Directorate of Water Resources Management
Ministry of Water and Environment
Uganda

EAST AFRICAN COMMUNITY
LAKE VICTORIA
BASIN COMMISSION

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International Institute for
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Report

Solutions for a water secure East Africa in 2050

Workshop on mid- to long-term water resources management and planning in Eastern Africa

December 4-6, 2017

Entebbe, Uganda

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Executive Summary:

In 2013, IIASA established the Water Program in conjunction with, the Water Futures and Solutions Initiative (WFaS) flagship project. WFaS seeks to incorporate water science into water policy and planning, and applied water management issues. Set-up as an inter-disciplinary scientific initiative to define the challenges, WFaS identifies and tests solution pathways across different economic sectors, including agriculture, energy and industry while safeguarding the environment. Stakeholder consultations support co-designing future development scenarios and possible solution options which are and important input for supporting mid- to long-term water management and planning based on informed decision making. After a global analysis undertaken in a first WFaS fast-track assessment, the initiative is currently focusing on Eastern Africa with the Lake Victoria Basin as a key research area. With funding from the Austrian Development Agency, IIASA's Water Futures and Solutions Initiative formed an East Africa node.

Key actors of the Lake Victoria Basin like the Lake Victoria Basin Commission and its member countries, the Nile Basin Initiative, the Global Water Partnership and others expressed interest to engage in mutual learning and participate in model development and co-creation of scenarios of future water demand and regional water management options. Regional stakeholders worked with IIASA staff to identify priorities, development pathways, and potentials for investments and solutions. Therefore, the Republic of Uganda in collaboration with IIASA as co-hosts called for a three days workshop in Entebbe/Uganda on the issue of projecting future water demand and water availability in the Lake Victoria Basin.

The expected outcomes of the workshop were:

- To have an improved understanding on approaches, tools and techniques useful for mid- to long-term water resources management and planning issues.
- To have a common understanding on key determinants for mid- to long-term water availability and demand trajectory.
- To have enhanced understanding on the specific purpose and areas of collaboration, mutual benefits among all partners are identified, and specific work packages guide the implementation of WFaS intervention in Eastern Africa until the end of 2018.

These were generally achieved as summarized below:

Day 1: Sharing experience on modeling work
Participants exchanged on ongoing activities, existing experience and planned initiatives in the area of modeling applications and tools supporting mid- to long-term water resources management and planning in East Africa. Interactive discussions revealed a number of key challenges & opportunities in regard to using modeling work for supporting wise water resources planning.

Day 2: Understanding regional development scenarios
The East African Community (EAC) vision 2050 and the countries' development visions together with the commitment to the SDGs will shape the future developments in the Lake Victoria Basins. One full workshop day was dedicated to have a deeper understanding of development scenarios resulting from these visions and how water can support these development aspirations as an enabler on the one side and how the water resources are likely to be adversely affected on the other side.

Day 3: Building collaboration on future research
On the last day, participants used the opportunity to build partnerships on boosting modeling and scenario building capacities in the region. Participants worked together in flexible groups which

focused on the aspects of capacity development, data and uncertainty, agricultural water and land use, and issues related to scenario development. This gives ground to work further on specific research collaboration and work packages which will be either implemented in the coming year or developed further into funding proposals.

Next steps

Building on the rich experience available in various institutions operating in mid- to long term water resources management and planning issues in Eastern Africa, the workshop triggered the following follow-up work:

- By mid-January a draft workshop report will be ready for input from participants: This report documents the presentations, related discussions and results from the different working groups (without major interpretation and further processing and data gathering). It includes an executive summary and is presented in a manner to inform the LVBC sectoral committee about the started work in the framework of the exploratory workshop.
- By April a paper on scenarios for EAC countries: This paper will include story lines and quantification of major drivers for regional development pathways of the EAC countries based on regional and national development visions and plans (regional scenario). In addition, it will include two development scenarios derived from global SSPs (Shared Socio-economic Pathways).
- By end September, based on the quantified drivers and story lines documented in the scenario paper, IIASA will produce a set of preliminary modeling results focusing on balancing water availability and water demand for discussion in a next workshop.

In order to address further research need identified during the workshop, one or several funding proposal(s) should be developed in collaboration between LVBC, Uganda and IIASA involving any interested partner in particular among the workshop participants and submitted to a range of development partners already engaged in transboundary water management issues.

The workshop was attended by over 50 participants covering a wide range of stakeholders:

- Secretariat of the Lake Victoria Basin Commission and National Focal Points
- Secretariat of the Nile Basin Initiative
- Nile Equatorial Lakes Subsidiary Action Program
- Global Water Partnership Eastern Africa and Chairs of Country Partnerships
- Directorate of Water Resources Management, Uganda
- Representatives from other relevant Ugandan Ministries and institutions
- Representatives from academic institutions of the region
- Representatives from business sector
- Representatives from Ugandan donor community
- International Institute for Applied Systems Analysis

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1 Introduction

1.1 Background

The scale and complexity of the water challenges faced by society, particularly in the world's poorest regions, are well recognized, as is the imperative of overcoming these challenges for a stable and equitable world. The International Institute for Applied Systems Analysis[1] (IIASA) is an international scientific institute that conducts research into the critical issues of global environmental, economic, technological, and social change that we face in the twenty-first century. In 2013, IIASA established the Water Program[2] in conjunction with, the Water Futures and Solutions Initiative[3] (WFaS) flagship project.

WFaS seeks to incorporate water science into water policy and planning, and applied water management issues. Set-up as an inter-disciplinary scientific initiative to define the challenges, WFaS identifies and tests solution pathways across different economic sectors, including agriculture, energy and industry while safeguarding the environment. Using in-house hydrological and hydro-economic models, a key research focus is on mid- to long term projections of future water availability and demand, and investment options on how to balance them under different socio-economic, demographic and climatic scenarios, both at global and regional scales including transboundary watersheds. Stakeholder consultation supports co-designing future development scenarios and possible solution options. After a global analysis undertaken in a first WFaS fast-track assessment, the initiative is currently focusing on Eastern Africa with the Lake Victoria Basin as a key research area.

The Agenda 2030 with the 17 interlinked Sustainable Development Goals (SDGs), the Paris agreement on Climate Change and the Addis Ababa Action Agenda on Financing for Development provide a framework of global commitments and call for mid- to long term planning to guide new approaches in policy and investment which cut across sectors (nexus) and countries (transboundary basin management).

