less than 1% of its area in the basin; and whilst Ethiopia is an 'exporter' of some 80% of all water received in Egypt, it receives virtually none itself as a 'water tower' state. Nile riparians also exhibit a range of political institutions, from unitary centralised systems, to different interpretations of federalism.

The economic balance within the Nile also tilts heavily towards downstream states and, in particular, Egypt, the economy of which is almost the combined total of all other countries (NBI, 2012). The nature of this 'collective body' of states has changed over time. Africa's newest state (South Sudan) was established just seven years ago in 2010. In the early 20th Century, however, much of the Nile basin was heavily influenced by an external power – British imperialism controlled a belt of countries from Kenya and Uganda running through Sudan to Egypt. In his book "The Nile Basin: National Determinants of Collective Action", John Waterbury (2002) captures well how the power dynamics have changed throughout the colonial, post-colonial and Cold War periods, and how national, regional and global political agendas come into play. Downstream states –and the wider development community – quickly took take advantage of the so-called 'new world order' of the 1990s to establish technical discussions on cooperation under the banner of the Nile 2002 Conferences, inaugurated in Aswan in 1993 (Brunnee and Toope 2002). Held each successive year, this informal process enabled the emergence of collective action under the Nile River Basin Action Plan between all countries sharing the basin.

Central to the challenge of establishing wider collective action in the basin, in spite of the willingness expressed, was pre-existing 'rules of the game' reflected in agreements signed in 1929 and 1959 (refer Agreement, 1929; Agreement, 1959). Upstream states argue that these treaties were signed during colonial rule and, therefore, under the Nyerere Doctrine are invalid i.

The 1959 Agreement included construction of the High Aswan Dam enabling Egypt to capture and store more than an entire annual Nile flood, most of it within its borders. As a provider (then) of 50% of Egypt's energy supply it become symbolic of state-led development, Egypt's

'mastery of the Nile' and its political strength. Upstream states came to view the dam as emblematic of Egyptian hegemony and, in response, the US began a comprehensive study of potential dam sites on the Blue Nile in Ethiopia (USBR, 1964). Though none of these projects came to fruition the so-called 'Border Dam' eventually formed the basis for the GERD, which we discuss in detail below.

This paper examines, through a framing using the Ostrom Principles, how collective action approaches have met challenges in the past in the Nile Basin, how current approaches are progressing and, in future, how collective action in the face of massive climate change will need stronger, more institutionalised mechanisms in order to ensure the co-generation of benefits that support both peoples and environments in this globally-significant basin.

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41. Hydropolitics, Hydro-hegemony and the Problem of Egypt's Securitization of The Eastern Nile Basin

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Areas of Expertise: IR, IPE, & Comp. Politics.

ABSTRACT

The main goal of this research is to provide an explanation of the concept of securitization as a hegemonic compliance-producing mechanism for preserving the *status quo* as per the 1959 Agreement in the Nile Basin. Though the systematic power-analytical approach and hegemonic and counter-hegemonic control strategies have been explored to analyze the interaction over the waters of the Nile Basin, not much attention have been devoted to explain the effects of Egypt's "asymmetric material power" from the realist paradigm in International Relations theory as the ultimate determining explanatory factor for the maintenance of the *status quo* in the Nile Basin. The conceptual framework of securitization deployed in this research reveals that asymmetric material power is the ultimate determining explanatory factor for Egypt's securitization of the Nile waters which rules out the possibility of promoting any alternative water agreement in the Nile Basin. The research also utilizes explanatory (causal) case studies research methodology to identify the causal factors to the problem of securitization of Nile waters. Path Analysis is used to establish direct-causal relationship between asymmetric material power, asymmetric water control and water security effects on securitization. The key finding of this research reveals that the foundational principle of equitable utilization to which all riparian have long committed themselves to ensure that "each basin state is entitled, within its territory, for a reasonable and equitable in the beneficial uses of the international basin drainage has become a subterfuge in the Nile Basin as the two Arab countries (Egypt and Sudan) have not shown any willingness to relinquish a drop of the Nile waters as per the 1959 Agreement and especially Egypt's obstinacy to and towards obstructing any meaningful alternative water sharing formulae. Another key finding of the research will show the causal effects of Egypt's favored political position and undisputed military power because of its alliances with powerful friends and organizations who contributes enormously towards its military power and foundations of military power have contributed to the to the perpetuation of the *status quo*, instead of the promotion of an alternative water-sharing formulae and agreement. The realist paradigm of military power has contributed to Egypt's political dominance over the Nile waters due to its military strength and superiority, thereby causing Egyptian political leaders to be willing to

intervene militarily to maintain the status quo, instead of promoting an alternative water sharing formulae and agreement. Thus the objective of the CFA, which was designed to achieve an inclusive, equitable, and lasting legal and institutional framework governing the utilization of the Nile waters has been a colossal failure as a result of Egypt's influence over Sudan to oppose to the wording of Article 14(b) of water security, arguing that the proposal did not recognize their current rights and use of the Nile waters and for that matter sought amendment to Article 14 (b) to read as follows *"Not to adversely affect the water security and current uses and rights of any other Nile Basin State.* Any attempt to promote cooperation under the CFA must first recognize the legal problem of Article 14(b) on water security and its adverse impacts towards promoting an alternative water sharing formulae and agreement under the CFA. Egyptian political leaders should develop the "political will" and with the help and support of United States and Singapore technological companies take concrete initiatives and pragmatic steps to diversify the Egyptian economy into more vibrant technological, industrial and manufacturing sectors to produce high-tech desalination machines for its [Egypt's] use and for exports to the other riparian states.

42. The role of diplomacy in fostering transboundary cooperation in Eastern Nile Basin: Application of experimental games, Mahsa Motlagh, Ph.D.

Dr. Mahsa Motlagh holds a Ph.D. degree in Transboundary Water Resources Management and Diplomacy from University of Bonn, Germany. She currently works as a researcher, study program coordinator, and lecturer in "International Cooperation and Development" and "Water Governance" and "Transboundary Water Diplomacy" at Institute for Technology and Resources Management in Tropics and Subtropics, TH-Köln (University of Applied Sciences), Cologne, Germany. Her interdisciplinary research and educational interests are to understand, characterize, measure, and model water issues ranging from economics to hydrology to hydro-diplomacy with a focus on transboundary stability and peace building, specially in the MENA region and Nile River Basin. With a background in natural resource economics and governance, Mahsa Motlagh has specialized in integrated water resource management and has worked on several topics and projects ranging from transboundary water sharing, social and economic analysis, watershed modeling and project design. She has experience in joint fact-finding assignments, stakeholder mapping, decision support approaches and workshop design and implementation.

Abstract

Tensions over the use of Nile waters have recently increased, and no basin-wide cooperative agreement yet exists. This study contributes to developing a series of experimental laboratory games as a platform to examine a set of compensation options encouraging cooperation through the reduction of decision-makers' uncertainties and simplification of complexity.

Preventing transboundary water conflicts cannot be realized without adequate cooperation in managing those waters which are built through robust and equitable structures and institutions for collaboration. This cooperation should not be seen as a goal itself, rather an essential tool to meet the aims of each riparian country, improve water governance, find equal benefit-sharing options and reach progress towards basin-wide security. It should be noted that conflict prevention and resolution approaches are highly political processes to make decisions as the result of long series of negotiation. Those water negotiations at the transboundary level, need much time, patience and

persistence and have better chances to succeed if the drivers and interests of the riparian states are known and quantified with the help of diplomatic mechanisms. In a basin with a transition economy, where a considerable share of water is used in agriculture sectors, a requirement of a good decision-making tool for water management considering the aspect of water, food and energy security and fair trade, is a must.

Transboundary water cooperation policy processes can be at different levels of reliability and will, therefore, offer different ranges of opportunities for including the results of a cooperative negotiation for decision-making. Even when no formal transboundary water cooperation policy process is in place, informal talks may be regarded as early stage transboundary water cooperation. At the other end of the scale, a transboundary water cooperation policy process may be characterized by a well-established formal framework that includes mutual legal agreements, institutional structures, and joint action programs. Positive-sum thinking brought by diplomacy is concentrating on water demand and uses the agreements dealing with water, energy and food strategies that aim to optimize benefits from all viewpoints. While existing uses of the watercourse are also one of the factors to be taken into account when deciding on equitable and reasonable utilization, water diplomacy enables decision makers to understand their common interests in enhancing water, food and energy security in a transboundary context and are willing to negotiate on the changes to existing use patterns.

The present research evidences the fact that transboundary cooperation requires a long-term capacity and trust building between riparian countries to create new opportunities through cooperative decision making. Cooperation is a step-by-step process that starts, for example, with the regular meetings of a joint committee and develops towards the in-depth nexus approach with inter-sectoral working and expert groups and public hearings. The essential building blocks of the cooperation are reciprocity and good faith between states as well as an increase in economic benefits. We explored the stages in which states are most likely to pursue to an agreement over the shared river. These are the conditions under which cooperative negotiations are most liable to be successful.

As a decision support tool, laboratory game experiment to simulate the real-world scenarios into simplified shape was designed to study the particular case of the Eastern Nile Basin shared by Ethiopia, Sudan and Egypt. This series of laboratory experiment used trust game algorithms to explore the role of trust building as well as transparency in data sharing among decision makers of the riparian states of the basin. The game has four rounds, 3-player, with no binding agreement, played by post graduate students of ITT research institute. Payoff schemes for trust games were calculated and provided for each player, using real-world data by developing a simple hydro-economic model of the Easter Nile Basin under different selected scenarios. The interests, potential, and priority of each riparian regarding irrigated agriculture and hydropower production are defined, and trade-offs among them are specified in scenarios which have Grand Ethiopian Renaissance Dam (GERD) in the river system and without it.

We focus on the fact that to initiate cooperation, understanding of the economic benefit of cooperation, willingness to cooperate and trustworthiness of decision makers are the key issues. The number of players, their economic capabilities, preferences, and transparency in information exchange among them affects the transactions towards cooperative decision making. Changes in any of mentioned variables may alter the level of motive for cooperation. The crucial question is how to effect positive changes in these variables such that cooperative outcomes are realized and favored. According to the rules of the designed game, players exchange water units based on given

combination of options from upstream to downstream and use the virtual money estimated from each riparian's economic power as side payments during the negotiation for compensation alternatives. If instead of side payments in our simulation, resources trade was considered as the primary source of compensation, building GERD can address the interrelation of food, water, and energy security in the basin by exchanging water and energy, based on their productivity and efficiency across the basin countries.

Game results found that optimal decision is sustained by a system of side payments as compensation for selection of the most optimal water allocation in the Eastern Nile basin that splits total profits close to equity among players. Thus, perceptions of fairness emerged as an important determinant of cooperative behavior in our experiment. Moreover, the experimental results reveal that cooperation is indeed hard to establish in a strategic environment with high sensitivity and sense of uncertainty for future, but it is still attainable. Thus, failure to cooperate should not solely be attributed to the unwillingness or incapability of decision makers since it may partly be due to inadequate compensation and an unfair split of total profit. Since the nature of cooperation is typically conditional, as long as a set of preconditions are available and certain ranges of incentives are ensured, cooperation takes place and continues. Finally, basin-wide efficiency and productivity require regional cooperation and cooperative decision-making is possible from a variety of compensation options, institutional changes, and incentive-compatible considerations. Also results of indicated that, however attractive the economic gains from cooperation may seem from the perspective of the basin as a whole, in some groups, decision makers could not access to such prospects to reach the higher level of benefit.

Keywords: *negotiation, diplomacy, transboundary cooperation, decision making, Eastern Nile Basin*

43. The Emotional River: The Hydropolitical Psychology of the Nile

Wondwosen Michago Seide:

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Abstract

"Reason alone can never produce any action or give rise to volition…Reason is, and ought to be, the slave of the passions, and can never pretend to any other office than to serve and obey them." - David Hume

We all have emotions. Emotions dictate everyday politics (Hutchison and Bleiker, 2014:494). Emotions used to be seen as a contrary to, deviation from and interference with cognition, rationality, and reason, in the analysis of the political psychology of international relations (de Sousa 1987; Elster 1999 cited in Hutchison and Bleiker, 2014:494). 'Starting from the Enlightenment period, rationality dominated world politics. There was a belief that reason was good and emotion was bad. This was mainly due to the work of classical political philosophers such as Aristotle, Plato, Hume, and Descartes' famous dictum 'I think, therefore I am', which epitomized the superiority of reason over emotion (McDermott, 2014:557). Kant also known for using the Latin motto Sapere aude ("Dare to be wise") in his essay "Answering the Question: What is Enlightenment." Contrary to this view, nowadays, Brader and Marcus (2013:166) explained that Western thought upholds both "reason and emotion as the two fundamental qualities of human nature."

I argue that emotions permeate hydro-politics. Emotions have played subtle and implicit, but a very crucial role in the Nile water politics. Emotions like-fear, trust, suspicion, hostilities have been defining elements in the Nile waters politics. Fear is one of the most important emotions. It is the most widely studied in related to foreign policy and international relations. "Once fear is aroused, there is no simple way to disentangle thinking from fear and fear from thinking" (Crawford (2014: 540). There are a lot of emotion-laden narratives about the Nile. Often, these narratives fail to account for the other countries' perspective, and thereby reinforce a self-righteous image. This has been able to entrench the 'fear of other riparians." As Crawford (2014: 539) noted, if we are not able to "turn off the fear and its response" the ability to distinguish non-threats from threats will be impossible, and this may lead to mutual destructive relationships.

Jonathan Mercer and Neta Crawford, pioneers in the field have perceptively placed emotion 'at the very heart of political reasoning' (Hutchison and Bleiker, 2014:495). They have successfully refuted the dichotomy of emotion and rationality. According to them "emotions and cognition are intrinsically interwoven" (Ibid.:503). Strengthening this view, Damasio, (2005, x–xi) asserted that "emotions actually assist the reasoning process" (cited in Jeffery, 2014:585), as there are limits to rationality (Stein, 2013:371). For Chong (2013) "pure rationality is something of a fiction" (cited in Huddy et al., 2013:6). Hutchison and Bleiker (2014:509) convincingly show that "rationality always includes emotion just as thinking always includes feeling." In essence, "without emotion, there is no rationality" (Stein, 2013:389).

Now, we are living in the 'era of emotional turn' (Hutchison and Bleiker 2014:492). It was only after the mid-1990s that emotions gained currency in international relations. Ling (2014:579) reminds us that "every leader from ancient to modern times knows one, fundamental truth about emotions and politics: each powers the other." The field of emotion has become the most exciting research areas. It is with this belief that I want to adopt and use emotion in the international transboundary water analysis. I am of the opinion that, not only international relations but also hydropolitcal relations rests on an emotional epistemology.

This paper's raison d'être is to question the traditional hydropolitics analysis that has always been concerned with power, geopolitics, cooperation and conflict perspectives. Moreover, positing that 'water security' rationales does not account for a comprehensive understanding of the Nile Politics. The hydropolitics literature has mainly focused on water scarcity induced conflict in the Nile Basin. To use Mirumachi's (2015:19) word the "quantitative aspect of water." Most of the literature fall to the neo-Malthusian school of thought of 'scarcity trap' which got a momentum after the Cold War World Order and still remain the main transboundary water analysis framework. However, I am arguing differently by emphasizing that the emotional aspect of the Nile waters management has to be investigated.

I strongly probe the unquestioned and unexamined fixation on the rationality-state-centered analysis of the Transboundary Rivers.' By so doing, I am employing a critical and an original angel to the transboundary water politics. I am arguing that transboundary politics has been affected, if not determined, by the emotions. The governance of water has not always been governed by reason and rationality, but also impacted by emotions of the policy makers, the engineers, the water users and the public at large. The politicians in the Nile Basin have been showing emotion-laden words in related to sharing the Nile River. Emotions have significant contribution in forming (mis) perception (Jervis 1976, cited in Hutchison and Bleiker, 2014:495). Emotions such as anger, regrets and fear have always been punctuating the Nile River Basin water management and development. Unless we unearthed the emotional aspect of the Nile River and its people, we will fail to get the whole grasp of the transboundary water analysis. I believe that most of the Nile related decisions have been made through emotion-laden approaches buttressed with water nationalisms and identity of respective countries. Hutchison and Bleiker, (2014:522) perceptively noted that "identity and emotion depend on each other." By drawing on the hydro-political psychology emotion, I am trying to show, as Nussbaum (2001) put it, "how emotion can shadow the present" water policy making decisions and water management and governance (cited in Strongman, 2003: 258). Moreover, I will investigate the role of emotion in the management of, cooperation and conflict over/ in the Eastern Nile River Basin.