The Directorate of Water Resources Management of the Uganda Ministry of Water and Environment participated in the Scenario Focus Group meeting[4] of the fast track phase of WFaS, which focused mainly on global level in order to identify hotspots of current and future water insecurity. With funding from the Austrian Development Agency[5], IIASA's Water Futures and Solutions Initiative formed an East Africa node. Visits to East Africa by IIASA researchers in February and July 2017 in the framework of the WFaS, allowed meetings and discussions with various actors engaged in mid- to long-term water resources planning. This included relevant institutions from the Ugandan government (Ministry of Water and Environment, Uganda Bureau of Statistics, Ugandan National Planning Authority), the Nile Basin Initiative, the Lake Victoria Basin Commission, the Global Water Partnership East Africa and representatives from key donor institutions.

Key actors of the Lake Victoria Basin expressed interest to engage in mutual learning and participate in model development and co-creation of scenarios of future water demand and regional water management options. Regional stakeholders will work with IIASA staff to identify priorities, development pathways, and potentials for investments and solutions. Therefore, the Republic of

[1] http://www.iiasa.ac.at/web/home/about/whatisiiasa/informationkit/brief.html
[2] http://www.iiasa.ac.at/web/home/research/researchPrograms/water/waterhome.html
[3] http://www.iiasa.ac.at/web/home/research/wfas/water-futures.html
[4] http://pure.iiasa.ac.at/14366/1/201606_SFG_IIASA_Report_final.pdf
[5] http://www.entwicklung.at/

Uganda in collaboration with IIASA as co-hosts called for a three days workshop in Entebbe/Uganda on the issue of projecting future water demand and water availability in the Lake Victoria Basin.

The workshop had three main objectives:

a) give stakeholders a detailed introduction to the Water Futures and Solutions Initiative, it's models and preliminary results in the East African Region, particularly the Lake Victoria Basin,
b) give an overview and share experiences on other modeling initiatives and efforts relevant for mid- to long-term water resources planning within the region, and
c) set the scene for research collaboration between IIASA and East African Water Resources Institutions, the Academia, Civil Society and Private Sector **on Solutions for a water secure East Africa**

Due to the lead road of the Directorate of Water Resources Management (DWRM) of the Ugandan Ministry of Water and Environment in bringing IIASA's WFaS to East Africa this first exploratory workshop was held in Entebbe and co-hosted by the Ugandan Government. The workshop was attended by 53 participants (incl. support staff) covering a wide range of stakeholders (see detailed list of participants in Annex):

- Secretariat of the Lake Victoria Basin Commission and National Focal Points (5)
- Secretariat of the Nile Basin Initiative (2)
- Nile Equatorial Lakes Subsidiary Action Program (1)
- Global Water Partnership Eastern Africa and Chairs of Country Partnerships (5)
- Directorate of Water Resources Management, Uganda (17 incl. about 5 support staff)
- Representatives from other relevant Ugandan Ministries and institutions (3)
- Representatives from Academic Institutions of the region (4)
- Representatives from business sector (6)
- Representatives from Ugandan donor community (1)
- International Institute for Applied Systems Analysis (5)

Costs of the workshop were covered by the co-conveners; the Government of Uganda which facilitated all representatives from Ugandan institutions and from some secretariats such as NELSAP while IIASA sponsored the participation of a number of regional participants (14) including the expenses for the venue and day catering.

1.2 Workshop layout

The workshop was structured in three days which have specific daily focus activities which complement each other and which will lead to achieve the overall expected outcomes of the workshop which are:

- an improved understanding on approaches, tools and techniques useful for mid- to long-term water resources management and planning issues.
- a common understanding on key determinants for mid- to long-term water availability and demand trajectory.
- enhanced their understanding on the specific purpose and areas of collaboration, mutual benefits among all partners are identified, and specific work packages guide the implementation of WFaS intervention in Eastern Africa until the end of 2018.

The following describes the brief scope of work of each workshop day.

Day 1: Sharing experience on modeling work
After the opening ceremony and the introduction into the overall workshop agenda, participants exchange on ongoing activities, existing experience and planned initiatives in the area of modeling applications and tools supporting mid- to long-term water resources management and planning.
Some selected institution presented the status of past and ongoing modeling work and provided an overview of future plans and aspirations. This introduced participants to the subject, which in turn helped to highlight key challenges & opportunities of modeling work for future water resources management and planning which is geared towards supporting the implementation of the SDGs and the development visions of the region and the EAC countries.

Day 2: Understanding regional development scenarios
The East African Community (EAC) vision 2050 and the countries' development visions together with the commitment to the SDGs will shape the future developments in the Lake Victoria Basins. This day was dedicated to have a deeper understanding of the development scenarios resulting from these visions and strategies and how water can support the development aspirations up to 2050 on the one side and how the water resources are likely to be affected by these developments on the other side.

Day 3: Building collaboration on future research
On the last day, participants were be given the opportunity to build partnerships on boosting modeling and scenario building capacities in the region. Participants worked together in flexible group settings which encouraged information exchange, forming partnerships and finally identify specific research collaboration and work packages which will be implemented in the coming year.

The detailed program can be found in annex.

2 Methodology

The co-hosts agreed to have a highly interactive and engaging workshop which was well perceived by the participants and supported by their active contributions throughout the event. Therefore, the workshop was characterized by rather view presentations (except on day 1) but specifically planned and prepared group work sessions based on methodologies which encourage engagement, deepen ownership and trigger participants' thinking and experience. The key concepts used are explained in more detail in the following sections.

2.1 Listening perspectives

On day 1, after the opening ceremony, stakeholders from the EAC countries and from LVBC and NBI shared their ongoing work in regard to mid- to long term water resources management and planning in the form of power point presentations. Participants, during the registration process, were assigned so called "listening perspectives" which help to focus on issues and questions in the description of these listening perspectives (see in annex). Listening perspectives support to listen well, especially with a specific purpose, and to provide a necessary feedback. Such an approach allows to gain deeper understanding of the messages/stories told in these presentations. In essence, a story (presentation) needs a listener to become what it can be.

In this way we used the presence of the around 50 participants to help us dig deeper into the existing modeling experience and understand **S**uccesses, **W**eaknesses, **O**pportunities and **T**hreats in the form of a **SWOT** Analysis. Results of this SWOT Analysis can be used to understand the key highlights of the learnings from day 1. Furthermore, this information was used to build the storylines for project ideas around the same 4 topics (Capacity development, development scenarios, water for agricultural use, uncertainties and data).

Figure 1 Group work on listening perspectives

2.2 Pro Action Café

On day 3 of the workshop these project ideas were presented to the participants by a group facilitator (caller) and discussed in depth in a "Pro Action Café" arrangement. This is a space for creative and action oriented conversation where participants help a "caller" who presents a project idea to develop it further. This allows interested participants to engage and contribute to the development of the action under discussion.

The conversations on these project ideas link and build on each other as people move between "café tables", cross-pollinate ideas, and offer each other new insights into the questions or issues that matter in order to build a solid project idea.

These conversations happened in 3 rounds of around 30 minute in café style, each guided by a few generic questions to help deepen and focus the discussions (see text box).

Round 1:
What is the quest behind the call /question/ project? This helps to deepen the need and purpose of the call. It is about digging under the surface of what we know already.

Round 2:
What is missing? When the quest has been deepened, a discover question explores what could make the project more complete and possible.

Round 3:
As caller, what are we learning for the project idea? - What next steps will we take? - What help do we still need in order to bring it all together and to make the project happen?
This 3rd round is in two steps:
First 20 minutes for the callers to reflect by themselves on the 3 questions above and harvest their key insights. Then a last round where new groups of contributors visit the tables to listen to the harvest of the caller, their learning, their next steps, help needed, and then offer any insights and further support.

2.3 Incasting on development scenarios

Day 2 of the workshop was fully dedicated to work on development scenarios for the coming decades (up to 2050) which respond to the following two key questions:

- Where is water an enabler for the development aspirations of the region?
- What are potential risks to water resources emerging from those development aspirations?

This discussion happened based on an incasting technique.
Incasting is a foresight technique that explores the specific details of a possible future based on a more general scenario description.
This more general scenario description is derived and informed by the EAC Vision 2050 which was presented by the Secretariat of the Lake Victoria Basin Commission and enriched by comments from distinguished representatives from leading organizations engaged in transboundary water resources management in the Lake Victoria Basin and beyond. Chaired by Dr. Richard J. Kimwaga from the University of Dar es Salaam, a high-level- panel composed as follows provided their view on the two key questions mentioned above:

- Dr. Mohsen Alarabawy represented the Nile Basin Initiative

- Dr. Ahmed Khalid Eldaw represented the Global Water Partnership Eastern Africa
- Godfrey Sengendo represented the Nil Equatorial Lakes Subsidiary Action Program

The participants were organized in four sub-thematic groups. Three of these groups - agriculture and livestock; industry, energy and commerce; domestic water and socio-economic trends – are mainly linked to future water demand and one of them – surface and ground water – was mainly looking at the changing water availability side.

Figure 2 Sub-thematic groups for scenario building

The incasting on development scenarios for each of the sub-thematic groups was organized in the following 4 steps:

- Step 1A: Identification of key drivers for creating qualitative storylines specific to each sub-thematic group. Under the future envisioned by the EAC, how will different sectors (sub-thematic groups) be changing in the Lake Victoria Basin by 2050? So called "driver cards" were used to trigger discussions. Samples can be seen in the detailed reports in annex.
- Step 1B: Quantification of major drivers: Using baseline and clues cards, quantify key drivers that will have a significant implication on water management in the Lake Victoria Basin. Samples of such "clue cards" can be seen in the detailed reports in annex. In essence, it was more about discussing the plausibility of some pre-selected quantification and to collect ideas how further quantification could be refined.
- Step 2A: Identify and evaluate challenges and trade-offs: Describe major water challenges in the respective sub-thematic group that need to be overcome in order to achieve development aspirations of EAC vision 2050. Identify any cross-sectoral implications and trade-offs.
- Step 2B: Identify and evaluate solutions and synergies: Describe potential solutions and synergies against challenges and trade-offs identified.

For the identification of trade-offs and synergies in steps 2A and 2B so called "messengers" were sent out from each sub-thematic group to discuss cross-sectoral issues with other sub-thematic groups either to identify and clarify trade-offs or to highlight and unveil synergies. The messengers were equipped with messenger cards which were drafted in the respective sub-thematic group sending the messenger out. These cards "mandated" the messengers to present the trade-off or synergy issue to the other sub-thematic group and framed the topic of discussion.

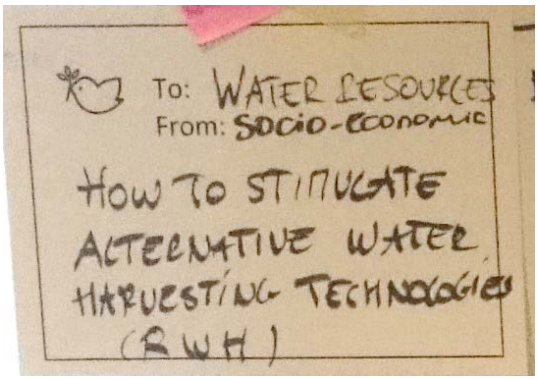

Figure 3 Sample of a messenger card

The presentations used to introduce into the different methodologies and group work processes can be downloaded from IIASA's workshop webpage using this link[6].

3 Results of deliberations

3.1 Sharing experience on modeling work

The presentations provided on day 1 helped to have an improved understanding on approaches, tools and techniques which are useful for mid- to long-term water resources management and planning issues.

Dr. Simon Langan, Director from IIASA's Water Program, provided an overview on some of the key elements of IIASA's research work on water with special emphasis on the Water Futures and Solutions initiative. It highlights IIASA's interdisciplinary approach and system thinking and includes some results from global studies but also elements on Eastern Africa and sets the scene for future opportunities of collaboration.

Link to presentation: Water Futures and Solutions, Dr. Simon Langan[7]

Eng. Sowed Sewagudde from the Department of International & Transboundary Water Resources of the Directorate of Water Resources Management (DWRM) in the Ministry of Water and Environment presented the application of the Nile Decision Support System for formulating the National Water Resource Strategy for Uganda. It looks at the water requirements for achieving the development targets set in the Uganda Vision 2040 and to provide a framework for management and development of the country's water and related resources by 2040. Despite no major water allocation conflicts are anticipated by 2040 according to the analysis made, the study concludes that to support policy and decision making regarding water resources planning, DWRM needs a tool to screen combinations of development options, and quickly identify trade-offs and implications on the main socio-economic sectors in the country.

Link to presentation: Application of the Nile DSS in the Development of the National Water Resources Strategy for Uganda, Eng. Sowed Sewagudde[8]

Eng. Omari Mwinjaka, Water Resources Management Officer at the Secretariat of the Lake Victoria Basin Commission (LVBC) provided an overview of the LVBC and the main challenges and development opportunities in the basin. The presentations included the key feature of the Lake Victoria Basin's Water Resources Information System which is a DHI MIKE customized platform to manage, exchange and share data and knowledge across the basin. It was developed to monitor surface water, groundwater and effluent water quality, and includes a GIS-based database for land-use, hydrology, and biodiversity. This key information is provided mainly by the member states and made available to them and other partners based on a Protocol for Sustainable Development of LVB, 2003[9]. The presentation includes the elaboration of key challenges which are mainly linked to issues related to data sharing among the member governments. It also includes a way forward which is to establish a IWRM data base and model for the Lake Victoria Basin, to support future investment decisions supported by KfW.