Key Words: Political Psychology, Emotion, Nile River, Transboundary water analysis

44. Realizing the Water Security of the Nile Basin States: Balancing existing uses and potential uses, *Dr. John Rao Nyaoro, HSC, PhD, Water law and Policy Expert*

Dr. John Rao Nyaoro, is a water law and Policy expert with over 35 years experience in the water sector having served as Senior Advisor and Executive Director of the Nile Basin Initiative Secretariat, Director of Water Resources in Kenya, Technical advisor to I GAD, Kenya Chief negotiator to Nile Basin Initiative and other Transboundary waters.

Abstract

The main problem in the Nile River basin today is the threat to the water security of the basin States as there is no permanent mechanism (legal and institutional) arrangement acceptable to Nile Basin States to enable full cooperation, joint planning in the management and equitable use of the Nile water resources. This situation warrants the development of a new Nile River Basin Regime based on the prevailing international water law to provide guiding principles, norms and rules to ensure cooperation, equitable utilization of the basin's shared water resources and peaceful coexistence of the basin States. Lack of acceptable legal and institutional framework has led to sometimes unilateral development of the Nile basin shared water resources hence mistrust and tension among the basin States leading to loose cooperation.

The new Nile River Basin Regime should enable the basin States to balance the existing water uses and potential uses, on one hand and the balance of the right to equitable use of Nile waters and prevention of harm to other Nile basin States on the other hand. The two balances would require the use of science to inform the policy on the available basin water resources and best efficient water uses while the prevailing international water law as a management tool would provide substantive rule detailing the rights and duties (obligation) of the basin States in the use of shared water resources and the procedural rules that would ensure the enforcement of the new Nile River Basin Regime. The new Nile basin Regime would guide the basin States to ensure equitable use of the basin shared water resources and prevention of harm to other basin States. This arrangement would build trust among the basin States and further strengthen the cooperation and to enables the basin States realize their water security.

Water security is nothing but legal entitlement and obligation of the basin States in the use and development of the shared water resources (Patricia Wouters 2005).

The new Nile basin regime based on the prevailing international water law that today is equitable utilization of the basin shared water resources, causing no significant harm to other basin States, cooperation in the conservation and protection of the sources of the Nile basin water resources to ensure availability and development (accessibility) to ensure equitable use and where possible joint planning as in the case of Gambia River and having in place a permanent institutional framework (Nile River Basin Commission).

With acceptable legal and institutional framework in place it would be possible to effectively use science such as Nile Basin Decision Support System (NB-DSS) to inform the policy that together

with the above prevailing international water law would enable the balancing of existing water use and potential water use.
The question now is how we use the prevailing international water law to enable the balancing of existing Nile Shared water resources and potential uses. In this case the prevailing international water law is clear and equivocal on the balancing of the existing use and potential water use.

The outstanding legal issues with regards to Existing uses are:

- The requirements of their protection under the international water law:
    - ✓ Article VIII of 1966 Helsinki Rules reflect the current international attitude as it gives protection to existing use on condition that the factors justifying its continued existence are not outweighed by factors showing the desirability of its modification or termination,
    - ✓ A modification or termination to be consistent with equitable utilization, may, in a particular case, require compensation to other user.
    - ✓ There may also be instances where an existing use will be "phased out" over a period of time in order to give the user the opportunity to develop alternative sources of water.

If the planned measure is considered to have injury then the following factors to Consider on Substantial injury are:

- the needs of a basin state may be satisfied without causing such injury.[14]**)**
- the various uses are compatible,
- any of the uses is essential to human life,
- the uses are socially and economically viable,
- other resources are available,
- any of the uses is "existing" within the meaning of equitable and reasonable,
- it is feasible to modify competing uses in order to accommodate all to some degree,
- financial contributions by one or more of the interested basin States for the construction of works could result in the accommodation of competing uses,
- the burden could be adjusted by the payment of compensation to one or more of the co-basin States, and
- Finally, overall efficiency of water utilization could be improved in order to increase the amount of available water.

It should be noted that these key statements are missing in the 1997 UN water causes convention hence the legal gap in this umbrella international water law.

This paper therefore, concludes that “The realization of the water security of the Nile basin States requires full cooperation of Nile Basin States, in the development and management of its waters to ensure the availability of the basin water resources and equitable utilization through joint planning to prevent ham to other basin States and balancing of the existing uses and potential uses based on the prevailing international water law informed with science (NB-DSS) to ensure peaceful accessibility of the Nile River waters, and early management and resolution of any conflict that might arise”.

[14] National courts in federal systems have noted that a state is denied the possibility of initiating a new use because of an existing use in another state may also be regarded as being "harmed". In the case of the US Supreme Court, in enumerating factors to be considered in arriving at an equitable apportionment as between two US states, identified as a relevant factor, "the damage to upstream areas as compared to the benefits to downstream areas if a limitation is imposed on the former". Nebraska v. Wyoming, 325 U.S. 589 (1945)

46. The role of media and science communication in shaping debates and negotiations over the Nile. Evidences from Ethiopia, Sudan and Egypt.

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Emanuele Fantini is lecturer and researcher at IHE Delft Institute for Water Education, Department of Integrated Water Systems and Governance (Delft, The Netherlands). He holds a PhD in Political Sciences (University of Turin) and a European Master in Human Rights and Democratization (University of Padua). Emanuele main research interests include: water governance and water conflicts, social movements, religion in public spaces (politics and development), media studies,visual research methods, with geographic focus on Ethiopia, the Nile basin and Italy. Emanuele is also associate researcher at the Programme in Comparative Media Law and Policy University of Oxford, and coordinator of the project "Open Water Diplomacy. Media, science and transboundary cooperation in the Nile basin, studying online media debates on Nile related techno-scientific and their impact on transboundary conflicts and cooperation. Emanuele has worked both long term and consultancy positions for bilateral agencies (Italian Ministry of Foreign Affairs), multilateral institutions (UN Habitat), local authorities and international NGOs in Ethiopia, Sudan, Morocco, Serbia and Myanmar.

Abstract

Keywords
Media, science communication, Nile, hydropolitics, water conflicts and cooperation.

Background
This paper aims at contributing to Sub-theme n. 5, "Water Governance", by focusing on the role of the media and science communication in shaping debates and negotiations over transboundary water resources in the Nile basin.
The media are often pointed at as key actors in contributing to securitize large scale water projects and in exacerbating transboundary or local water conflicts (for instance Hussein and Grandi 2017, Zeitoun and Mirumachi 2008). International institutions - including NBI - are increasingly aware of the role of communication in shaping water conflicts and cooperation and have been promoting training and capacity building activities targeting journalists and the media. However the role of the media in shaping debates over contentious large scale water projects or in influencing transboundary water negotiations remains an uncharted field of research.

We aim at contributing to filling this gap and to offering scientific evidence to inspire future media training activities at basin level, by presenting the preliminary findings of a research that maps debates on Nile related issues in mainstream media and social networks in Ethiopia, Sudan and Egypt. Our paper will focus on specific Nile events (i.e. the announcement of the building of the

GERD by Ethiopia in April 2011, institutional meetings within the NBI framework) and it will situate these events within the broader political dynamics shaping national debates and international relations (i.e. the Egyptian revolution, the independence of South Sudan…). We are particularly interested in understanding how techno-scientific issues related to transboundary water resources are communicated, by whom, and what kind of knowledge is used to legitimise specific projects and claims over the use of Nile waters.

This study is part of a wider action research project, "Open Water Diplomacy Lab", funded by the Dutch Ministry of Foreign Affairs "Global Partnership for Water and Development", and implemented with networks of water journalists (AWJ) and water scientists (NBCBN) in the Nile basin. Its main goals are: to reflect on current practices of water science communication in the Nile basin; to understand how these practices impact on transboundary water negotiations; and to build journalists and researchers' capacities to co-produce new Nile narratives, going beyond the traditional "national interest" perspective and towards a shared vision for the Nile.

Methodology and approach
The study is bases on:

- semi-structured interviews to key informants (journalists, policy makers, researchers) in Ethiopia, Sudan and Egypt;
- a content analysis of selected newspapers in Ethiopia, Sudan and Egypt;
- the analysis of a sample of statements in social media (i.e. Facebook post) in the three countries, through a method developed in a previous research on online debates in Ethiopia (Gagliardone et al 2016);
- three participatory videos on the culture and practice of water science communication in Ethiopia, Sudan and Egypt, produced by local journalists in cooperation with local researchers We will also try to combine the three participatory video in one video-documentary and if you are interested we can screen it during the Forum.

Key findings, conclusions and recommendations
We started our research in January 2017 therefore at this stage its findings cannot be disclosed yet. However we are confident that this study will produce meaningful evidence and recommendations for key actors and institutions involved in media training and scientific communication on Nile related issues.

47. **Integrated approaches to improve stakeholder roles and impact on water governance in Nile Basin,** Mohamed Hassan Tawfik, Email: mohamedseo90@yahoo.com, Country: Egypt

My name is Mohamed Hassan Tawfik, I have a master degree in Environment In December 2015 from the University of Melbourne, Australia with specialization in Integrated Water Catchment Management. I am interested in sustainable development, promoting and advocating more sustainable practices, policies and strategies to achieve water and food security in developed and development countries. I have four years of international experience in the field of integrated water management and sustainable development; I had the chance to work in countries such as Egypt, Australia, Ghana and Sri Lanka as well as supporting in data collection and critical analysis for water and wastewater sector in Jordan and Lebanon. Currently I am working as Water Policy and Regulation research intern at IWA Headquarters in The Hague, The Netherlands.

Abstract

Background

There are many studies on governance and management within the water sector that highlight the slow progress on the adoption of efficient water policies in the face of ever increasing water challenges in the Nile Basin. Such challenges could be described as “wicked problems” (Rittel and Webber 1973 and Mysiak et al., 2005) where “multi-layer problems” are handled by a large number of stakeholders, with fragmented or limited sharing of information and/or baseline data. Therefore each one of the stakeholders sees the problem from different perspective. Under these governance conditions, decision making processes are often described as non-participatory and even contradictory to intended solutions.

Few studies have explicitly investigated the role of stakeholders in the governance scheme and its relation to the state of water governance in the Nile Basin and, based on this perspective, the recommendations that emerge and the ways forward. Therefore, the main objective of this research is to discuss – at a conceptual level – the impact of providing a shared online platform that provides stakeholders throughout the Basin with a common ground to share the water management data. Such a platform can support a more successful and synergistic decision making process within the context of transboundary water governance within the Nile Basin.

The proposed approach can be used to analyze and prioritize the current issues that require the involvement of stakeholders on the national and basin level. The approach will allow for a multi-faceted analysis of the interlinkages between water governance strategies, institutional set-up, political, social, infrastructure, available alternatives, norms and cultural factors.

Methodology

The methodology applied in this research will introduce two approaches presented in an integrated framework. The first approach is the interdisciplinary “10 Building Blocks for sustainable water governance” developed by Rijswick et al (2014) and The Flood & Drought Management Tools project developed by DHI and International Water Association (IWA).

10 Building Blocks assessment tool

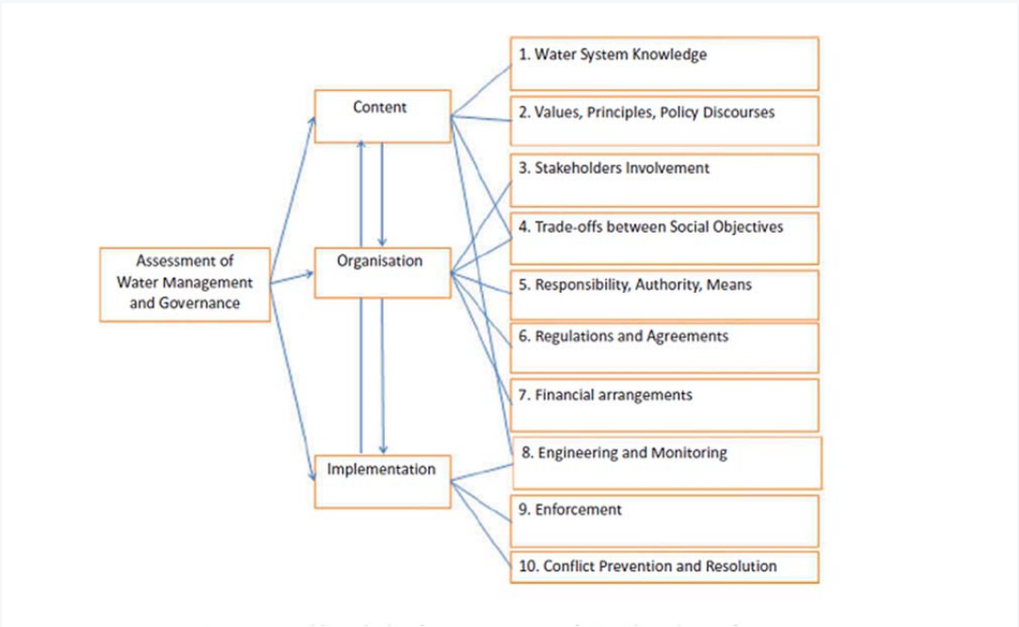


Figure 1 10 Building Blocks of water governance (Rijswick et al., 2014)

The 10 Building Blocks is a helpful assessment tool used to understand the different dimensions of water management and governance on a national and basin level. The following steps outline how to adapt the assessment tool to specific contexts:

- Each of the 10 Blocks will be reviewed, redefined and adapted according to national/basin contexts.

- Once the 10 building blocks have been adapted to the Nile Basin context, the relevant stakeholders can be identified for each building block.

- A set of questions will be prepared in the form of questionnaire that reflects the assessment criteria of each building block and addressed to the stakeholders identified in the step above - Each answer will be rated on a scale from 1-10, where 1 indicates severe weakness in the building block for water governance, while 10 indicates that a building block as a strength point.

- Based on this rating system, priority building blocks and key collaborating stakeholders can be identified.

The Flood & Drought Management tools project

The Flood & Drought Management tools project is an online technical application to support planning and decision-making to adapt to the various water governance and management challenges stemming from flood and drought cycles, targeted at users from the transboundary basin level to the water utility level. The project is being implemented by UNEP and executed by DHI and IWA from June 2014 to June 2018. The Flood & Drought Management tools project can be used to

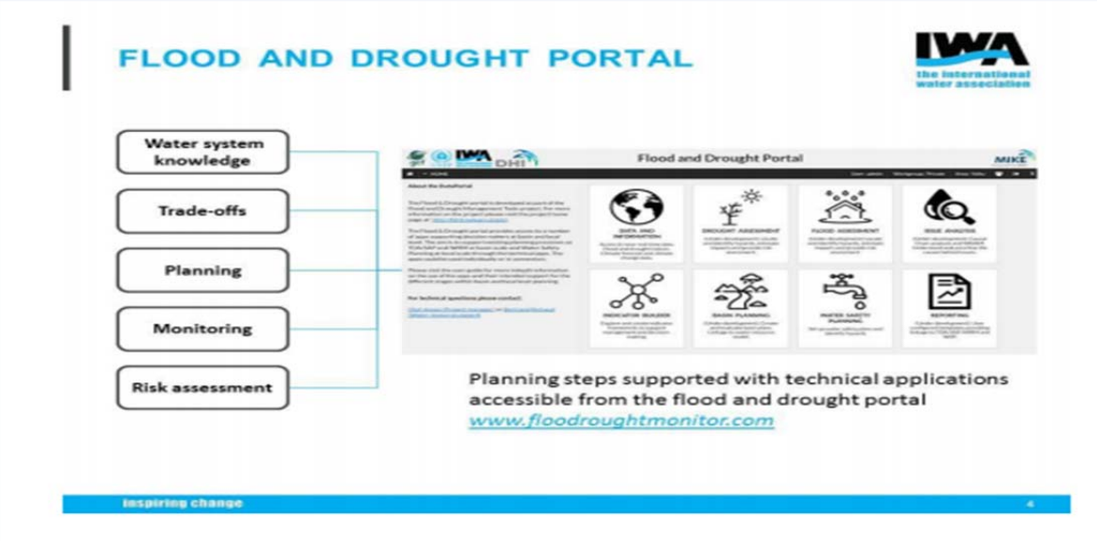
support stakeholders to enhance the 10 Building Blocks of water management and governance, through:

- Enabling greater shared access to information in order to encourage stakeholder participation and contribution to water management

- The tools enable users to carry out baseline assessments using readily available satellite data and impact assessments through the analysis of data. The tools offer assistance in coordinating planning options and is a means for disseminating information to relevant stakeholders

- The portal provides access to climate data and tools for analyzing the risks and hazards for climate impacts, including floods and droughts.

- Such a mechanism creates a transparent and focused platform where stakeholders can build their decisions based on common ground.



Conclusion

The Flood & Drought Management tools and 10 Building Blocks were chosen for this research for a number of reasons, including:

- The simplicity, yet, systematic design of the two approaches is an advantage for this research case where different countries are included.

- The flexibility of both analysis tools is easily adapted to the Nile Basin context.

- Both approaches have the potential to convert qualitative data into quantitative data that gives more clear indication.

- Both approaches can be used for national and regional contexts.

- Both approaches reflect the interdisciplinary and polycentric nature of water governance in the Nile Basin countries.

48. The Nile Project: culture and education dimensions of water diplomacy;

Mina Girgis

Mina Girgis, Producer & CEO - The Nile Project

Mina Girgis is a serial entrepreneur with expertise in the hospitality and music industries. In 2011, Mina started the Nile Project – an initiative combining music, education, and innovation programs to promote water sustainability in the Nile Basin. In 2009, Mina founded Zambaleta, a community World Music school based in San Francisco, California. Mina constantly exploring new ways to cultivate communities that are conducive to learning, making, and experiencing music. As an applied ethnomusicologist, Mina has researched, curated and produced a wide variety of cross-cultural musical collaborations. He has received multiple fellowships from Wired Magazine, National Arts Strategies, Synergos and Seeds of Peace.

49. The Value of the Sudd Wetland, South Sudan: Implications for Integrated Policies for Environmental Sustainability and Human Well-Being in the Nile River Basin

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This abstract is based on a completed case study undertaken on behalf of the United Nations Environmental Program, Nairobi, Kenya: Gowdy, J. and H. Lang. 2016. The Economic, Cultural and Ecosystem Values of the Sudd Wetland in South Sudan: An Evolutionary Approach to Environment and Development. UNEP Nairobi, Kenya.

Abstract:
The Sudd wetland in South Sudan is one of the world's largest and most unique ecosystems. It is a major feature of the Nile River Basin and provides numerous ecosystem services to the ecology, economy, and cultures of the region. It is threatened by development pressures ranging from small-scale drainage to the massive Jonglei canal project that would completely drain the wetland. The threats to the Sudd illustrate the need for active and comprehensive policies to protect the world's remaining large natural areas to preserve ecosystem integrity and to promote human well-being. The conflicts over the Sudd involve different visions of "value" and thus different visions of "development."

In this case study, we discuss the role of the Sudd in the ecology of East Africa, its importance to the integrity of the Nile River Basin, and its potential to be the anchor for future economic development in South Sudan. We discuss the limits of standard economic methods in valuing very large-scale natural features. Tremendous advances have been made in recent years in documenting and understanding ecosystems and the structure of human societies. All available information—including GIS maps, DNA analysis of ecosystem structure, demographic and economic data and projections—should be used in all stages of policy formulation. This information should not be reduced to a single number to simplify cost-benefit calculations. Our study takes into account complexity and contingency and acknowledges the difficulties involved in understanding the ecological and social consequences of different environmental policies.

Our approach recognizes (1) the role of ecological process in maintaining the integrity of life support systems, (2) the role of these life support systems in maintaining human societies, (3) the fact that top-down government policies, including allowing business as usual, channels future governance possibilities, and (4) the conflict between local ecosystem integrity and the unregulated market economy.

The key findings of this study are:
• The Sudd wetland is potentially the greatest economic asset in South Sudan. The wetland, if properly managed, could provide income, jobs, and irreplaceable ecosystem services indefinitely.

• We estimate the potential economic contributions of the Sudd to be almost 1 billion US$ per year using the method of transfer valuation and the results of a meta-study of similar wetland areas.

• This figure represents only a fraction of the Sudd's total value which includes its potential as a symbol of national identity, its role in climate change mitigation, regulation of the flow of the White Nile, and in supporting South Sudan's unique wildlife and cultures.

• Major threats to the Sudd fall into two broad categories: (1) Major drainage project like the proposed Jonglei canal and (2) Small but cumulatively devastating projects like small-scale canals, unsustainable logging, and illegal poaching of wildlife.

● We introduce the concept of “directed evolution” to argue for a path toward sustainability. We point out the danger of "the tyranny of small decisions" and the advantages of long-range planning and comprehensive public policies.

The policy decision to preserve an ecosystem like the Sudd wetland or not is in many ways typical of the decisions having the greatest impact on the environment and human livelihoods. Globally, large projects affecting the environment set into motion an irreversible chain of events whose consequences can only vaguely be predicted. Whichever path is chosen for the Sudd will have large and irreversible consequences for the environment, equity, and institutions. If the Sudd is severely degraded, options for sustainable development will be eliminated. This loss of options will result in a loss of economic diversity and increase the risk of disruption due to volatility in markets, political stability, and increased susceptibility to exogenous events lying beyond the control of the local population. Our approach emphasizes the value of a system’s resilience and allowing for the reversibility of decisions.

Essential to the sustainable use of the Sudd is the importance of stable institutions supporting conservation efforts. Successful conservation efforts (Africa's world famous national parks in Botswana, Kenya, Tanzania and South Africa for example) have all taken place within a framework of transparent legal systems, mechanisms to control civil strife, and sound integrated policy planning. Likewise, the worst cases of environmental abuse have occurred when there is a lack of institutions that allow stability, a lack of cooperation among competing interests, and a lack of comprehensive planning.

50. Applying a standardized methodology to value biodiversity and ecosystem services from three biologically significant areas in the Lake Victoria Basin. , Dr. Brenda Bergman

Dr. Bergman is an ecological and social scientist with 20 years of experience in design, implementation, research, and evaluation of initiatives in integrated water resources management, biodiversity and natural resources conservation, and learning for behaviour change. She has led and implemented initiatives for transboundary water resources management and landscape-scale conservation in Southern Africa and East Africa and for watershed management, decentralization, and coral reef conservation in Southeast Asia. Her academic research focuses on ecological phenomena at landscape scales and the design of learning programs to realize behaviour change. Dr. Bergman is currently Deputy Chief of Party of the project *Planning for Resilience in East Africa Through Policy, Adaptation, Research, and Economic Development* (PREPARED), a USD $25 million initiative to strengthen the resiliency and sustainability of East African economies, trans-boundary freshwater ecosystems, and communities.

Abstract

While economic valuation can provide strong – and often much-needed – arguments in support of biodiversity and ecosystem conservation, it is yet to reach its full potential as a tool for conservation planners and managers. A recent review carried out by the Planning for Resilience in East Africa through Policy, Adaptation, Research and Economic Development (PREPARED) Project found a large, and growing, literature on ecosystem valuation in East African countries. However, one of the key lessons learnt was that many of the economic valuation methods that are commonly used to value biodiversity and ecosystem services are overly complex in terms of their data and analytical requirements and are primarily geared towards an academic audience, rather than being targeted at supporting real-world conservation planning processes. The review also found that many valuation studies do not move beyond demonstrating the economic importance of biodiversity and ecosystem services; in other words, they fail to point to needs, niches and opportunities to better capture and redistribute values in support of more effective, equitable and sustainable conservation on the ground. This is of critical importance: however convinced decision-makers are that it is in the public interest to conserve biodiversity, this will have little impact unless both the people who live in areas of high biodiversity and the agencies that are mandated to deliver conservation are both financially and economically empowered and willing to do so.

The findings demonstrated a need to: build approaches and methods that can be applied in situations where time, resources and expertise are scarce; and to generate practical and policy-relevant information (especially on how valuation can be used to identify conservation incentives and finance) to feed into and strengthen conservation planning. To fill in this need, PREPARED developed guidelines for the rapid economic valuation of biodiversity and ecosystem services East Africa, and tested it at 3 biologically significant (BSAs) sites in the LVB, namely, lake Nabugabo wetland complex in Uganda, Sango Bay – Minziro ecosystem (Uganda/Tanzania) and the Mara wetlands, Tanzania. The rapid assessment approach was specifically designed to be able to generate technically credible, practical and policy-relevant information to feed into conservation management planning in each site. It is also explicitly based on engaging local stakeholders as key participants in the economic valuation process.

The valuation methodology follows a three-stage process of: identifying ecosystem services and economic linkages, assessing the value-added and costs-avoided from conserving biodiversity, and identifying needs and opportunities to better capture and redistribute values in support of conservation.

It was found that the value ecosystem services provided by Nabugabo Ramsar Site is some USD $44 million a year, while the value of the Sango – Minziro ecosystem was estimated at USD $237 million

a year and for Mara Wetlands, the estimated value is USD $5 million a year. From the results of this assessment and lessons learnt, it is easier to articulate the high economic returns and value-added from investing in enhanced conservation of biodiversity and wise use as well showing that the costs, losses and damages that will arise from continued forest degradation runs the risk not just of undermining local livelihoods and development processes, but also of incurring considerable additional economic costs and losses to national economies. These figures provided an important justification for the conservation of the three sites in support of sustainable development processes. Furthermore, they identified the urgent need to develop concrete Conservation Investment Plans (currently under preparation) which could be used to capture funding for conservation and in support of the groups that bear these costs, and secure financially sustainable futures for the biologically-significant areas that had been valued.

51. Rapid Assessment of Ecosystem Services Values at Yala Wetland, Kenya

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Abstract

Key words: Ecosystem services, Toolkit for Ecosystem Services Site-based Assessment, Yala wetland

Background: Yala swamp is one of the most important riparian and floodplain swamps around Lake Victoria in Kenya. The site covers an area of 17,500 ha and is comprises of three freshwater satellite lakes namely; Kanyaboli, Sare and Namboyo. It is an Important Bird and Biodiversity Area (IBA) and supports the livelihoods of many people. It is, however, under increasing pressure from reclamation for agriculture, wildlife hunting and papyrus overharvesting. Lake Kanyaboli was gazetted as a national reserve in the year 2010 and covers an area of 41.42km^2. An ecosystem service assessment was conducted between 2014 and 2015, driven by the need to increase the delivery of ecosystem services and exploration of existing opportunities and improve the understanding of benefits delivered by the swamp under various use scenarios.

Methodology and Approach: A rapid appraisal was conducted to identify the ecosystem services delivered by the swamp., The alternative site needed to be identified based on the comparative nature of the study. This needed to be a better-managed alternative, with the gazetted Lake Kanyaboli National Reserve seen to represent that vision hence being selected to provide representative data based on methods from Toolkit for Ecosystem Services Site-based Assessment (TESSA). Data on the five ecosystem services (global climate regulation, harvested wild goods,

cultivated goods, nature-based recreation and water services) selected for assessment were then collected as follows.

Global climate regulation: The assessment of carbon storage and sequestration was based on existing literature values. The wetland was first stratified into three main habitats namely; papyrus dominated reed-bed, cropland and open water. The carbon storage for the papyrus dominated reed-bed and cropland was estimated as the sum of above ground biomass, below ground biomass carbon stock (Mg C) and soil organic matter except for open water. The total above and below ground biomass of habitat was calculated by multiplying the estimated above-ground biomass by the area of the habitat. The total above-ground and below ground biomass carbon stock (Mg C) was then calculated by multiplying the total by a conversion factor of 0.47 for wetlands. The total carbon stocks and the total carbon equivalents for each of the gasses were considered as the global climate change mitigation benefit of the habitat.

Harvested wild goods and cultivated goods: The cultivated crops and harvested wild goods were identified at two community workshops. Household surveys were conducted to obtain the economic values of each cultivated crops and harvested wild goods identified.

Nature-based recreation services: The value of nature-based recreation services was estimated from a questionnaire survey of 300 local and international visitors to obtain information on the direct expenditures. Daily site visit numbers were also used.

Water Services: Three categories of water services were measured namely; flood protection, water provision and water quality improvement. Information on flooding was obtained from six (6) stakeholder meetings and the information used to determine flood protection services offered by the site. Flood protection services were estimated using household surveys and Costing Nature for a mapped estimate of the flood protection services and beneficiaries. The total benefit of the reserve in flood control was estimated as the value of avoided damage to property and crops. Household surveys were conducted to establish the category of beneficiaries and the amount of water obtained from the current and alternative sites annually.

Results: The value of crop under the agricultural scenario was estimated as the average value for gross farm income of $100 ha-1yr-1 of all cereal crops considered. The value of crop production is higher than that of any other ecosystem service for which monetary value was attached, although with equally high management costs. Approximately 2300 visits were estimated for the site each year under the alternative state with an estimated annual value of $17,200 compared to 280 visits under the agricultural state with an estimated value of $3,000. The high number of visits under alternative state was based on the recreational opportunities that exist. The capacity of the reserve to store floods has the potential to protect 1200ha of cropland around the reserve. 25% of this area would be affected directly by floods during a 1-in-10year flood event. Additional 128 homes would be affected by floods in absence of the conservation measures at the reserve. The flood control service provided by the reserve, therefore, saved the nearby communities a total of $30,000 annually from avoided losses. The total carbon stock of the alternative state is estimated at 39,650 Mg C, which is three times that of the agricultural scenario. This difference is attributable to considerable quantity of above ground biomass and soil organic matter stored in the papyrus reed-bed.

Conclusions: There were uncertainties with the ecosystem services measured because of the overlapping boundaries of current and alternative sites since both sites are all part of the same wetland, thereby posing the risk of double counting. Uncertainties in published values of carbon storage linked with different habitat types underlined potential errors hence the need for site

specific data. Despite the shortcomings, our results provide useful indications of the capacity of the site to provide ecosystem service benefits to the society.

Recommendations: There is a need for improved recognition of ecosystem services delivered by conservation strategies to help inform conservation, but this information must be considered by decision makers alongside legislative requirements and indigenous knowledge to develop future conservation and restoration schemes that benefit both people and biodiversity. An extensive ecosystem services assessment to cover other ecosystem services not considered in this study would be necessary. Similar studies should be conducted in the region and in the Nile Basin to benefit similar wetlands.

52. Economic Valuation of Wetlands Ecosystems for Wise Use Review and Case Studies from the Nile Basin

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Abstract

Key Words: Wetlands, ecosystem services, economic valuation, Nile Basin, Wise Use

Background
The global decline in extent and quality of wetlands over the last century (Davidson, 2014) is now especially manifest in Africa. Main proximate drivers of these changes are agricultural development, large infrastructural projects and urban development. These pressures reflect underlying causes related to economic development, food insecurity, and population growth, and the policies and regulations that facilitate wetland conversions (Asselen et al., 2013). While greater utilisation of wetlands for crop production that takes advantage of supplies of water and carbon may be intuitively attractive, impacts on e.g. sustainable food production, flood attenuation, water quality, and livelihoods provide a series of risks for both social and ecological resilience (Walker et al., 2004) of wetlands and the communities they support. Wetland ecosystems provide a wide array of market and non-market benefits to society. The economic and social value of these ecosystems is often unrecognised by both citizens and policy-makers (Lin et al., 2007; Kimmel et al., 2010; Adekola and

Mitchell, 2011), despite 168 signatories to the Ramsar Convention (www.ramsar.org) and high level policy agreements on the need to protect water resources, including wetlands. The shared Water Vision for Africa 2025 (UN Water Africa, 2009) clearly identified the importance of wetlands for livelihoods, but weak institutional arrangements, uncertain legal frameworks for ownership, allocation and management of water resources, and inadequate public awareness and stakeholder involvement offer possibilities for continued degradation, despite legislation for protection in many of the riparian countries of the Nile Basin. While natural goods and services are recognised as important, their benefits are often hidden in decision making because their economic value is not explicit.. The Millennium Ecosystem Assessment brought ecosystem goods and services to the fore of political thought, with a recognition that valuing ecosystem services provides a mechanism for sustainable use of what are often perceived as "free" goods, and the internalisation of so-called externalities involving hidden costs (MEA, 2005; Russi et al., 2013).

Development of environmental economics has provided methods to quantify ecosystem services in monetary terms, as recently highlighted by The Economics of Ecosystems and Biodiversity (TEEB) for Water and Wetlands report (Russi et al., 2013). Interest on the TEEB approach and other economic valuation approaches has been growing in Africa over the last year, with a number of outreach activities aimed at policy makers, practitioners of wetland management, and researchers. However, research on appropriate selection of methods in particular circumstances, and the links between economic valuation and policy decisions are lacking in the Nile Basin and elsewhere in Africa. There is a major gap in understanding the different categories of ecosystems services, and especially how to incorporate regulating, habitat and cultural services into wetland and wider catchment management. Alongside these knowledge gaps are limits in individual and institutional capacity development. This review paper highlights economic assessment tools and approaches of wetlands services, wetland services assessment and economic values of these services with focus on case studies from the Nile basin. This review paper ois based on the results of the research project Nile Eco-VWU, funded in 2015-2016 by the CGIAR's WLE program the Nile Basin and East Africa.