[6] http://www.iiasa.ac.at/web/home/research/researchPrograms/water/171204-EastAfrica2050.html

[7] http://www.iiasa.ac.at/web/home/research/researchPrograms/water/171204africa/1.2_Water_Futures_and_Solutions__Dr._Simon_Langan.pdf

[8] http://www.iiasa.ac.at/web/home/research/researchPrograms/water/171204africa/1.3_Application_of_the_Nile_DSS_in_the_Dev_t_of_the_National.pdf

[9] https://www.internationalwaterlaw.org/documents/regionaldocs/Lake_Victoria_Basin_2003.pdf

Link to presentation: Lake Victoria Basin Water Resources Information System, Eng. Omari Mwinjaka[10]

Dr. Abdulkarim Seid, Head of the Water Resources Management Department of the Nile Basin Initiative Secretariat provided an overview on the NBI strategic water resources analysis which responds to the question on how to meet demands for water, food and energy within the Nile Basin in a sustainable manner. Future projection of water demand is based on future development projects as anticipated by the NBI countries. The presentation frames the structures of tools and models used for determining the status and future of water availability and demand. It quantifies current key water demands and parameters for future scenarios and projections. The study concludes, if future water resources investments are not coordinated and optimized basin-wide, there are risks of incurring substantial shortfalls. The deficit is likely to grow to over 50 % of historically available water resources.
Link to presentation: NBI strategic water resources analysis, Dr. Abdulkarim Seid[11]

Dr. Vincent Odongo and Risper Ondiek from the Department of Agricultural Engineering of the Egerton University presented the Nile Ecosystems Valuation and Wise-Use (Nile-Eco-VWU) Project which includes researchers from Universities and institutions in Kenya, Uganda, Egypt, The Netherlands, Sudan, Hungary and the UN. The presentation lays down the framework of the project which is about developing and testing integrated tools for ecosystem services, and valuation and assessment that can be applied to local and regional scales within the Nile Basin. Some preliminary results on comparing rainfall regimes and discharge (appearance of peak flows) and economic valuation of products from wetlands are also discussed.
Link to presentation: Nile Ecosystems Valuation and wise-Use (Nile-Eco-VWU) Project, Dr. Vincent Odongo and Risper Ondiek[12]

Dr. Peter Burek, Senior Researcher at IIASA, presented the hydrological modeling work based on the open source Community Water Model (CWATM) which includes a detailed description of the modeling framework, characteristics of the model and application of CWATM to the lake Victoria Basin. He also presented IIASA's work in developing a continental-scale hydro-economic model for integrating water-energy-land nexus solutions. This model was applied at a continental scale in Africa and is looking at water management options based on a cost optimization routine. The presentations also informs on next steps and IIASA's ambitions using the models in further work.
Links to presentations: Hydrological modeling, Community Water Model, Dr. Peter Burek[13]
Hydro-economic model for integrating water-energy-land nexus solutions, Dr. Peter Burek[14]

Dr. Sylvia Tramberend, Senior Researcher at IIASA, presented IIASA's work on agricultural development scenarios. It includes an ecological-economic modeling framework and zooms in to the importance of development scenarios, integration of climate change, the agro-ecological zoning methodology and elements of an agricultural economic model and also the link to the Community Water Model (CWATM). Furthermore, some selected results in regard to the African context are shown.

[10] http://www.iiasa.ac.at/web/home/research/researchPrograms/water/171204africa/1.4_Lake_Victoria_Basin_Water_Resources_Information_System__.pdf
[11] http://www.iiasa.ac.at/web/home/research/researchPrograms/water/171204africa/1.5_NBI_strategic_water_resources_analysis__Dr._Abdulkarim_S.pdf
[12] http://www.iiasa.ac.at/web/home/research/researchPrograms/water/171204africa/1.6_Nile_Ecosystems_Valuation_and_wise-Use__Nile-Eco-VWU_Pro.pdf
[13] http://www.iiasa.ac.at/web/home/research/researchPrograms/water/171204africa/1.7_Hydrological_modeling__Community_Water_Model__Dr._Peter_.pdf
[14] http://www.iiasa.ac.at/web/home/research/researchPrograms/water/171204africa/1.9_Hydro-economic_model_for_integrating_water-energy-land_n.pdf

Link to presentation: Agricultural Development Scenarios, Dr. Sylvia Tramberend[15]

3.2 SWOT Analysis on listening perspectives

The analysis of the Successes, Weaknesses, Opportunities and Threats (SWOT) in regard to four broader topics – i) capacity development, ii) development scenarios, iii) water for agricultural use, iv) uncertainties and data – emerging from the presentations and discussions resulted in issues which are specific to each of the four topics but also in issues which are cutting across the four topics. The elements which are specific to each topic can be depicted from the individual SWOT grids on the following pages. Cross-cutting issues are:

- Conducive institutional/organizational setting: The water management in the Lake Victoria Basin in principle is characterized by a set-up of well-organized and mandated organizations (LVBC, NBI, NELSAP, GWP EA, IGAD etc.) working on transboundary water management issues in the 5 countries of the East African Community which complement the capacities and mandates of the national institutions. Group members reflected on opportunities and efficiency gains for improved synergies among these organizations and fully using all knowledge and experience required for mid- to long-term water resources planning and management also available in academic, private sector and civil society organizations. There are a number of organizations which have responsibility or where water plays a central role in the operation/business. These organizations are somewhat fragmented. However, discussions indicate moves towards consolidation e.g. LVBC Centre of Excellence on IWRM and Uganda Water Research Institute etc.
- Using systemic tools (models) for informing decision making in water resources allocations and management: There are more thought needs to capture more effectively the future for water in the regional and national development visions and strategies. In principle there is quite solid experience in using tools for responding to water management challenges which are mainly linked to the Nile Decisions Support System. However, these systems are mainly available to national governments and the mandated multilateral transboundary water management organizations but not to the academia and other stakeholder who could contribute to important water management solutions with further research work. This leads to sub-optimal use of the existing modeling tools and also to policy decisions which are often not informed by systemic hydrological and/or hydro economic analysis.
- Availability, quality and accessibility of data: All groups indicated huge challenges regarding data availability, data quality and mainly accessibility of existing data. This seems to be a very wide spread phenomena across all areas of water research. Where data exist it can often not be accessed by stakeholders due to perceived sensitivity issues by the organizations holding and managing these valuable data. This limits researchers and practitioners in undertaking critical analysis across the broad field of water management challenges.
- Unknowns about future water demand and interaction between drivers of water demand: While there is fairly sound knowledge about availability of water resources, discussions around the four topics revealed that future water demand in the different key sectors (domestic, industry & energy, agriculture, environment) is not very well known. In particular key drivers of water demand stemming from socio-economic transformation and systemic interaction among the key water consumers incl. environment require more attention in tools and models supporting decision making in water management.
- Critical mass of capacities: Lack of capacities was subject of discussion not only in the group discussing specifically capacity development issues, but also in all other groups. Despite