Methodology and Approach

A comprehensive analysis of wetlands ecosystems services and valuation methods and tools was done on four different case studies from the Nile Basin representing different types and characteristics of wetlands in the basin: Nakivubo wetland (Uganda), Burullus Lake (Egypt), Mara wetlands (Kenya-Tanzania) and Back Swamps and Dinder Park (Sudan). The research methodology depended on identification of the baseline status of the different reported services from different studies and field work missions for new data collection and surveys fro assessment and verification of the existing services and management procedures in the different regions of the case studies. A detailed assessment study was conducted on the existing wetlands services. A detailed analysis of the methods and tools for economic valuation were tested to select the most appropriate method that fits with each case study based on specific selection criteria that was developed. The economic value of wetland eco-systems can be divided into four categories based on the benefits/functions/services provided by the ecosystem: direct (DV), indirect (IV), option (OV) and existence (EV) values, where the Total Economic Value is: (TEV) = DV + IV+ OV + EV
However, most policy makers/planners consider only the direct value of ecosystems and neglect the other values which lead to an underestimation of the true economic value of the wetland. This is one of the factors that have the lead to the loss of wetlands in many developing countries. This research lead to the development of a guideline for the economic valuation of the services was developed including the detailed steps of conducting the valuation study in different wetlands in the Nile basin.

Key Findings and Discussions

The economic valuation of wetlands ecosystems services in the different wetlands of the Nile basin showed that based on the characteristics of each wetland and the main exiling services that this ecosystem provides there are a set of relevant tools that can be used to economically valuate the services and create tradeoff scenarios for optimum wise use and investments in these wetlands. There are several methods for valuating ecosystems. Each one has strengths and weaknesses, and certain methods are most appropriate for specific situations depending on the type of information

that is desired. There are different methodologies to economically valuing goods and services provided by ecosystems in general and wetlands ecosystems in particular. All of them differ in its validity for the case at hand, their theoretical underpinning and their informational requirements and feasibility (Bishop, 1999), choosing an appropriate methodology for wetland valuation should be based on three factors: time and cost for study, capacity and experiences of those carrying out the study and information and characteristics of wetland. A number of different methods were developed for Economic valuation of ecosystems undertaking different aspects and purposes of wetland valuation. In order to assist Contracting Parties in having economic valuation information better available for decision-making on wetlands, monetary valuation methods fall into three basic types, each with its own repertoire of associated measurement issues:

- Direct market valuation;
- Indirect market valuation;
- Survey-based valuation (i.e., contingent valuation and group valuation).

This research paper shows the different selected valuation approaches and methods. A frame work containing detailed steps has been developed as a guide-line to be followed that lead towards identifying the ecosystem services and their economic values for the different case studies representing different types of regions. The paper shows the applications on fours case studies that were implemented with different valuation methods and approaches. The research showed that Valuation is an important tool for stakeholders and decision makers to support the sustainable development of wetlands. Fishing is the main economic activity of the local communities in the districts of Burullus Lake that considered as the main source of income which can be directly evaluated using market price method. The limited numbers of markets and facilities around the lake affected the price of fishery income. The losses of the lake area and pollution affected negatively the quality and the quantity of biodiversity in the lake. In Dinder Park Sudan, The field work results present the different needs, priorities and interests of the local communities, for the products and the services. The results reflect the challenges they face, in relation to water, land and ecosystems. The human activities are highly related to ecosystem services and interact with wetland seasonal situation.

The economic importance of the wetlands is definite. The economic evaluation methods are mainly by direct use and market prices. The data collected has highlighted the main drivers of change, such as seasonal fluctuation in wetland functions, stakeholder priorities and suggested plans as related to these changes. In Nakivubu Uganda, The direct use value of the main provisioning services of the Nakivubo wetland Local Communities (one household per hectare per year) is worth about ($15000). This implies that a wetland is improving people's livelihoods. However, this is occurring at the expense of the main ecosystem service that this wetland used to provide, which is wastewater treatment. In Mara, Economic valuation of wetlands entails non-market and market valuation techniques. In cases where the Ecosystem service (ES) in question lack explicit markets where they can be traded, non-market valuation techniques may be used to establish the Willingness To Pay (WTP) or Willingness To Accept (WTA) for these dis/services. Benefit transfer may be applicable if a study already exists that valued an ES similar to the one in question. In Mara wetland, the economic values of provisioning ES traded mainly in the local markets such as charcoal, bricks, thatching grass, firewood, fish and papyrus mats were assessed using market price-based methods.

Conclusions and Recommendations

The research done on the applications of valuation methods on the Nile wetlands concluded that Wetlands ecosystems are amongst the richest life-support systems on Earth. It provides a variety of benefits to humans, either in the form of products, or in the form of services. It is recommended that an updated data is needed for calculating the operating cost of fishing gears in Burullus Lake as the available data was taken in 2005. More measurement are needed for valuating of supporting ecosystem services in Burullus lake as a non use value. In Mara Gross income per day for fish should be included in the valuation to countercheck calculations and avoid the likelihood of over-estimation

in fish production. Sustainable cutting of trees used for charcoal production and firewood and initiative of afforestation in the basin by the local communities is needed. Further research in Mara should be conducted on other ES particularly agriculture which were not valued in this study. In Nakivubu, Market price method was used to value ecosystem services. In the subsequent valuations, other methods should be used. Despite the fact that this wetland is providing livelihoods to the surrounding communities, the wetland be restored with natural vegetation and agricultural activities be limited to the wetland edge, after carrying out a consultative wetland management planning. In Dinder Park, Ecosystem services, values and the extent of benefits provided by the Dinder wetland to the beneficiaries would be sustainable through the wise use of wetland resources. The balance between the conservation of Dinder as protected area and the sustainable utilization of the resources by the local communities is very essential towards sustainable development. Development plans are needed for the effective management and wise use of the wetland available resources for the benefits of the communities, the ecosystem and the region in general. Close collaboration with relevant partners and stakeholders, effective advocacy at the appropriate time and place are essential. Further research and studies, and more efforts are needed for valuating the costs associated with ecosystem functions and the substantial economic benefits from better management and conservation of Dinder Wetland. It is also recommended to develop models for total economic valuation of ecosystem services at national and regional scales, Including both market and non-market based economic approaches for total valuation of the identified ecosystem services and Implement structures and frameworks for decision making that takes account of the total ecosystems values.

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53. Water in national economic planning: utilization, challenges and valuation.

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Abstract
It is hard to study the economics of water without incorporating the economics of energy and food because these three systems are interconnected and interdependent. While energy requires water for its generation, cooling and transportation, water needs energy pumping, drainage, desalination and distribution. Irrigation water is used to produce food, while food production and waste affect the quality of water. Additionally, energy influences the supply of food because it is used in harvesting food crops, producing fertilizer and processing food, while food crops are used to produce bioenergy. Now, these three interconnected systems are confronted by several external factors and challenges including climate change, economic and income growth and population growth among others (Figure 1).

The challenges facing this interconnected system are common across the Nile Basin countries. Climate caused the inter-annual variability of the total Nile-water flow to increase by up to 50% in the twenty-first century (Siam and Eltahir, 2017), which increases the uncertainty associated with future Nile water flow and usage. Population of Nile Basin countries is estimated at 487.3 million (Philip et al., 2016), which is expected to double by 2050 reaching a billion inhabitants. At the same time, the population living within the Nile Basin alone, which is 53% of total Basin countries population is expected to exceed 300 million as soon as 2025 (Salman, 2016; Siam and Eltahir, 2017). The combined effects of climate change and the growth of population and income is projected to increase global prices of food and other commodities, some of them to a considerable level. For instance, world prices of wheat, sorghum, millet, maize and vegetables are expected to increase from their 2016's levels of US$ 234, 158, 313, 163, 909, respectively by 37%, 24%, 33%, 86%, 49%, respectively in 2050 (Robinson et al., 2015).

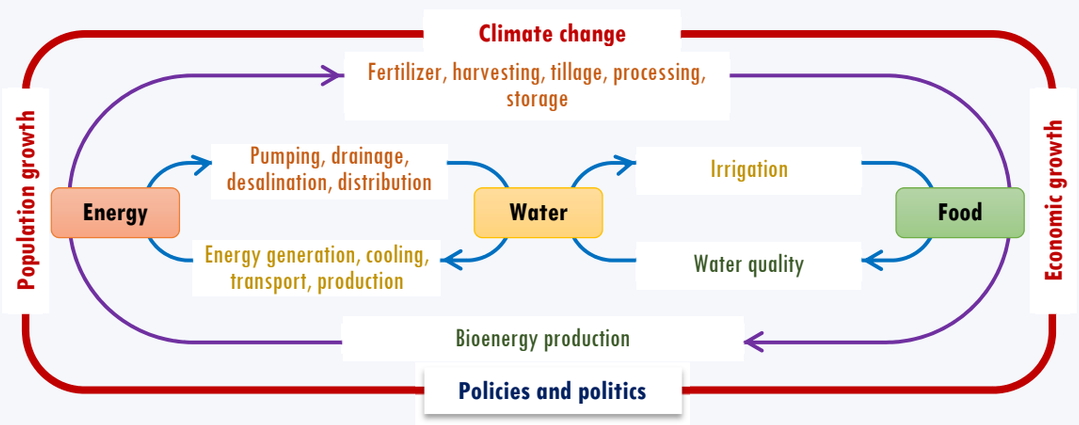

Figure 1: The interplay between water, energy and energy and its external influencers.[15]

Now returning to the interconnected system of Figure 1, the fourth external influencer is the policies and politics. Fortunately, this component provides a larger room for collective interventions, not only within the interconnected system of each country, but also between the different countries of the Nile Basin. This collective planning becomes even more important and possibly useful within the Nile Basin countries where the Nile water is commonly used and crucial to food and energy securities of the entire Basin.

[15] Inspired by Mohtar and Daher (2012).

The significance of agriculture in the national economies of the Nile Basin varies and similarly the dependency of agriculture on irrigation as well as irrigation on the Nile water. Taking Egypt, Ethiopia and the Sudan as examples, the shares of agricultural value added in the Gross Domestic Product (GDP) in 2016 were 11.9%, 37.2% and 39.5%, respectively in the three countries with irrigated agriculture playing the major role in Egypt. Freshwater withdrawals in 2014 for the three countries in billion cubic meters were 78.0, 10.6 and 26.9, respectively, while the utilizations of withdrawn fresh water in agriculture make 85.9%,91.8% and 96.2%, respectively in the three countries (World Bank, 2017). The remaining share of freshwater is used in industry and municipalities, which indicates that water is predominantly used in agriculture in the three countries. However, water value for each water usage portrays a completely different picture. In the Sudan, which is no exception among Nile Basin countries, the share of water used in agriculture in the total annual water value is less than 20%. Moreover, a classification of water by type (irrigation water, pipe water and porterage water) shows that the share of irrigation water in the total value of national water usage is only 18%. This clearly indicates a huge discrepancy between water usage in quantity terms and water value. Collectively addressing this discrepancy within the Nile Basin and associating with water a unified unit price across countries and uses (agriculture, industry, domestic use, energy, and ecosystem services) is a proposal for enhancing the efficiency of water usage within the Nile Basin.

Key words: water usage, water value, water use efficiency, irrigation, Nile Basin.

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54. Eastern Nile Multipurpose Option Scoping Model (ENMOS_v_6.1)

Eastern Nile Technical Regional Office (ENTRO); Mikiyas Gonfa[a], Azeb Mersha [b], HelenBerga[c]

My name is Mikiyas Gonfa, from Ethiopia. I completed my BSc in Soil and Water Engineering from Haramaya University and MSc in Engineering Hydrology from and Bahir Dar University both with great honor. During my six years of experience, I got the chance to be involved in projects such as HIS/BIS (hydrologic information system or basin information system), Micro watershed monitoring project and my currently area of expertise, water resource modelling more on resource optimization. I developed a consecutive version of "Tana sub-basin multi sectoral investment scoping model" for Tana sub-basin office (Bahir Dar Ethiopia) were currently serving as junior water resource modeler. Using it I produced different studies including cost of uncollaborated water resource development in Tana and Beles sub-basin. My latest project was developing the latest version of ENMOS_v_6.1, which was during my internship time in ENTRO (Eastern Nile Technical Regional Office).

Abstract:

Water scarcity is a global challenge for this century especially Eastern Nile Basin since it is already under water stress and shared by four countries. Hence how well the basin manage and develop the water resources will be a decisive factor in avoiding conflict of water, achieving food security, alleviating poverty, establishing reliable electricity supply to support broad-based growth, and securing safe and reliable domestic and industrial water supply. Therefore there is a need to have cooperative water resource planning for sustainable water use and for avoiding high cost of investments.

The Eastern Nile Technical Regional Office (ENTRO) under the previous projects has ported the Eastern Nile Countries in preparing investment programs and projects. ENTRO recognize the challenges that the countries may face for coming future with increasing population and demand that there should be a new approach to optimally use the Nile water with maximum benefit out of it. It's here that this study comes handy in quantifying the benefit of this investment per sector considering possible treads by using optimization with hydro economic configuration using Eastern Nile Multipurpose Option Scoping model (ENMOS). ENMOS is a useful tool to convene experts from the respective countries to arrive at shared understanding and agreement on the physical and economic parameters for the selection of the optimal technical options based on an economic analysis.

The development of ENMOS have gonne through various updates and this version (ENMOS 6.1) have various additional functionality that could be valued in to three main aspects; methodological, input data, user interaction aspects. The model is a holistic, deterministic optimization model applied to a 102-years' time horizon (1900-2002) with monthly time intervals developed using GAMS. System losses (such as evaporation from wetlands) were modeled endogenously which make it promising to evaluate reservoir operation strategies to save extra water. Besides, a spatial disaggregation feature makes it possible to formulate a separate model to a minimum and maximum of a sub-basin in a country and Easter Nile as a whole respectively, enables to make different collaboration (collusion) scenarios lining trough an exogenous upstream boundary flow resulted from a preceding scenarios. Regarding data updating aspect, a recent and representative data for

sectors such as irrigation and domestic demand were used that represent the current situation of the basin. Finally a well-designed data management architecture from scenario formulation to result visualization enables users to formulate to a maximum of 20 scenario that very close future reality of the basin, whereas result visualizations assisted with excel based GIS interface ease user interactions in evaluating options.

To ensure model credibility for further analysis, model result from current situation were compared with historical one and found satisfactory to conduct further options investigations. Sensitivity analysis on over year storage constraint shows higher variation in reservoir evaporation and generated power specifically for large reservoirs (such as HAD and GERD) and found to be sensitive.

Particularly compared with corresponding simulation study (Easter Nile Multi-Sectoral Investment option Analysis), result from this study shows more irrigated area and power production through an extra water comes from a reduced system loss by in a range of 10 to 20%, optimized reservoir operation and crop zooning. Under the full development scenario, if maximizing gross economic benefit is considered, overall power production and irrigated area could reach 83 TWh/year and 8.9 million hector respectively. Similar to previous studies, almost half of the hydro-power generation comes from Abay-Blue Nile sub-basin strategically make it the main source of hydropower power than other sub-basin, interestingly if existing crop pattern relaxed by 20%, the study found a possibility to develop 80% of the potential irrigation with sacrificing 10 TWh/year hydropower production.

In conclusion contrary to simulation models this study unleash the ability of hydro-economic optimization model to efficiently allocate water across time and space and how to use the resource with full coordination between decision makers.

Keywords: Eastern Nile Basin, ENTRO, Optimization, allocation, investment, development, GAMS

55. Projecting the downstream impacts of the Greater Ethiopian Renaissance Dam: the case of irrigated schemes in Sudan,

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Mr. Shamseddin Musa Ahmed graduated in agricultural engineering in 2000 at University of Gezira, Sudan, with first class (honor). Immediately, joined the academic staff of the Water Management and Irrigation Institute (WMII), University of Gezira (UofG) where he finished his M.Sc. and PhD in Water Management, 2003 and 2009,respectively. Since 2014, Dr. Ahmed is associate professor working for WMII. His teaching and researching activities span a range of integrated water resources management issues, e.g. soil water conservation, irrigation systems, groundwater hydrology, remote sensing & GIS. The UofG awarded him the Best Publication List Prize in2014. He developed a newer approach for assessing the sustainability of irrigation system, published in Sustainability Science Journal. Through the ENTRO-NBI internship program, he effectively participated in developing the *Irrigation Toolkits* of the Eastern Nile Irrigation Projects. Currently, he is the president of the African Professionals'Initiative for Water, Environment, Energy and climate (APIWEC).

Abstract

The Blue Nile River is the artery of irrigated schemes in Sudan and Egypt. However, it is a transboundary river (originated in Ethiopia) with variable seasonal flows (July-October) of 50 km^3. Ethiopia has started in 2011 the establishment of what is being called as "*the Greater Ethiopian Renaissance Dam (**GERD**)*" to store 79 km^3 of water, raising downstream warranted fears despite the claim of hydro-power generation purposes. There is no much available data regarding the operation of GERD, nevertheless it will not be different from the upstream reservoir of Karadobi. The reservoir will be filled during the flood season starting from July to October and emptied gradually from January to June. Thus, the construction of GERD will smooth flood peaks and increase the recession flows. Moreover, according to the Basson and Rooseboom diagram, GERD could be classified as a storage reservoir. Thus, all trapped sediment (245 million ton) will remain within Ethiopia and the sediment load entering Sudan (146 million tons yr^{-1}) will be substantially reduced by 97%, authors' estimation. Such hydrological alterations would have impacts on the irrigated agriculture in Sudan. This study aimed at assessing the impacts of GERD on the performance of the irrigated schemes in Sudan, with emphasis on the Gezira and Rahad schemes (GRS) of 1.01 mha. The Objective function (maximized net benefits) was being optimized using the GAMSIDE 24.8.3 software, constrained by the availability of land and water resources. Two main scenarios were developed: the first optimized the current on-going practices, i.e. running the business as it is (hereafter known as *RBAI*); the second modeled the impacts of GERD under different conditions (referred to as *GERD impacts*). Compared to the baseline datasets (1990-2004), the optimized cropping intensities, especially those under GERD conditions indicated the room for tremendous increases in net benefits (117 – 1283%) coupled mostly with significant reductions in the irrigation water requirements (19 – 47%). The study concluded to the detrimental impacts of food crops expansion, e.g. sorghum onto irrigated schemes with reference to net returns and water use.

Keywords: Greater Ethiopian Renaissance Dam; Irrigation; optimized benefits; GAMS; Sudan

56. Updating the hydrology of the Baro-Akobo-Sobat basin

Authors: V Jonker (Aurecon), M Botha (Aurecon), S Crerar (BRL), A Mersha (ENTRO), JE Muso (ENTRO), F Negash (ENTRO), N Sicard (BRL)

Verno specialises in water resources management and has more than 20 years of experience as a water resources engineer in the fields of catchment and flood hydrology, integrated water resources analysis, planning and management, decision support systems, flood risk assessments, systems operation and environmental flows. He was the team leader for the project which piloted the application of the NB-DSS in the Nile Basin and was the water resources key expert for the Baro-Akobo-Sobat Multipurpose Water Resources Development Study Project. He obtained his PhD in Civil Engineering from the University of Stellenbosch. He is currently the Water Resources Management Design Director for Aurecon and is based in the Cape Town office, where he is involved with various projects in South Africa and Africa.

Abstract

Keywords: Baro-Akobo-Sobat, hydrology, water balance, remote sensing, water resources development, scenario analysis

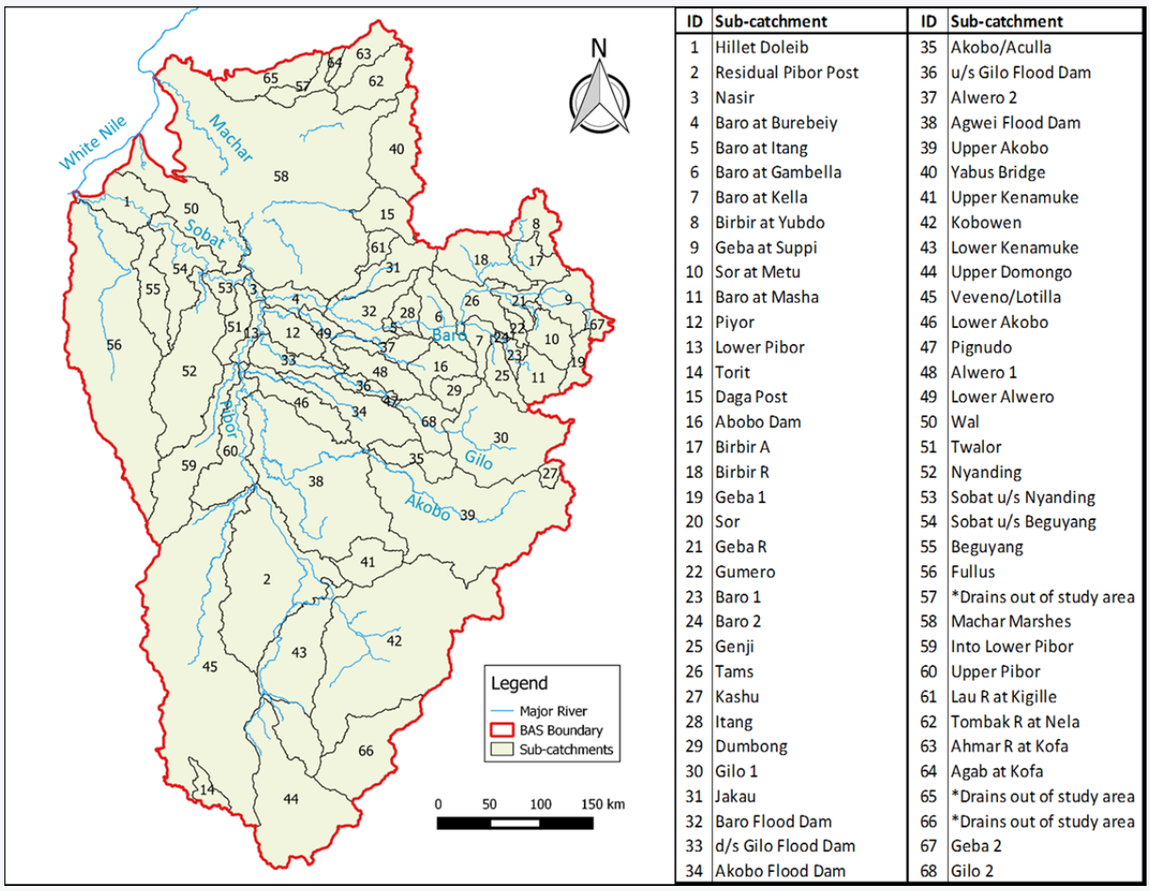
Background

The Baro-Akobo-Sobat sub-basin constitutes one of the main sub-basins of the Nile and encompasses parts of Ethiopia and South Sudan. The mean annual flow from the basin of 12.3 BCM equates to about 15% of the flow in the Main Nile at Lake Nasser. Access to water supply, sanitation and electricity in the basin is currently very low, while a general lack of infrastructure coupled with frequent flooding and droughts as well as hydrological and climate variability worsen the vulnerability of communities. The sub-basin also hosts wetlands of international importance. Despite the current low levels of socio-economic development, the Baro-Akobo-Sobat sub-basin is anticipated to have signification potential linked to water and other natural resources developments. Recognizing the potential for integrated water resources development and management in the basin, ENTRO commissioned the Baro-Akobo-Sobat Multipurpose Water Resource Development Study Project in 2015 to promote socio-economic development, regional cooperation and peace through sub-basin wide cooperation in integrated water resources development and management based on a Strategic Social and Environmental Assessment.

Methodology and approach

This paper presents the outcome of the hydrological and water balance analyses undertaken as part of the Baro-Akobo-Sobat Multipurpose Water Resource Development Study Project and provides details on how the model was used to inform the development of an Integrated Water Resources Management and Development Plan. This entailed a review and update of the surface water drainage network in the basin using satellite imagery, the delineation of sub-catchments based on physiographic and future development considerations, the quantification of existing water use, the

configuration of a detailed model network to ensure the accurate representation of floodplain and river interaction, attenuation and losses, the quantification of surface water flow and the evaluation of a range of scenarios in terms of hydrological and associated social, economic and environmental impacts. Groundwater resources in the basin were also quantified using new data sets derived from geology, topography and recharge.



ID	Sub-catchment	ID	Sub-catchment
1	Hillet Doleib	35	Akobo/Aculla
2	Residual Pibor Post	36	u/s Gilo Flood Dam
3	Nasir	37	Alwero 2
4	Baro at Burebeiy	38	Agwei Flood Dam
5	Baro at Itang	39	Upper Akobo
6	Baro at Gambella	40	Yabus Bridge
7	Baro at Kella	41	Upper Kenamuke
8	Birbir at Yubdo	42	Kobowen
9	Geba at Suppi	43	Lower Kenamuke
10	Sor at Metu	44	Upper Domongo
11	Baro at Masha	45	Veveno/Lotilla
12	Piyor	46	Lower Akobo
13	Lower Pibor	47	Pignudo
14	Torit	48	Alwero 1
15	Daga Post	49	Lower Alwero
16	Abobo Dam	50	Wal
17	Birbir A	51	Twalor
18	Birbir R	52	Nyanding
19	Geba 1	53	Sobat u/s Nyanding
20	Sor	54	Sobat u/s Beguyang
21	Geba R	55	Beguyang
22	Gumero	56	Fullus
23	Baro 1	57	*Drains out of study area
24	Baro 2	58	Machar Marshes
25	Genji	59	Into Lower Pibor
26	Tams	60	Upper Pibor
27	Kashu	61	Lau R at Kigille
28	Itang	62	Tombak R at Nela
29	Dumbong	63	Ahmar R at Kofa
30	Gilo 1	64	Agab at Kofa
31	Jakau	65	*Drains out of study area
32	Baro Flood Dam	66	*Drains out of study area
33	d/s Gilo Flood Dam	67	Geba 2
34	Akobo Flood Dam	68	Gilo 2

Figure 2: Delineation of model sub-catchments

The water resources analyses entailed a comprehensive review of existing literature, reports, data and models, the use of station recorded and global climate datasets, and the use of remote sensing data along with global datasets on seasonal inundation extents of wetlands and marshes within the basin. After the successful calibration and validation of rainfall-runoff and water balance models, the models were used to generate a time series of synthetic flow sequences, spills and floodplain storages at key nodes in the basin for the period from 1905 to 2014 under a range of development and management scenarios. First order estimates of environmental water requirements were determined using a desktop model. The groundwater component of the study entailed a secondary assessment of groundwater availability and potential at basin scale. A physically-based distributed hydrological model was also used to develop a sediment yield map of the basin. The outcomes of these analyses were used to inform the formulation of an Integrated Water Resources Development and Management Plan.

Key findings

Key outcomes of the water resources analysis task included an improved understanding of the spatial and temporal hydrological regime, the hydrological connectivity between the main river channels, floodplains and marshes, and the overall water balance within the basin. In addition, various combinations of basin development interventions including hydropower, irrigation, water supply etc. involving single- and multipurpose dams were evaluated using the water balance model, ranging from full development to limited development (precautionary principle) scenarios. Examples of key model outputs which informed the evaluation of alternative scenarios included hydropower generation, irrigation areas and deficiencies in water supply, environmental flow compliance, areal extent of marshes and floodplains, duration and seasonality of floodplain inundation, water storage and water availability.

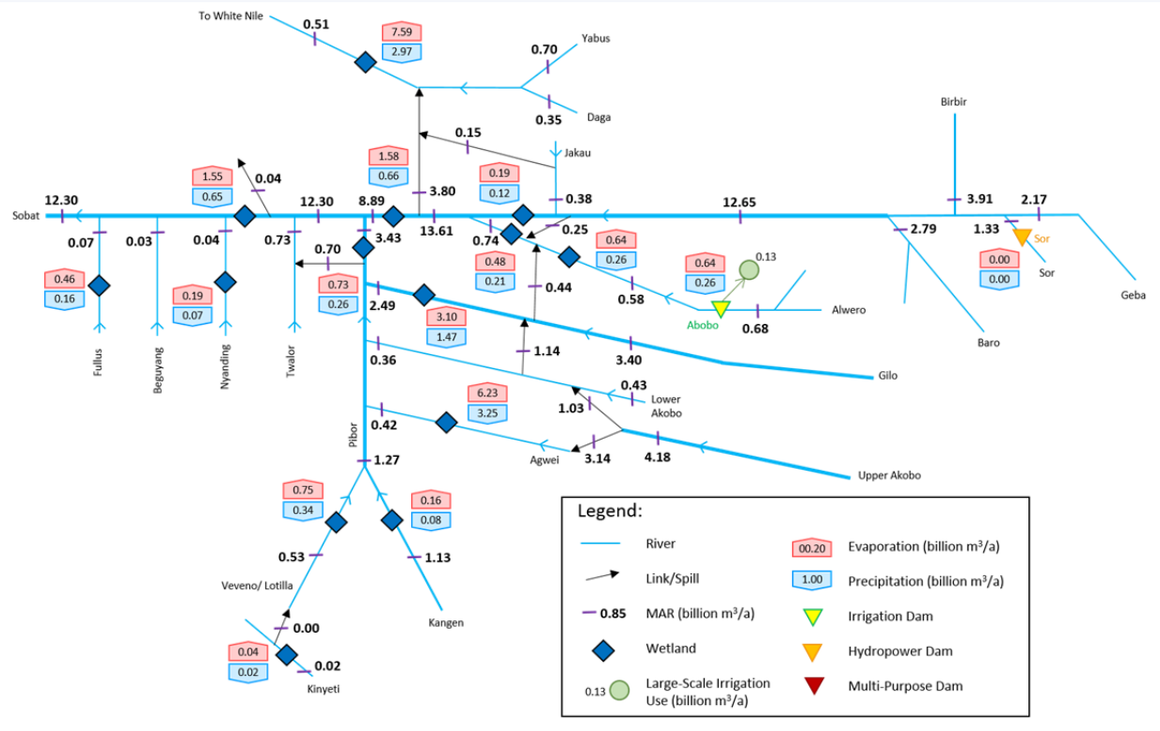


Figure 3: BAS Water balance - Baseline

Conclusions and recommendations

The water resources analyses which were undertaken as part of this project highlighted the need for improved hydro-meteorological monitoring in the Baro-Akobo-Sobat basin, especially in the South Sudan part of the basin. However, it was demonstrated that when remote sensing data in conjunction with readily available global datasets are used to supplement observed data, satisfactory results are obtained to inform water resources development studies at basin scale. The spatial resolution at which the water resources models were configured along with the extensive simulation period of the models - spanning more than a hundred years – provide a useful tool for the accurate assessment of the potential impacts associated with large-scale developments while ensuring compliance with social and environmental sustainability objectives. These models can also be easily updated and improved as new information becomes available.

57. The Political Economy of Large-scale Agricultural Investments in the Nile Basin: Exploring opportunities and challenges of private sector financing in Land-Water Resources Development , Ramy Hanna

Ramy Lotfy Hanna is a Doctoral researcher at the Institute of Development Studies (IDS), University of Sussex in the U.K. His research interests encompass resources politics, sustainable use of natural (land/water) resources, and trans-boundary water governance. His academic background is economics and international relations, and he earned his Master degree in Environmental Studies from York University in Toronto. His professional portfolio as an economic development researcher and an environment specialist in Egypt and the MENA region includes a number of agencies such as the UN Economic Commission on Africa (UNECA), the African Development Bank

Abstract

The presentation explores the role of private financing and investments in land and water resources development in the Nile basin. Since 2008 and 2011, large-scale land acquisitions have taken different shapes and forms in the Nile basin as well as other countries in Africa and globally in search for water and food security. Several actors have been involved in large-scale agricultural projects including private equity funds, sovereign wealth funds, specialized agricultural companies, amongst other private sector actors. Investments denote a form of state-capital alliance, which aims at developing land and water resources commercially using technology and capital. This engagement of the private sector denotes a new modality towards the development of the Nile basin resources and entails both opportunities and challenges for the state, the society, the investors, and the environmental sustainability of the Nile basin's natural resources.

The presentation provides a multi-scale analysis of these large-scale land-water investments on local, national, and trans-boundary levels. Findings are derived from a political economy analysis for these investments based on empirical evidence and PhD fieldwork, which included a wide range of actors including government representatives, private investors, local communities, and policy makers in Nile basin. The findings focus in particular on how these investments can promote cooperation within and outside the basin given the wider global challenges of water and food security, as well as the sustainable use of natural resources. It also analyzes how these investments address the narratives of water scarcity and security within and outside the Nile basin, while forecasting different scenarios for future development. Initial findings indicate that land and water acquisitions by non-state corporate actors take several shapes and forms. Different political economy and environmental factors affect and are affected by these investments such as; water availability, water quality, the role of infrastructure, the livelihoods of small farmers, and climate change.