[15] http://www.iiasa.ac.at/web/home/research/researchPrograms/water/171204africa/1.8_Agricultural_Development_Scenarios__Dr._Sylvia_Tranberen.pdf

considerable support, progress and efforts in capacity development from various stakeholders and possible efficiency gains through improved coordination, there is further need of engagement at all levels of society (government, academia, civil society, private sector) in order to achieve a critical mass of capacity which also allows for free fluctuation of professionals across all sectors and levels of society.

- Solutions on local level which lack scaling-up: Discussions revealed that numerous initiatives support pilot cases of solutions to almost all challenges in water management which respond to local needs. However, scaling-up of such solutions into broader policy making and implementation remain to happen and are constrained by a number of factors such as resource constraints, lack of harmonization and alignment, coordination among stakeholders etc.
- Resource constraints, poverty, insecurity: Implementation of actions which support forward looking and sustainable mid- to long-term water resources management require a certain level of stability in terms of available resources, widely overcome poverty issues and political stability and security. Discussions exposed the high pressure on decision makers to focus on immediate needs rather than long-term visionary planning and related decision making. There is a specific requirement to build and enhance integration of capacity and resource needs.

UNCERTAINTY/INPUT DATA

Success	Weakness
1. Models can already deal with uncertainty: use different scenarios, work with ensembles on uncertainties e.g. Representative Concentration Pathways (RCPs), Shared Socioeconomic Pathways (SSPs) 2. We are not starting from Zero: We have Nile DSS, data are collected and is available, organizations exist dealing with water quantity and water quality, cooperation and partnerships exist.	1. Model structure not adequate for East Africa: most models are developed in US, Europe, Japan etc. and lack representing the particular features of the African continent (e.g. Sudd in South Sudan) 2. Quality and accessibility of data: Data have gaps, not harmonized, are uncertain and in most cases not available, 3. Continues monitoring programs (surface water, ground water) are missing and if in place differ very much from one region/country to the other
Opportunities	**Threats**
1. Institutional collaboration: Use existing institutions and partnerships for harnessing harmonization and integration 2. Put the few people who can deal with uncertainty together: building and expanding the critical mass of expertise (technical, modeling) 3. Harmonization of i) datasets, ii) data collection and iii) data validation 4. Emerging technology, explore and use of new technologies	1. Insufficient interaction between science/policy 2. As already standard monitoring data is insufficient it seems even more challenging to deal with the upcoming need of more high resolution data (spatial, temporal). 3. Political instability

DEVELOPMENT SCENARIOS

Success	Weakness
1. Catchment management planning is done in large parts of the EAC 2. Policy and planning is well developed 3. Short term development path ways are well known for each sector	1. Insufficient groundwater monitoring data 2. Insufficient data on changes in land use 3. Hydro-economic models are still at infancy stage 4. Government/planners is not using models or modeling results for decision making. 5. Low capacity of governments to reach vision targets 6. If water demand future is fuzzy, how to decide on investment? 7. Insufficient data collection on recent developments (scale and time) 8. Models are calibrated on hydro data, not on development pathways

Opportunities	Threats
1. There is a common vision on regional development, and the presence of regional institutions 2. Access to new and cheap technologies for data sharing and collection 3. Potentials for real time data in models 4. Hydro-economic models can be used for better system understanding/modeling	1. Different development rates among countries in the region that are not sufficiently captured by models 2. Insufficient funds for planned developments as well as monitoring 3. Unforeseen risks cannot be factored in (civil unrests, oil exploration/extraction depending on global oil prices) 4. Emerging water demands (international companies) necessitate new demand data 5. Poverty

WATER FOR AGRICULTURE

Success*	Weakness
1. Efficient irrigation systems exist in some regions (e.g. drip irrigation of cash crops in Kenya, sugar industry etc.) 2. Alternative wetting and drying in paddy rice fields 3. Water conservation practices exist locally (e.g mulching, stone bounds, terracing etc.) 4. Local knowledge on integrated agricultural systems exists (e.g. livestock – fish pond – crop production system)	1. Lack of information on crop water management 2. Poor or no monitoring (e.g. no information on crop water management) 3. No or poor data (e.g. on water demand) 4. Even when data is available in selected regions, it is not communicate to or compiled by a central unit 5. The high number of small-scale farmers is a challenge for the collection of data 6. Underdeveloped irrigation schemes
Opportunities	**Threats**
1. Availability of fresh water resources 2. Availability of platform for regional cooperation and implementation of policies (e.g SLM, LVBC, NBI) 3. High biophysical potential due to conducive climatic conditions(2 rainy seasons in a year) 4. Urbanization will increase demand 5. Cash crop production to generate income 6. Knowledge on integrated agricultural systems 7. Cash crop production for income generation	1. Climate variability 2. Population growth 3. Lack of finance & capital for investments 4. Conflicts between farmers on water use 5. Lack of capacity (trained personnel/farmers/extension work) 6. Urbanization results in sealing of fertile agricultural land 7. Cash crop production may threaten food security

* Note, the group assessed all themes listed in success to represent as well an opportunity. Local knowledge may support up-scaling to larger regions.

CAPACITIES

Success	weakness
1. Many interested and different groups, including research, is under way. NBI, LVBC, GOVERNMENT, NGO'S, IIASA 2. 3. Data is available 4. UNDP support to cleaner production centers	1. Access to data and associated capacity to analyize and collaborate. 2. Lack of good co-ordination between organizations. 3. Little regional sharing through established platforms. 4. Limited access to existing tools. (Models in universities) 5. Development of individual capacity; then person moves → loss of institutional capacity. 6.
Opportunities	**Threats**
1. Develop common platform for capacity building across water issues 2. Recognize different country expertise and share with neighbors where not as advanced. 3. Get water resources considered more fully in planning. 4. Develop common shared vision for water now and for future 5. Capacity building programs (technical)	1. Poor coordination of development efforts 2. Different interpretation rules by countries even under agreed treaties 3. Poor water governance, need to raise profile and enhance capacity

3.3 Story lines for future development pathways

The second expected workshop outcome was to have a common understanding on key determinants for mid- to long-term water availability and demand trajectories. This was approached by incasting on these determinants in four sub-thematic groups (see section 2.3 for the description of the methodological approach. The following preliminary story lines can be derived for each sub-thematic group as summarized below:

3.3.1 Socio-economic trends and domestic water

1. Population will increase, this will provide a significant increase in demand. However, the significance of the population increase is likely to have strong spatial dimension to it through both differences in growth rates as well as migration in rural and urban areas. It is possible population rates may be lower in urban areas, but this may be offset by inward migration from rural to urban areas. The overall increase in population will lead to an increase in water demand.
2. Urbanization will increase and as a result will lead to both a higher demand. This was suggested to be the largest driver both in demand and consequent discharge of waste waters. At the same time with this increase in population density it will become more cost-effective to provide both water access and sanitation services. People in urban areas are increasingly likely to be able to afford. In contrast rural areas are not envisioned as being significantly different from today. Although it is possible that with outward migration there will be a loss of culture and traditional values which may be lost to the next generation and result in leas indigenous knowledge relating to natural resource management.
3. Domestic consumption per capita will be higher in the growing urban areas with increasing prosperity. In contrast it is likely rural areas will not change significantly from current usage.
4. Across all drivers the increasing consumption of water also has implications for the quality of water in rural areas from conflicting needs of multiple uses. In urban areas the generation of waste water.

3.3.2 Surface water and ground water resources

1. Climate change will put additional pressure on all sectors. Temperature increase and increasing number of hot days will lead to increasing water demand and to increased evaporation loss. Precipitation change is highly unknown at the moment but more droughts and more flooding are expected. Climate change might also affect seasonal variability by changing the grow periods of crops. By 2050 water demand might be reduced by using more efficient methods of irrigation, decrease losses due to leakages, increase decentralized water storage. Crop and livestock insurance will reduce the risk of harvest failures.
2. Water quality will be a major issue in the next decades. Increasing waste water from domestic and industrial use and increasing use of fertilizer and pesticide will put pressure on environment and water resources. By 2050 waste water treatment and water recycling has to be implemented. Land use planning has to involve water resource planning from large scale (e.g. natural reserves) to small scale (e.g. sand dams, roof rain collection). Faecal sludge waste management system and centralized waste water treatment will be put in place.
3. Groundwater use will increase. By 2050 monitoring and sustainable groundwater use is in place. Abstraction rules and planning will prevent over pumping and destroying groundwater aquifers.

4. Leakage of pipes because of old infrastructure or illegal abstraction is a major problem. By 2050 the planning of infrastructure will be harmonized and improved.
5. Paucity of data is another major problem. By 2050 data on surface water quantity and quality, and ground water will be accessible, harmonized and adequate monitoring programs are installed. Remote sensing will play a more and more import role.

3.3.3 Agriculture, livestock and fishery

East Africa's decision makers recognize the importance of the agricultural sector and integrated land use planning and management for achieving by 2050 the vision of food security and sustainable use of land and water resources while safeguarding the environment. Although over time the contribution of agricultural production to economic growth and output declines, especially in the first decades the sector is critically important for boosting the economy and providing employment. Against the background of three forth of the population employed in agriculture today (2017), agro-industrial production is aggressively developed by relying on two cornerstones. First food- and non-food industries using crops, livestock and fish products generate demand for agricultural products. Second, farmers gradually increase productivity and are closing yield gaps towards achieving sustainable biophysical production potentials. Irrigation development is a key strategy to protect against climate variability. The agricultural sector is perceived along its entire supply and value chains. Accordingly, support and management strategies encompass all elements from 'field to consumption'. This leads to the development of agro-industries based on increasing production of crop and livestock products.

3.3.4 Industry incl. energy, manufacturing and commerce

1. Access to electricity will increase, and is seen as the most important driver of change and key to achieving the EAC Vision 2050. Energy will become cheaper/affordable and will be more stable (no cuts, stable voltage). Electricity will be produced more and more by renewable energy sources (solar, wind, geo-thermal). Power will be supplied for the whole basin, i.e. the inter-connectivity will increase. Impacts will be improved livelihoods, more employment. The environmental degradation will decrease as people will have employment other than those impacting directly on the environmental natural resources (i.e. brick making, local brewing etc.). Also electricity will be used for cooking, reducing deforestation for firewood and charcoal production. Finally, electricity will be used to increase local productivity and promote manufacturing. There may be scarcity of water locally, when water is diverted to other basins resulting in conflicts.
2. The percentage of local value addition will increase, as the second most important driver of industrialization and commerce in the basin. These improvements in value addition processes will lead to higher incomes, also on a national level greater wealth will be achieved as less needs of products to be imported. Other expected benefits are reduced post-harvest losses and a higher employment rate. It will lead to a higher water demand, increased pollution and therefore indirectly to higher risk of water use conflicts.
3. The third most important driver towards industrial growth is industrialization itself. Man industrialization is expected in the fish processing, mining, oil & gas exploration/production and refining. Expected impacts on water in the basin include an increase in water consumption, increased water pollution and an increase in related conflicts.

The detailed reports on each of the sub-thematic groups which include reflection on challenges and trade-offs as well as solutions and synergies can be found in the annex.

Some highlights from the discussions on solutions and opportunities are:

- Training and education: Investments in training of professionals and education and sensitization of the general public on water scarcity issues.
- Technological improvements: Using the wide range of technologies available often successfully tested in pilots for technological transformations at scale e.g. boosting efficiency in irrigation, managing wastewater and sewage as resources etc.
- Improved management: To sustain infrastructure investments, their management is crucial.
- Improved indicators, monitoring and evaluation to assess good/appropriate progress.
- Better and more integrated communication to ensure synergies met and trade-offs minimized.
- Look for economic opportunities in improving WRM and demand
- Need to go beyond the box of traditional water management and to integrate land and water management, water-energy-food, water for environment etc.