58. Food, Fodder and Flowers: the critical role of global and regional virtual water trade in the Nile Basin, Ana Elisa Cascão, Stockholm International Water Institute (SIWI)

Dr. Ana Elisa Cascão is currently an independent consultant working in the field of transboundary water management and cooperation – she is a political scientist with experience of 13 years in this field and has been working in the Eastern and Southern Africa regions, and as well in the Middle East and North Africa region. She holds a PhD in Human Geography (2004-2009) on the 'Political Economy of water resources management and allocation in the Eastern Nile Basin' (King's College London, UK). For the past eight years, Ana has been involved in several major projects, in particular in the Nile Basin, as Programme Manager at Stockholm International Water Institute (SIWI) where she worked across different units – Capacity Building, Advisory Services, Applied Research, and Transboundary Water Management. She is the author of several academic publications on topics related to transboundary water management. Her latest co-authored book is entitled "The Grand Ethiopian Renaissance Dam and the Nile Basin: Implications for Transboundary Water Cooperation" (Routledge, 2017).

Abstract

Keywords:Virtual Water Trade, Food, Livestock, Crash-crops, Blue water, Green water, Regional cooperation

A short background

This article will provide a critical and in-depth study of the role of Virtual Water Trade (VWT) in the Nile Basin for the past four decades, namely by looking at the key importance of food imports and exports in national political economies of the Nile riparian countries and by trying to understand how VWT have directly or indirectly influenced processes of management, allocation and development of water resources (both blue and green).

Besides, the article will look at the geopolitical and geoconomic implications of VWT, as well as the challenges and opportunities associated with global and intra-regional trade. This article has been developed as a keynote speech for the First International Virtual Water Conference, which took place in Tehran – Iran (29-30 April 2017).

Methodology and approach

The article will include a comprehensive review of existing literature, which will be complemented by interviews with key actors, in order to assess, map and analyse three types of VWT trajectories: 1) From outside to within the Basin: as food imports and food aid; 2) From within to outside the Basin: as food exports, namely as food crops and livestock but as well as cash-crop exports; and, 3) VWT within the Basin, i.e. intra-regional trade.

Quantitative and qualitative analysis will allow to understand the fundamental role of VWT in national political economies, in particular in Egypt which one of the major virtual water importers in the world. Besides, the article will explore the concepts of Blue and Green Water to understand which of these water resources is being utilised in both Virtual Water imports and exports – what are the dimensions, complexities, challenges and opportunities.

Key findings Only to name a few of the key findings:

For the past 4 decades, VWT has a significant and growing strategic significance in the political economy of Egypt, including influencing processes of water management at national and regional level. VWT in Egypt has contributed to ensure Food and Water Security, as food imports have balanced the water deficit and relieved pressures on blue/Nile water resources. This did not come without challenges, as issues such as dependence on external resources, challenges of diversification of trading partners, fluctuations in global food prices, WTO rules, and possible impacts of climate change in agriculture productivity worldwide, highlight the risks associated with the exposure to external factors.

Upstream riparian countries are net virtual water exporters of Virtual Water, in the sense that they export more than what they import. Analysis of available quantitative data will show which crops are being produced and exported, what its 'virtual water' dimension, and to where – both under old and recent land developments, including those recent deals under Foreign Direct Investment. The main finding is t hat, so far, most of the water being exported under both 'old' and 'new' land deals is Green water (from rainfed agriculture, outside of the Nile basins, and in principle with no significant transboundary impacts).

One of the other findings is that Sudan is currently a net virtual water importer, but the importance and relevance of its exporting capacity has been increasing. Sudan mainly exports Green Water (namely through livestock), but also Blue Water (food and cash-crops grown in both Blue and White Nile Basins). The article will highlight that Sudan is by far the Nile riparian with the highest (unexploited) agriculture potential, and that possible expansion of this capacity can be utilised to increase agriculture production and exports, and there are vested interests (both internal and external) to tap that potential. This is expected to have impacts on the management and allocation of blue/Nile water resources, but as well in the hydropolitical relations between Nile riparian countries.

Conclusions and recommendations

Complementary to the above analysis, the article will also critically examine the current status of intraregional/basin virtual water trade, it will attempt to understand why has historically and currently been so low, and what are the associated obstacles and challenges. On the other hand,

will appraise are the opportunities/benefits (for all riparians) of promoting an internal agricultural commodity trade and increasing intra -regional VWT. These analytical conclusions will be the basis for two major policy recommendations: 1) the need to promote/strengthen transboundary water cooperation with an explicit focus on regional food security; and, 2) the need to build strategic and sustainable regional/basin-wide virtual water markets.

59. Business Corporations in the Eastern Nile Basin: Engine or Barrier of Water Governance?

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Abeer R.Y. Abazeed is Phd rsearcher at the Institute of Security and Global Affairs, Faculty of Governance and Global affairs and a visiting phd student at the African Studies Center in Leiden University (Netherlands). Her Phd research tackles the role of civil society in hydrpolitics issues in the Eastern Nile Basin (Egypt- Sudan –Ethiopia). In Egypt, Abeer is working as assistant lecturer of political science at Faculty of Economics and Political Science in Cairo University. Abeer has BSc of Political Science from Cairo University, and then she earned her M.A degree and a diploma in Public Policy and Administration from the American University in Cairo. Her research interest is international political economy and she published articles in Arabic journals using this approach. Civic engagement is her current research interest that derived from her engagement in many Egyptian civil society organizations also she contributed in founding initiatives aim to consolidate bonds between Egypt and other African countries.

Abstract

Keywords: corporations; agriculture business; energy sector; non-state actors; economic development.

The recent development strategies in the Nile Basin countries show heavy dependence on water as an initial natural resource to generate energy and to increase agriculture products. On the other side, water consumption in the River Nile has increased considerably as a result of population growth. This upsurge in water consumption has coincided with environmental threats such as floods; droughts and water pollution.

Accordingly, different social forces became critical actors in the hydropolitics of the Nile River. Attaining economic development gains drove the Nile basin governments to consider the regional collaboration either with other basin countries or with non-state actors is a must not a desirable action.

The legal and technical multilateral arrangements had been the dominant manifestations of the Nile regional cooperation such as: Hydromet project, Undugu, and Tecconile. In these regional arrangements, the nation state, represented by officials and technocrats, was the only actor to set out the rules of the Nile relations.

However, the Nile Basin Initiative (NBI), the last cooperative institutional frameworkwhich includes all of the basin countries, is a unique regional institution compared to any previous arrangements because the scope of cooperation has been widened to cover non-water issues. Moreover, it has acknowledged the role of civil society as a stakeholder in governing the affairs of the basin. On the other side, the transnational non state cooperation can be captured in the activities of the Nile Basin Discourse as a network of civil society organizations in the Nile basin. Also, the East African Communities Organisation for the Management of Lake Victoria Resources (ECOVIC) that includes non-governmental organisations in Kenya, Tanzania and Uganda. And at the community level, the Nile project is a cultural initiative to sustain dialogue in the basin countries through musicians. Additionally, the student union of basin countries was established in Cairo as a platform for students studying in Egypt.

However, business corporations are the critical non-state actors that the Nile basin governments cannot discount their interests or preferences when they formulate their regional actions. This paper will explore the dimensions of dynamic between governments and enterprises in water – related projects and how this dynamic has been mirrored in the Nile water governance.

The importance of business corporations as an significant actor in managing the Nile water internally and regionally is relied on the pace of economic development in the Nile countries.

The Nile Basin countries have pursued economic development policies leading to their integration into the neoliberal global economy. The implementation of these policies has promoted foreign investment, free market and privatization. Furthermore, an increased energy consumption which necessitated the need for generating more energy to meet the development plans has also increased dramatically. Therefore, maintaining higher levels of hydropower production requires the sustenance of water levels conducive to meet an accelerated need for energy production.

Along these developmental policies, the Nile Basin is vulnerable to climate change which has been linked to low precipitation and variability of water flows. The Nile water levels have been very sensitive to environmental changes such as prolonged drought due to reliance on rain for irrigation. Hence, frequent floods and droughts have direct impact on the development plans. Therefore, the dependency on water is considered critical for up and downstream countries.

The paper will focus on the Eastern Nile Basin that includes the downstream countries (Egypt and Sudan) and Ethiopia, the major upstream country in the Nile Basin. The effectiveness of the regional cooperation among the Eastern Nile basin has been challenging many times due to economic aspirations particularly.

The regional arrangements played significant role in fostering mutual trade and

investments. Ebaidalla (2006) argued that since establishing Comesa in 1993, the bilateral trade in the Eastern Nile countries improved; however, its progress is limited. He shows that Ethiopian exports to Egypt increased from 6 million USD in 2000 to 26 million USD in 2012 and to Sudan increased from 1 million USD in 2000 to 74 million USD in 2008; imports as well increased among the eastern Nile countries.

Agriculture products and energy (oil products) are the core of trade and investment movements in these countries. That is why business corporations are intensively present in the dynamics among the Eastern Nile basin mainly in agriculture and energy sectors. For instance; Egyptian investment in Ethiopia was estimated 2 billion USD in 2015; while Sudan was ranked the 2nd investor in Ethiopia after China in 2014. In spite of this intra-region economic interactions, there is a debate about the role of business actors, the perspective of regional integration and national development strategies consider them an engine of increasing the national growth rate and consolidating regional mutual investments; while others highlight the situations when business interventions have exploitive effects. In this regard, land grabbing is the negative side of agriculture investments. The available data on Land Matrix database shows asymmetry of intra-regional investments. When Egypt is a target country by Gulf corporations that invested in more than 150000 intended hectares, Egyptian investors mainly target Sudanese lands with more than 132000 intended hectares and they are absent in Ethiopia.

To interpret this debate, there are different factors define the impact of business on the regional cooperation in the Eastern Nile basin. They are: the convergence/divergence of national development priorities; the technological advancement of business corporations; the nature of relations between politicians and businessmen and the connections with international investor.

The paper will demonstrate how these factors shape the scope and degree of cooperation among Egypt, Sudan and Ethiopia in the Nile governance.

60. **Climate Finance: opportunities for transboundary water project Investment ,**Herman Kwoba, Pan African University Institute of Water and Energy Science (including climate change) *Kwoba.herman@gmail.com*

Herman Kwoba is a Climate policy expert with extensive knowledge in policy development and strategic interventions. He has a degree in Environment Studies (and community development) and a Masters in Water Policy and climate change from The African Union's Pan African University Institute of Water and Energy Sciences (Including Climate Change) in Algeria. Herman was part of the team that developed the Kenyan Green Economy strategy and Implementation Plan, was also actively involved in developing the Country's Nationally Determined Contribution, the Climate Change Act 2016 and has also consulted for GIZ on several occasions. Herman is currently working on climate change mitigation assessment and emissions quantification in Kenya's key sectors as a Technical expert. He comes to the conference with a very clear understanding of the Global Climate Change financial mechanisms and will provide insights on the available channels for the Nile Basin countries to exploit.

Abstract

Key words: climate finance, water resources, UNFCCC, Paris Agreement, Nile Basin

Background

Based on a research whose primary focus is on opportunities for water sector financing under the UNFCCC, the power point presentation will be on the avenues through which trans boundary investments can leverage climate finance to strengthen multi country cooperation in regional investments. The focus will be on transboundary projects with significant adaptation potential in the Nile Basin, which, if packaged well, would fit investment criteria provided under the climate finance mechanism. The study takes a very practical approach and offers transboundary project practitioners clear and well defined analysis on how financing under the United Nations Framework Convention on Climate Change (UNFCCC) is structured and their existing channels of access. The researcher will outline the basis under which historical awarding of financial resources to transboundary projects have been done as well as the most appropriate financial mechanisms.

The Key question will be on how climate finance has been utilized in the water sector, and the basis on which successful projects have been considered worthy of being financed under such an arrangement. This will be answered through investigations of whether there are metrics that determine development of climate change project and what level of consideration is put in categorizing projects specifically under the water sector as climate change projects? Or is any water project consequently a climate adaptation project.

Methodology and Approach

The study was largely qualitative; adopting a mixed research approach. It delved deep into the phenomenon of climate finance with an aim of providing detailed descriptions of existing mechanisms. This was followed up with analysis of several case studies focusing on transboundary water projects that have benefited from the financing. It sought to explore the boundaries within which transboundary water projects could effectively benefit from climate finance. Such an approach helped uncover the key elements for consideration in allocation of climate finance.

Systemic review of key literature was carried out based on the PRISMA statement and key informant interviews were also carried out to complement the reviews.

key findings

A well outlined procedure of how climate finance flows in Africa are being channeled, how the money is being invested, and most of all how this could be translated to transboundary water resource investments in the Nile Basin. An examination of how adaptation and mitigation allocations have been distributed in the sector was also done.

These findings are essential in determining how to optimize investment from climate finance in the water sector. The ultimate aim will be on how to formulate a proposal that will meet the international standards set as well as one that meets the needs of the vulnerable community. This will be with a focus on how these finances can be used to strengthen multi country cooperation,

conclusions and recommendation

Definitive indications on how much money is coming into Africa under climate finance, and how these has been distributed within the public and private domain is of great importance for figuring out how to leverage ourselves. This study thus provides a basis on which countries can obtain and invest climate finance under a cooperative framework. It will help nations within the Nile Basin find ways of developing transnational proposal for addressing transboundary issues.

Modalities of coordination at the transboundary level, and the best avenue for financial exploitation have been proposed. These are customized to the unique experiences and political dimensions surrounding the Nile basin. This study is thus of great relevance to the basin as opportunities for sourcing finance needed to implement the CFA are being explored.

Thematic Panel Session Abstracts

Groundwater as supplementary water source in the Nile basin, Seifu Kebede, School of Earth Sciences, Addis Ababa University.

Dr Seifu Kebede is a hydrogeologist and authors more than 35 peer reviewed scientific articles and a book entitled 'Groundwater in Ethiopia: features, numbers and opportunities'. He is involved in research related to the multifaceted dimensions of groundwater (rural water supply, groundwater irrigation, groundwater and health, isotope and geochemistry application for water resources mapping, household water economy and groundwater role). Currently and recently he is involved in the following groundwater projects: Climate Risk Screening for Rural Water Supply in Rural Ethiopia (ODI-DFI project); A technical assistant study on Groundwater Development and Management for Ethiopia (World Bank); Capacity building for drought mitigation (UNESCO-Addis Ababa); UPGro's Hidden Crisis research consortium; Developing Adaptive Water Resources Management Strategy for Ethiopia (SCIP-DFID funded); REACH: Improving water security for the poor (DFID funded Oxford University led project). He has been involved in international expert missions (eg Kenya, Sierra Leone, Morocco, Tunisa, Lesotho, Malawi, Uganda), such as for the International Atomic Energy Agency mainly related to isotope hydrology and project management in groundwater sector.

Abstract

Groundwater use has become a new phenomena in Africa in recent decades. It has become source of domestic water for growing urban population. It has become of paramount importance in rural areas. There are several reasons why groundwater is of paramount importance in rural areas: Groundwater is generally cheaper to develop relative to

alternatives; aquifers are able to offer natural protection from contamination; and groundwater offer reliability of supply and a buffer against drought. For irrigation the benefits of controllability are also significant, allowing efficient and flexible in field application on demand. This is key reason why yields from groundwater irrigated areas are typically much higher than under surface water schemes. Groundwater is the only practical means of meeting rural community in arid and semi-arid regions of the Nile Basin countreis, and note that groundwater also supplies many urban centers including the capital city Addis Ababa, Nairobi, etc. In this regard future development of settlements and urban centers are highly dependent on the potential of nearby aquifers to meet ever increasing demand from population growth and industries. In rural poverty reduction, groundwater is an important credit. There is an increasing shift of paradigm considering groundwater as source of drinking water to a new paradigm: groundwater use for development and economic growth, groundwater as strategic resource, groundwater in poverty reduction, groundwater has environmental function.

This paper aims to present evidences around the importance of groundwater as supplementary as well as main source of water in driving economic growth and development in the Nile basin countries.

Improved demand side management and use of non-conventional water,

Dr Mohamed Hassan

Dr Mohamed Hassan is water resources and modelling expert with more than twenty years' experience. He is currently the project manager of the GEF/UNDP funded project "Adaptation to Climate Change in the Nile Delta through Integrated Coastal Zone Management". He also worked at the Ministry of Water Resources and Irrigation in Egypt, Nile Basin Initiative Secretariat in Entebbe and HR Wallingford in the UK undertaking a mixture of national, regional and international projects in various water related aspects such as water resources management, flood and drought mitigation and Climate change risk assessment.

Abstract:

Pressures on the conventional water resources have led many countries to improve demand side management through, for example, raising the efficiency of the irrigation and drinking water networks and the use non-conventional water resources such as desalination and reuse of drainage water and treated wastewater. The Nile Basin is no exception. Due to various reasons such as population growth, climate change, most if not all of the Nile Basin countries face challenges in satisfying the demands of the different sectors that use water. This presentation focuses on presenting those challenges and potential approaches that

either have been used or can be used to face them through demand side management and the use of non-conventional water resources. Examples of successful examples are also presented.

Integrated Watershed Management for Protection of Water Source Areas and Sustainable Livelihood

Seifu A. Tilahun[1], Mamaru A. Moges[1,2], Dessalegn C. Dagnew[2], Adugnaw T. Akale[2], Tigist Y Tebebu[3], Christian D Guzman[4], Petra Schmitter[5], Tammo S. Steenhuis[1,3]

[1] Faculty of Civil and Water Resources Engineering, Bahir Dar University, Bahir Dar, Ethiopia
[2]PhD program in Integrated Water Management, Faculty of Civil and Water Resources Engineering, Bahir Dar University, Bahir Dar, Ethiopia
[3]Department of Biological and Environmental Engineering, Cornell University, Ithaca, NY
[4]Department of Civil and Environmental Engineering, Washington State University, Pullman, NY
[5]International Water Management Institute, Yangon, Myanmar

Seifu Admassu Tilahun holds a BSc in Civil Engineering from Bahir Dar University, a MSc in Hydraulic Engineering from Addis Ababa University and a PhD in Biological and Environmental Engineering from Cornell University. His research interest is on rainfall-runoff processes, soil erosion and sediment transport, irrigation and water productivity, sustainability of water supply, non point source pollution and water quality, and improving soil and water conservation. He has currently an Associate Professor position within Faculty of Civil and Water Resources Engineering of Bahir Dar Institute of Technology in Bahir Dar University. He has been working in the university since 2001.

Abstract

Over the last half century, agriculture has developed rapidly in the highlands of Ethiopia. During the same time, sediment and phosphorous concentrations in streams have increased continuously despite many efforts of soil and water conservation (SWC) interventions to reduce soil loss. In order to understand the change within the landscape, we measured the soil penetration resistance and organic matter (OM) at different land uses. In addition, we monitored the discharge, sediment, and phosphorous concentrations of 10 watersheds with and without SWC effectiveness and to assess optimum placement of soil and water conservation practices. By comparing the soil penetration resistance and OM of forests with agricultural fields, we found that in the agricultural and pasture soils, the loss of organic matter resulted in finer soils. The high infiltration rates (36 to 180 mm hr^{-1}) at the surface has infiltrated these newly developed fine soil with the water plugging up the original pores

and accelerating the formation of slowly permeable layers that increases the penetration resistance. These layers increased “fast” interflow (compared to “slow” baseflow) in the landscape bringing change by developing gullies in the valley bottom of the landscape and affecting the livelihood of small holder farmers.

Our research showed that soil and water conservation measures (infiltration furrows) installed in the landscape were effective in increasing infiltration of the uplands and reduced sediment yield up to 80% for a relatively short time. Subsequently, the sediments yield returned back to the original levels because the infiltration furrows filled up. In addition, all the interventions in the past had focused on the steep hillslope areas (neglecting the downslope areas, where gullies are located) and sediment concentrations were marginally decreased in some of the upland watersheds. Dissolved phosphorus concentrations were increasing with discharge and sediment concentrations in the upland watersheds implying that application of fertilizers and manure should be avoided on the runoff source areas. Available phosphorus was the highest in the crop fields at mid-slope while dissolved phosphorus concentration (DPC) in groundwater was mostly elevated in the intermittently saturated valley bottoms. The elevated phosphorous concentrations are causing eutrophication of water bodies such as Lake Tana where only recently water hyacinths have been observed.

Model that are simply based on landscape positions that are identified in the monsoonal climates of the Ethiopian highland are also developed. Using the Parameter Efficient Semi-Distributed Watershed Model (PED-WM) with the phosphorus module, it enables the identification of runoff and nutrient source areas as well as the prediction of phosphorus and sediment loading which yields valuable information for watershed management and placement of best management practices.

Strengthening the dialogue: Structured dialogue as a means for exploring breakthrough options in transboundary cooperation, Prof. Dr. Jon Martin Trondalen, www.Compass-Negotiation.net

Prof. Dr. Scient. Jon Martin TRONDALEN

Since 1993, Dr. Trondalen has been a 'front-line' negotiator, facilitator, and mediator in several contentious regions involving bi-, tri- and multilateral negotiations; as well as providing strategic advice to national governments and international organisations. As a full professor at the University of Oslo, he specialised on international 'Resource Geography' with emphasis on conflict resolution. Both the World Bank and emergency operations are parts of his career. Author of several book, scientific papers and reports on negotiation & crisis management training manuals, recently; The Art of Handling Crisis – Media, Conflict resolution and Life-Decisions – Personally, Corporate, Public and International . Founding Director of CESAR Foundation; Compass Foundation, and Compass Negotiation. Through systematic observations and experiences over 30 years, he aims to convey constructive ways of resolving conflicts and crises, and has been teaching management of crises and conflicts to participants from over 50 nations.

Abstract

Causes of stalemates and grid-locks in negotiations

Even before a grid-lock is reached, three basic questions should continuously be asked: What do the other riparian countries want; what does your country want; and what do we both/all want? Answers to these questions sound easy, but are fundamentally difficult. The reasons for this are that countries aim at different things (i.e., the interests of the state). Furthermore, they often stick to fixed positions and therefore do not develop options to unlock stalemates. In many ways, states become "prisoners" of their own thinking, especially with strong public support.

How to handle sabotaged dialogues, deadlocked situations or dealing with a "difficult counterpart"? Quite often, the broader conditions are beyond the influence of negotiators and delegates. However, there are ways to unlock deadlocked situations- such as:

- New substantive information; or rather, new information provided to key-decision makers – f.ex, technical studies…
- New trade-offs between two or more of them – f.ex, technical studies show possible "win-win" solutions…
- Changed general political climate or relationships – f.ex, Changed political leadership with new ideas…
- New external power-brokers (extra-regional Parties).

What is an Impasse? It is a disagreement over an issue that threatens the negotiations, and could be resolved by addressing some of the minor issues first - thereby avoiding narrowing the negotiation to only one issue.

What is a Stalemate: Deliberations are going on, but little progress is made. If both parties still want to find a solution, but are not able to move forward; one may try to change the dynamics of the negotiation by altering one of the issues – thus, develop more options .

What is a Deadlock? No progress: One of the parties (or more) doesn't find further deliberations fruitful. A real deadlock is normally 'unlocked' by getting assistance from a 'third party'. However, always, have in mind that you may reach a deadlock. In any case, in almost all international cases: Request assistance from a Third Party.

Who is your "difficult counterpart"? Maybe the "difficult counterpart" is not difficult seen from the other country's perspective? It is always necessary to understand the rationality of your "difficult counterpart" in order to look for face-saving solutions. Also, at times call it what it is ("…don't react to threats…"). A fundamental key in unlocking a dead-lock is to develop negotiable options. Finally, always consider your BATNA ('no agreement')

Creating a forum for dialogue is based on the perception that the parties agree that a dialogue is better than no dialogue. The question is HOW to create / maintain a dialogue? Different options: (1) High level talks: Good to get political legitimacy, but not good in terms of substantive progress. (2) Diplomatic / technical talks: Highly relevant for the basin-countries. Some matters to consider: What should be discussed? Start with technical issues and take major issues later. (1) How should the process look like? (2) In phases or with no 'benchmarks'? (3) Be conscious about when to bring in political decision-makers. Advise: make sure that the dialogue forum is anchored politically, but also ensure that political discussions should not be merged into technical discussions.

Final Advice: (1) Negotiate for the best (2) Plan for the realistic, and (3) Prepare for the worst.

NBDF, Oct. 25, 2017 BRIEF SUMMARY

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"**Food security through basin-wide approaches of agricultural water management**", Bart Hilhorst

Bart Hilhorst is a water resources specialist with over twenty-five years of experience in land and water resources management, focusing on transboundary rivers and natural resources development and use. He has extensive field experience in complex transboundary water projects in Africa and Asia, and served as a Chief Technical Advisor for the project "Information Products for Nile Basin Water Resources Management" with the Food and Agricultural Organization (FAO) of the United Nations. His areas of interest include the water/energy/food nexus; transboundary water resources management; water resources assessment and strategy; permaculture design, among others. He facilitated a comprehensive multi-stakeholder scenario process that investigated the complex water-agriculture-energy sector in the Aral Sea basin, and recently completed a scenario project on the 'future of Nile cooperation' for the Nile Basin Initiative. He recently published "Water Management in the Nile Basin: A Fragmented but Effective Cooperative Regime," in CIRS Occasional Papers (2016).

Abstract

The Nile Basin is characterized by high climatic diversity and variability, a low percentage of rainfall reaching the main rivers, and an uneven distribution of its water resources. Potential evaporation rates in the Nile region are high, making the basin particularly vulnerable to agricultural and hydrologic droughts – a situation further exacerbated by climate change. The Nile water are now fully allocated, mostly for irrigation in the downstream riparians Egypt and Sudan.

Agriculture is the dominant component of the water demand function. Demand for agricultural produce is set to increase significantly in the coming decades because of demographic trends and socio-economic developments. It implies that the Nile water challenge is closely tied to food provision and food security. Evidently, food security is a principal concern to governments in all Nile countries.

There are about 5.6 million hectares of land under irrigation or equipped with irrigation facilities in the Nile Basin. A large proportion – 97 per cent – of the land is located in Egypt and The Sudan, with the remaining 3 per cent distributed among the upper riparian states. Productivity and water use efficiency is high in the irrigation schemes in Egypt, and on commercial irrigation schemes in the rest of the basin, but generally low in the large smallholder irrigation schemes in The Sudan.

Close to 90 per cent of the land currently used for agriculture is under rainfed farming systems. These systems are characterized by subsistence-level production and low yields of crops and livestock.

Presently about 70% of the basin population resides in rural areas. The dominance of rural populations is predicted to persist to 2030 and beyond in most Nile countries. Since most rural people cannot afford food imports, most food needs to be produced in close vicinity of its actual consumers. Improving yields and water-use efficiency in small-holder rainfed agriculture, therefore, is at the core of the Nile challenge.

Strategies to cope with irregular and poor rainfall are based on existing and proven technologies such as soil conservation, rainwater harvesting, creating micro-climates, supplementary irrigation, and reducing evapotranspiration through cover crops, mulching, or no-till agriculture. Nevertheless, the wide-scale adoption of these technologies has proved challenging. Farmers are aware of these technologies, but seem unwilling to adopt them. Why?

A scenario thinking exercise implemented by FAO found that agricultural productivity is low in large parts of the basin—both in irrigated and rainfed agriculture—not only because of periodic moisture deficits, but also because of a broad range of non-biophysical factors. These non-biophysical constraints are presently dominant. They are related to market access, low farm-gate prices,

insecure land tenure, high post-harvest and processing losses, unfavorable agricultural trade regimes, absence of value chain infrastructure, etc. Under the current agro-economic conditions, small-holder agriculture simply does not make sense from a financial perspective, and required investments in soil conservation or supplementary irrigation infrastructure are not warranted. Thus, improving water productivity of agricultural activities in the Nile countries starts with improving the comprehensive agricultural system, particularly for small and mid-size land-holdings. This is feasible, necessary (because of the large rural population), does not lay large claims on the Nile waters, and potentially highly effective.

Increasing water-use efficiency in large commercial schemes is mostly related to technology and management practices, and should be implemented by farm operators without government support.

It is noted that addressing the institutional and economic constraints in the agricultural system is predominantly a national issue rather than a Nile basin issue. Nevertheless, Nile cooperation can substantially contribute to a conductive economic environment for agricultural production. Focus areas for collaborative action at Nile basin level are related to opening-up foreign markets for processed high-value agro produce (rather than low-value bulk produce), establishing the value chain, introducing a common agricultural policy that increase farm-gate prices, or improving road network or electricity supply, etc.

Thus, while the Nile Water Allocation Challenge is obviously related to the Nile waters, its solution will probably involve many issues outside the water domain. This is promising as it vastly increases the solution space, and takes the Nile discussions away from the classic zero-sum water allocation game.

Challenges for Adaptive Transboundary Governance in the Nile Basin: Parallels with the Colorado River Basin

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Prof. Zagona is a Research Professor of Hydrology, Water Resources & Environmental Fluid Mechanics ,Civil Systems

Director, Center for Advanced Decision Support for Water and Environmental Systems (CADSWES) 2000-Present and holds B.A. Philosopy, University of Arizona, Tucson, AZ, 1975; B.S. Civil Engineering, University of Arizona, Tucson, AZ, 1978; M.S. Civil Engineering, Colorado State University, Ft. Collins, CO, 1983; Hydraulics and Sedimentation Program;Ph.D. Civil, Environmental and Architectural Engineering, University of Colorado, Boulder, CO 1992; Water Resources Program.

Abstract

Keywords: transboundary governance, Colorado River Basin, collaborative decision making, robust decision making under deep uncertainty

The Nile Basin (NB) countries are faced with an extraordinary challenge in forging a cooperative governance framework that can secure equitable water and economic benefits to the countries, sustain the environmental health of the riparian system, and resolve inevitable conflicts among the states, sectors and interests. The Nile Basin Initiative (NBI), as the first all-inclusive basin-wide institution, has at its core the shared vision principle and provides a platform for discussion and collaborative decision making. It proposes a cooperative framework agreement, has developed analytical tools and capacity building programs, and is undertaking Strategic Analysis to explore possible futures. The NB has extraordinary parallels with the Colorado River Basin (CRB) in the southwest United States, in terms of the hydrologic system, the challenges of multi-state sharing of waters, the uncertain future, and also in terms of the activities undertaken in attempting to address these problems by creating a collaborative decision making framework. This presentation describes the parallels between these basins and their respective activities, and proposes as an outcome of the comparison lessons that can be learned for both basins.

The Colorado River (CR) is shared by 7 states and the country of Mexico. Within the US, the river is managed by the Bureau of Reclamation (Reclamation), a federal agency in the US Department of Interior. The river is about 2330 km long, drains about 637,000 km2, has an average yield of about 18 BCM per year, and has the capacity to store a total of about 74 BCM, more than 4 years of average yield. It provides domestic water to about 40 million people and agricultural water supply to about 2.4 M hectares. About 85% of the yield of the CR originates in the Upper Basin alpine regions as winter snowfall at elevations from 1000 to 4000 m. The annual runoff is typically in a 3-4 month period in the spring, but much of the water demand, particularly agricultural, is later in the summer, so storage is needed to provide reliable supplies. Water use is concentrated in the lower reaches of the river, in the arid, low elevations of the southwest US deserts and Mexico. In addition to water supply, the CRis a major source of hydroelectric power and provides flood control, environmental and recreational benefits to the basin. Although the CR is a fraction of the size and yield of the Nile, it is proportional and has similar geographic, hydrologic and water use characteristics.

The management of the CRB is codified in the “Law of the River,” numerous compacts, legislated laws, court settlements, records of decision and international treaties that have been enacted beginning in 1922. The Upper Basin states have not been able to develop their full allocation due to geographic and environmental challenges and also because they are required to deliver the Lower Basin allocation regardless of shortage. Throughout the 20th century, supply met demands and the Lower Basin was able to take advantage of many surpluses. The state of California in particular got

in the habit of using much more than its official allocation. In the NB as well during this period "business as usual" implied historical use patterns and infrastructure, and resisted basin wide perspectives.

The 1980s and 90s were a time of worldwide changes in water management perspectives that introduced new environmental constraints, and increasing stakeholder engagement and empowerment (reflected in the principles of IWRM) in addition to increasing demands for both water and energy due to population and industrial shifts. During this time, also, the specter of climate change came into focus and, simultaneously, great leaps forward in science and technology resulted from increased capabilities for computation and analysis. These changes motivated the need for, and development of,frameworks for collaborative decision making in both the NB and CRB.

In the Nile Basin, the Nile Basin Initiative was created and plans began for developing technical capabilities for collaborative analysis and decision making. The NB Decision Support System was designed and developed with a database aimed at sharing information for the benefit of viewing the basin development as a whole. Similarly, in the CRB, Reclamation saw the need for a new distributed database for the entire basin as well as new modeling and analysis tools that could be understood and used by stakeholders. A key aspect of the capabilities was flexibility of expression of data and operating policies and transparency of all processes and policies. The power of these tools for collaborative decision making cannot be understated. The key additional pieces are the vision of basin wide benefits and the will to collaborate towards that end.