The process to reflect on trade-offs and synergies was facilitated by a process of sending out messengers into other sub-thematic groups (see for detailed description in section 2.3). This process was highly interactive and unveiled a number of issues which require cross-sectoral, cross-scale and transboundary collaboration and coordination. The exercise had also the character of a role play. Participants, who were given the task of a messenger, experienced the role of a mediator when they entered the other sub-thematic group as the trade-off or synergy issues were often perceived quite differently by the sending and by the receiving sub-thematic groups. This led to engaged debates and opened people's eyes on different perspectives for one and the same issue. Some examples are:

- Pollution issues emerging from activities in different sectors: Agricultural and industrial activities but also supplying water to urban population result in wastewater which may cause significant pollution issues if not handled properly. This impairs on the resource base for other sectors or sub-sectors and my hamper their development. Despite the widespread consensus on a polluter-pays-principle, discussions emerged to what degree a particular sub-sector can shoulder treatment costs without relying on public funding.
- Allocation of financial resources and prioritization of needed investments and funding for operation & maintenance: All sectors require additional funding for investments in terms of capital cost and also operating cost for sustaining these investments. Discussions showed differences in opinion on prioritization of such investments and also on whether maintenance costs can be fully paid by the consumers (e.g. funding for reducing leakages in domestic water supply by adjusting water tariffs etc.).
- Use and/or reuse of treated waste water and/or by-products such as sludge etc.: Use of treated waste water for irrigation or treated sludge as fertilizer in agriculture was discussed without uniform consensus on safety for human health and payment for such resources and products. The industrial sector demonstrated that there are a number of innovations available for scaling up which follow an important characteristics of a circular economy of "producing without producing waste".
- Allocation and conflicts among water users: Prioritization of water resources for different uses other than domestic water use was discussed with unclear view on allocation principles in case of scarcity. In practice, it is difficult to step out of the box of sector thinking and to have an open perspective on allocation requirements and prioritization without conflicting actions and behavior.

- Environment and ecosystem services: Generally participants recognized the importance of services provided by ecosystems and the need to allocate water for environmental health. Whether this principle can also be preserved in situations of water scarcity was debated.
- Implication of improved socio-economic situation: As the region is striving towards improving the socio-economic situation across society a complex pattern of implications on water resources can be expected. Aspects of it such urbanizing society, modernized agriculture etc. with higher risk of water pollution emerged in the cross sectoral discussions.
- Regulations and their enforcement: The discussions also exposed the need to go beyond regulation. Many existing regulatory provisions including laws and by-laws lack enforcement impacting negatively on general discipline regarding to regulatory frameworks.

3.4 Building collaboration for further research

On the last day participants were organized in four groups in order to think about needs and opportunities for build partnerships on boosting modeling and scenario building capacities in the East Africa region. In a pro-action café arrangement (see section 2.2 for more details), participants engaged and helped to identify specific ideas for research collaboration and work packages which will be implemented in the coming year 2018.

Figure 4 Group work on further research collaboration

The groups discussed the following four project ideas:

- Capacity enhancement: Assessment of capacity needs and their enhancement options.
- Advancing water resources relevant development scenarios to 2050 for the East Africa Community countries.
- East Africa Land Use - Agriculture – Water Zoning (EA-LAW Zoning)
- Improving data accessibility and harmonization at the example of a few pilot regions

The detailed outcomes of the group discussions can be found in annex.

The harvests for these group discussions are preliminary ideas in order to guide further engagement in developing joint research proposals. There is manifested need and interest from all represented sectors of society (government / multi-lateral institutions, academia, civil society, private sector) to engage in further research work for advancing mid- to long-term water resources planning and management in East Africa.
These project ideas should not be seen in isolation but relate to each other and are by no means a representation of the holistic research requirements. Whether they should be addressed as a package or rather subject to individual smaller research proposal depends on further dialogue among the key institutions driving and advising future water resources decision making in the region and possible funding institutions.

4 Way forward

The organizing committee of the workshop involving the Ugandan Directorate of Water Development of the Ministry of Water and Environment, the Secretariat of the Lake Victoria Basin Commission and IIASA met after the workshop to discuss the follow-up activities and milestones for 2018.
There are 2 main work streams for 2018; i) processing workshop outcomes and related modeling activities and ii) drafting a joint proposal for further and deepened collaboration between LVBC and its member countries (incl. Uganda), IIASA and interested partners.

4.1 Processing workshop outcomes and further modeling

The workshop allowed to harvest important elements which allow for further modeling work. Support from all workshop participants will be required to refine further developing of future development

scenarios and solution options to mid- to long-term water resources management and planning. Results on further modeling based on these new scenarios should be presented towards the end of 2018.

The following process action plan is suggested:

Timelines, 2018	Description of task
January 15	Draft workshop report ready for input from participants: This report documents the presentations, related discussions and results from the different working groups (without major interpretation and further processing and data gathering). It includes an executive summary and is presented in a manner to inform the LVBC sectoral committee about the started work in the framework of the exploratory workshop.
January 30	Input from participants on draft report.
February 9	Final report on workshop.
End of March	Draft paper on scenarios for EAC countries: This paper will include story lines and quantification of major drivers for regional development pathways of the EAC countries based on regional and national development visions and plans (regional scenario). In addition, it will include two development scenarios derived from global SSPs (Shared Socio-economic Pathways).
Mid of April	Input from workshop participants on the draft scenario paper.
End of April	Final scenario paper in the format of a WFaS project report.
End of July	Preliminary modeling results focusing on balancing water availability and water demand based on scenarios developed in the scenario paper finalized by end April.
End of September	Presentation and discussion of modeling results based on a draft WFaS project report.
End of October	Receiving input on draft report on WFaS modeling results.
End of November	Final WFaS report on modeling results.
Sept. to Dec. 2018	Using one of the regional meetings of LVBC for back-to-back reporting and discussion on WFaS reports on scenarios and modeling results.

4.2 Proposal for further research work

The current phase of the Water Futures and Solutions Initiative (WFaS) allows only preliminary works on mid- to long term water management and planning in Eastern Africa. Deeper work which includes capacity development and linking scientific research results to policy making in regard to broader future water management requires additional work and input from all partners with additional resources. For that matter one or several funding proposal(s) should be developed in collaboration between LVBC, Uganda and IIASA involving any interested partner in particular among the workshop participants and submitted to a range of development partners already engaged in transboundary water management issues. The topics debated on day 3 of the workshop (capacity development, water for agriculture, uncertainty and scenario development) could be a first input. The proposal(s) should fund collaboration between LVBC and its member countries with IIASA and include collaboration with selected academic institutions as an open partnership. The following milestones are proposed:

Timeline, 2018	Description of task	Lead
End of February	First draft concept note describing background, brief objective and expected outcomes, scope, partnership, timeframe, rough budget outline (max. 10 pages).	IIASA
End of February	Identifying potential donors	LVBC
End of February	Identifying potential partners from the academia in the region	LVBC
End of February	Identifying potential partners from the academia at international level	IIASA