Beginning in 2000, the CRB has experienced a severe drought of record that has recently highlighted a 'structural deficit,' i.e., the recognition that demands exceed supplies in the Lower Basin and Mexico by about 1.85 BCM per year, and called to attention the lack of anyplan for shortage sharing in the basin. The draining reservoirs served as wakeup call for the need for a collaborative plan to face shortage, as there was no time to spend years in litigation. In 2007 an interim agreement among the states, and with Mexico in 2014, was reached in the first successful collaborative decision in the basin's history. But this agreement expires in 2026 and Mexico's agreement expires this year, 2017. Meanwhile the drought continues and the urgency of a long term plan to avert looming disaster is pressing. In the NB, the wakeup call came in the form of construction of recent new infrastructure by upstream countries, driven to a large extent by the urgent need for energy for development, which will result in modified flow regimes that will affect downstream countries. The timeframe for addressing this is now, as the operational effects are imminent.

Meanwhile, both CRB and NB have undertaken long range planning studies with their stakeholders, aimed at ultimate collaborative planning for development and allocations with an eye to basin-wide

shared benefits. NBI's Strategic Analysis has developed a baseline model of the entire basin that represents the key processes and abstractions, and based on the stated development plans of each country, historic hydrologic data as well as climate change scenarios, it projects possible future states of the basin given "business as usual" use and development schemes. Employing recent techniques of the science of robust decision making under deep uncertainty, the stakeholders are charged with developing scenarios for development that improve the future outlook for sustainability. In the parallel Colorado River Basin Supply and Demand Study, 2012-14, and the follow on continuation study, Reclamation created a baseline model that projects the "business as usual" future, which foretells demands that cannot be met. Stakeholder – the states, cities, NGOs, power companies, Mexico, recreational interests, etc. are working together to propose "options and strategies" to mitigate the projected supply-demand imbalance.

These studies are key to developing long term collaborative decision making frameworks in the respective basins. However, both basins are currently faced with the urgent need to avert conflict with the impending shortage in CRB and new infrastructure coming online in NB. In the CRB, the Drought Contingency Plan among the states and Mexico is highly political and contentious, with pressure brought to bear by the low reservoir levels. It has been relieved a little by a good spring runoff, but cannot be postponed due to the end of the current agreement with Mexico. At this writing, it is not clear how this situation will be resolved; it is further complicated by an uncertain political climate in the US and Mexico. By October, the time of this presentation, some resolution will be known. In the NB, decisions about the filling of the GERD must be made soon. We are hopeful that current efforts to analyze and negotiate will culminate in some positive outcome by the time of this presentation in October 2017.

Regardless of the outcomes, the take away lesson here is the potential power of collaborative processes and the importance of foreseeing future vulnerable states in advance of urgency, the establishment of adaptive policies that are robust to the most unforeseen situations, and the avoidance of the need to make highly contentious decisions without a collaborative framework. Although strickingly similar, each of the two basins has something to learn from the other's process.

The regional economics of water resources development: Assessing tradeoffs and opportunities for integration, *Marc Jeuland is an Associate Professor of Public Policy and Global Health at Duke University*

Marc Jeuland is an Associate Professor of Public Policy and Global Health at Duke University. His research interests include nonmarket valuation, water and sanitation, environmental health, energy and development, the planning and management of trans-boundary water resources and the impacts and economics of climate change. Jeuland's recent research projects consider the economic implications of climate change for water resources projects on transboundary river systems. He has also worked on multiple field experiments on issues such as: the role of water quality information in affecting household water and hygiene behaviors; the demand for, and impacts of cleaner cookstoves on household well-being; and the long-term sustainability and effects of rural sanitation and water supply projects. He has also conducted fieldwork on preferences for a range of environmental health improvements including cholera vaccines, household water treatment technologies and improved cookstoves. Jeuland has worked with the World Bank, USAID, the Millennium Challenge Corporation, UNICEF, and many field-based NGOs and community-based development organizations.

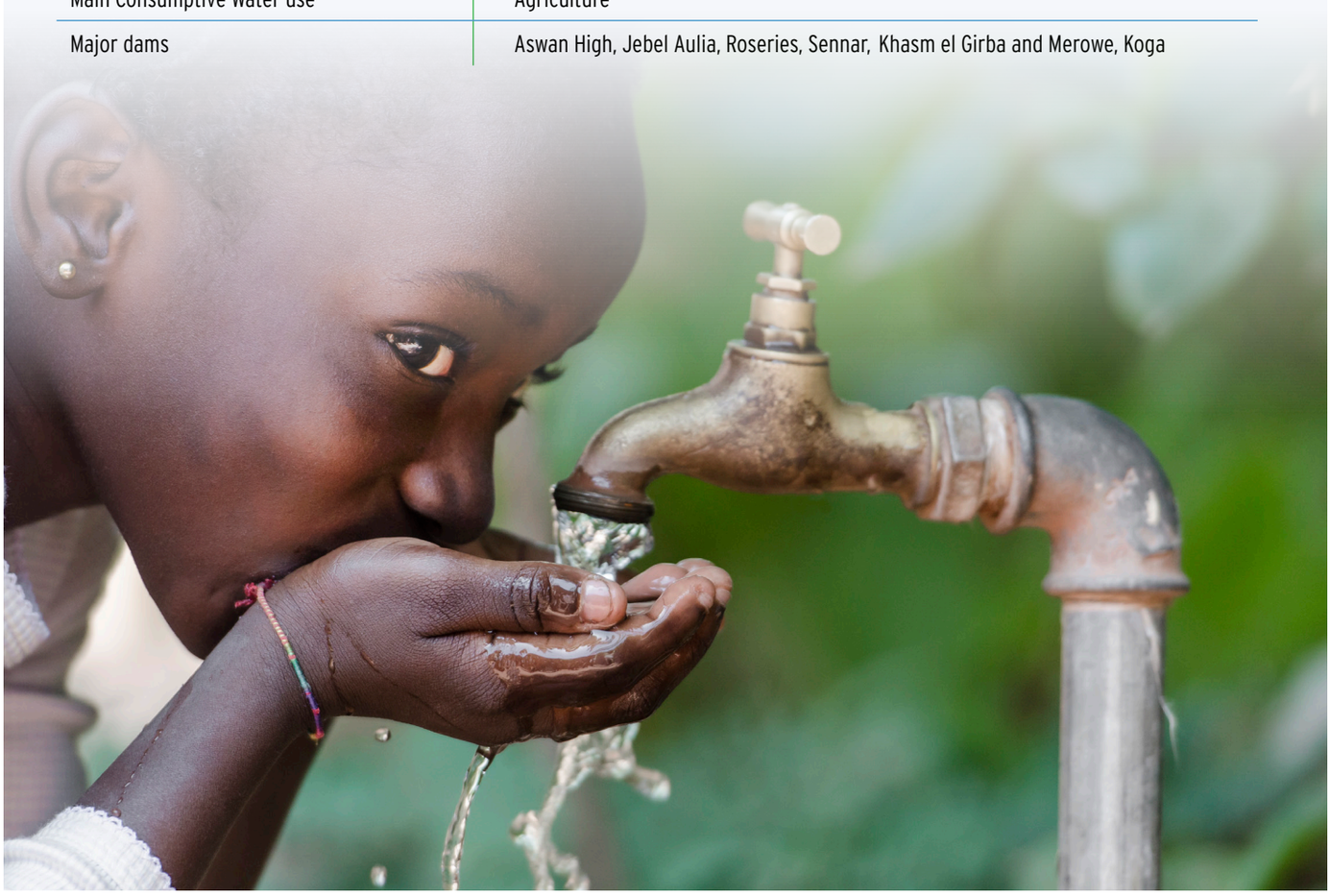
Abstract:

As global water scarcity increases due to increasing demand from population growth and economic development, use of resources from shared water resources also increasingly involves complex tradeoffs across different types of uses, as well as the environment. Hydroeconomic models (HEMs) represent one set of tools that help inform water infrastructure planning and management decisions. Broadly speaking, such tools aim to incorporate “regional scale hydrologic, engineering, environmental and economic aspects of water resources systems within a coherent framework” (Harou et al. 2009). Unlike simple hydrological models that that aim for simple and general descriptions of the behavior of these systems, HEMs aim for discovery or better characterization of strategies that advance the economic efficiency of water use, measured in terms of overall gross or net benefit. To do so, HEMs integrate more conventional hydrological descriptions with economic optimization or simulation methods. They have been applied to a wide range of problems and basins globally, although notable areas of concentration exist, as reviewed recently by Bekchanov et al. (2017).

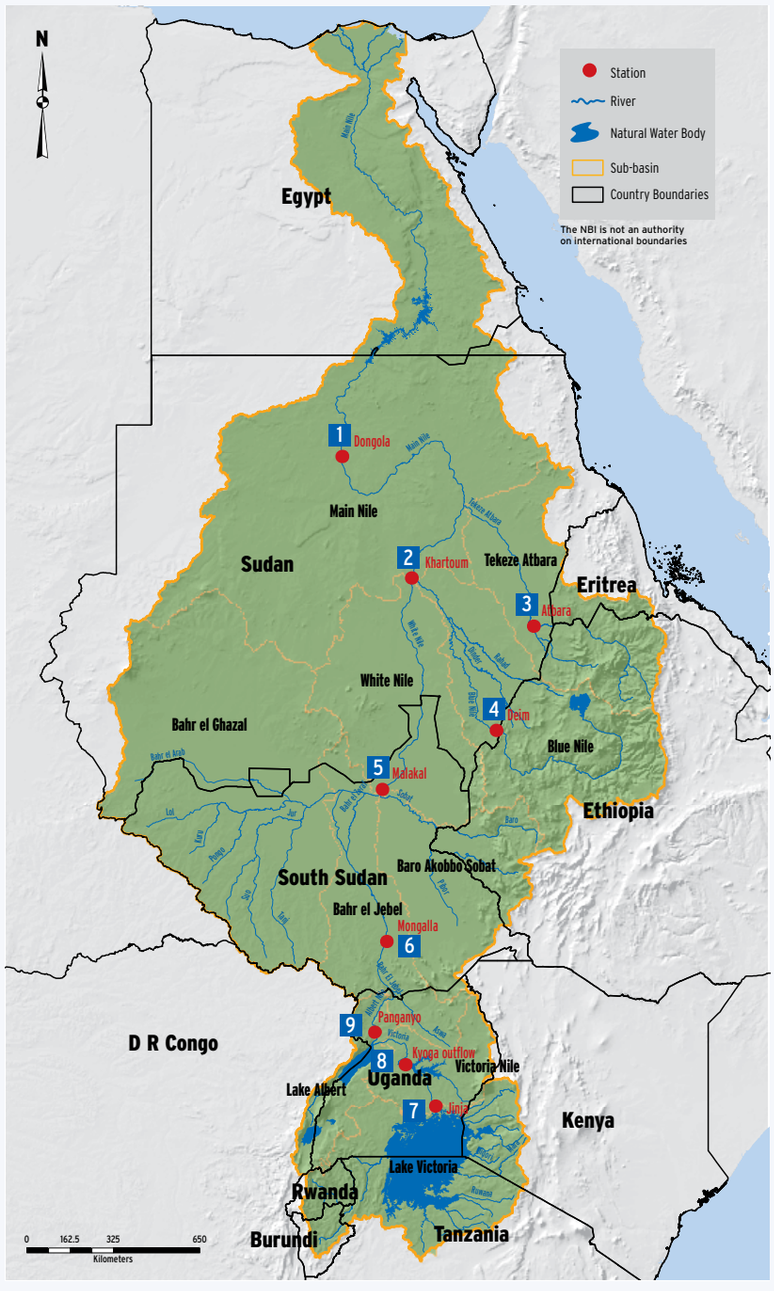
This presentation will summarize the findings of prior HEM work in the Nile basin, and discuss how this work illustrates well the variation in potential model architectures, as well as how applications to Nile Basin problems conform to the basic trends in applications documented by Bekchanov et al. We will then reflect on blind spots in previous Nile Basin analyses. This will motivate a synthesis of general issues that could be studied using HEMs to further enhance understanding related to improved management of the water resources of the Nile.

Quick Facts about the Nile Basin

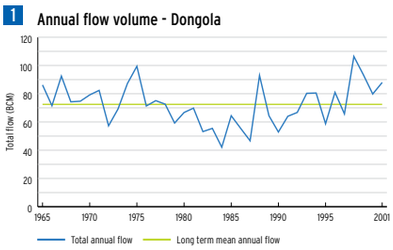
Name	Nile, from *Neilos* – Greek name for the River God of ancient Egypt
Length	6,695 km
Navigable length	4,149 km
Basin Area	3,176, 543 Km^2
Location	-4^0S to 31^0N and 24^0E to 40^0E
Riparian States	Burundi, DR Congo, Egypt, Eritrea, Ethiopia, Kenya, Rwanda, Tanzania, South Sudan, The Sudan and Uganda
Mean annual flow (at Aswan)	84 billion cubic meters/yr
Main Tributaries and sub basins	Lake Victoria. Victoria +Albert Nile, Sudd (Bahr El Jebel) , Bahr El Ghazal, Baro-Pibor-Sobat, Blue Nile (Aby), Atbara (Tekezze), White Nile, Main Nile
Major Lakes within the Basin	Victoria, Kyoga, Albert, Edward, Tana
Highest point	5,110 m (Mt. Stanley, Rwenzori Mountains, Uganda)
Lowest point	-133 m (Quattara Depression, Egypt)
Population (Total in all the Nile Countries)*	Estimated at 480 million
% Population within the Nile Basin*	53% (Estimated at 257 million)
Temperature	Night Minimum -10^0c and daily Maximum in June 47^0c
Precipitation	Max Annual 2,098 mm/yr in Ethiopia Min Annual 0 mm/yr in Egypt
Mean Annual flow (Discharge) (Km^3/yr) at Aswan	84 X 10^9 m^3
Discharge/Unit area	28 X 10^3 m^3/Km^2
Main Consumptive Water use	Agriculture
Major dams	Aswan High, Jebel Aulia, Roseries, Sennar, Khasm el Girba and Merowe, Koga



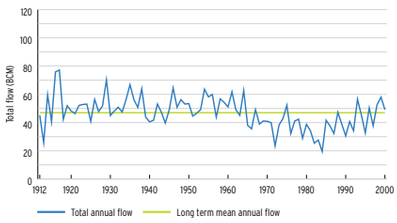
ANNUAL RIVER FLOW PATTERNS FOR KEY NILE HYDROLOGICAL STATIONS



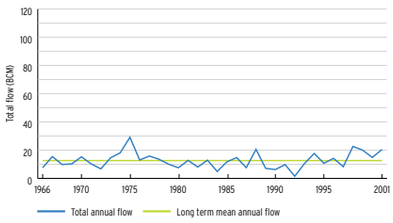
1 Annual flow volume - Dongola



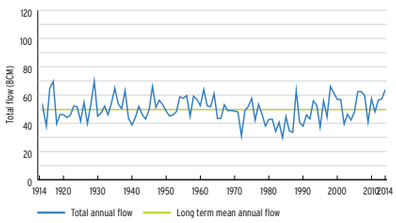
2 Annual flow volume - Khartoum



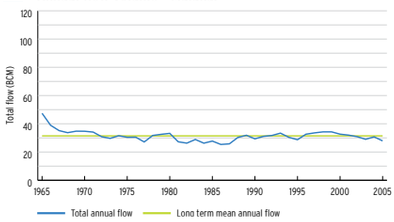
3 Annual flow volume - Atbara (on Atbara River)



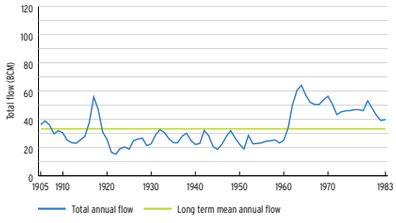
4 Annual flow volume - Diem



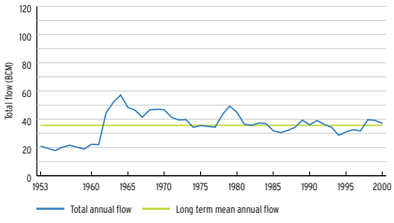
5 Annual flow volume - Malakal



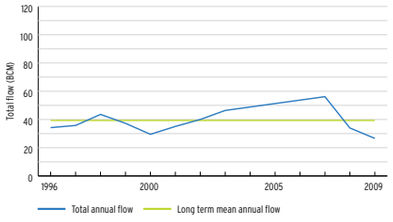
6 Annual flow volume - Mongalla



8 Annual flow volume - Kyoga outlet



9 Annual flow volume - Albert Nile, Panyango



Source: Nile Basin Water Resources Atlas 2016. atlas.nilebasin.org

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