Mid of March	Feedback on first draft	LVBC, DWRM
End of March	Agree on donors to be targeted	LVBC/IIASA
End of March	Final concept note	IIASA
End of April	Consultations with member states of LVBC and partners from academia	LVBC
End of April	Consultations with donors targeted	LVBC
End of May	Draft full proposal	IIASA
End of June	Comments from member states of LVBC and partners from academia and donors	LVBC
End of July	Final proposal	IIASA
August	Submission to donors	LVBC
End of September	Finalizing negotiations and adjustments requested from donors	LVBC/IIASA
End of October	Agree on contract with donors	LVBC/IIASA
End of November	Internal agreement	LVBC/IIASA
1.1.2019	Start of activities on new project	LVBC/IIASA

Annex

- Detailed Program
- List of participants
- Listening perspectives
- Reports on the sub-thematic groups
    - Socio-economic trends and domestic water demand
    - Subsurface and groundwater resources
    - Agriculture, livestock and fisheries
    - Industry incl. energy, manufacturing and commerce
- Ideas for further research:
    - Capacity enhancement
    - Development scenarios
    - Water for agricultural use
    - Uncertainties and data

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Detailed Program

DAY 1: Sharing experience on modeling work

Agenda:

08:00 – 09:00	**Registration and welcome**	
09:00 – 10:10	**Opening Ceremony** - Call to order (Nebert Wobuzobozi) - Setting the scene for the workshop (Robert Burtscher) - Introduction of participants: Who am I? What do I expect to gain from the event? (All) - Welcome statement by Dr. Simon Langan, Director of the Water Program, IIASA - Welcome statement by Dr. Aly Said Matano, Executive Secretary of the Lake Victoria Basin Commission - Welcome by Mr. Günter Engelits, Head of Office of the Coordination Office of the Austrian Development Cooperation, Austrian Embassy - Welcome statement and official opening by Florence Adongo, Director of the DWRM/MWE	Chair: Nebert Wobuzobozi
10:10 - 10:30	**Introduction to workshop agenda** (Robert Burtscher) - General aims, format and ground rules, listening perspectives	
10:30 – 11:00	**Introduction to the Water Futures and Solutions Initiative** (Simon Langan) - Presentation by IIASA (15 min) - Questions and answers (15 min)	
11:00 – 11:20	Break	
11:20 – 13:00	**Sharing experiences on modeling work and future projections:** **Presentations (20 min each):** - Uganda: Application of the Nile Decision Support System in the Development of the National Water Resources Strategy for Uganda - Lake Victoria Basin Commission: Water Resources Information System - Nile Basin Initiative: Nile Decision Support System, Aspects of Climate change modeling - Egerton University: Nile Ecosystems Valuation for wise-Use (Nile-Eco-VWU) Questions and answers (clarifications only):	Chair: Uganda or LVBC
13:00 – 14:00	Lunch break	
14:00 – 15:00	**Sharing experiences on modeling work and future projections:** **Presentations (15 min each):** - IIASA: Community water model (CWatM) - IIASA: Hydro-economic model (ECHO) - IIASA: Agricultural Development Scenarios (AEZ – WFS)	Chair: Uganda or LVBC

	Questions and answers (clarifications only):	
15:00 – 16:00	**Coffee Break discussion:** - What can we learn from the presentations on modeling work presented so far (based on assigned listening perspectives)?	Facilitators
16:00 - 16:45	**Harvest of the day:** - Reporting back from coffee break discussions - Conclusions for further work - Where can we help each other?	Facilitators
16:45 - 17:00	**Check out:**	Facilitators

DAY 2: Understanding regional development scenarios

Agenda:

09:00 – 09:15	**Presentation on the EAC vision 2050 by LVBC**	Chair: Jackson Twinomujuni
09:15 – 09:40	**Statements by participating organizations on the EAC vision 2050** Uganda and any other represented country, NBI, GWP EA, NELSAP make contributions on their respective opinion and ideas on mid- to long term water use and availability scenarios - Where is water an enabler for the development aspirations of the region? - What are potential risks to water resources emerging from those development aspirations?	
09:40 - 10:00	**Introduction to scenario workshop** - General aims, format and ground rules	Facilitators
10:00 – 10:55	**Step 1A: generation of narratives regarding major socioeconomic drivers** - Breakout group discussions (55 min)	Group leaders
10:55 – 11:15	Break	
11:15 – 12:10	**Step 1B: quantification of major drivers** - Breakout group discussions (55 min)	Group leaders
12:10- 12:55	Reporting back session: - 5 min presentation each (20 min total) - Feedback and any adjustments in narratives/quantifications needed (25 min)	Facilitators
12:55 – 14:00	Lunch break	
14:00 – 15:00	**Step 2A: challenges and trade-offs associated with the EAC vision and potential solutions.** - Breakout group discussions (45 min) - Cross-group discussions on trade-offs (30 min)	Group leaders
15:00 - 15:20	Break	
15:20 – 16:20	**Step 2B: Identification of major solutions and synergies.** - Breakout group discussions (45 min) - Cross-group discussions on trade-offs (30 min)	Group leaders
17:00 - 17:45	Reporting back session: - 5 min presentation each (20 min total) Feedback and any adjustments in narratives needed (10 min)	Facilitators
17:45 - 18:00	**Wrap-up of the day (Check out)**	Facilitators
19:00 – 21:00	**Evening program**	On invitation by IIASA

DAY 3: Building collaboration on future research

09:00 - 09:20	**Introduction to work and methodology of the day** - General aims, format and ground rules	Facilitators
09:20 – 10:00	**Check-in and reflection on day 1&2:** - What are the key learnings and opportunities for future collaboration from day 1? - What are the key learnings and opportunities for future collaboration from day two? - Forming high interest groups	Facilitators
10:00 – 12:00	**Breakout groups (around 4 high interest groups)** - Working phase for high interest groups	Group leaders
12:00 – 13:00	Lunch	
13:00 – 14:15	**Presenting outcome from high-interest groups** - Each group presents in 10 min - Q&A after each group presentations (5 min)	Facilitators
14:15 - 14:40	**Check-out:** - Reflection on take-aways from the workshop - Next steps of collaboration	Facilitators
14:40 – 15:00	**Closing:** - Closing statement by Dr. Simon Langan, Director of the Water Program, IIASA - Closing statement by Dr. Aly Said Matano, Executive Secretary of the Lake Victoria Basin Commission - Official closing by Florence Adongo, Director of the DWRM/MWE	Chair: LVBC or Uganda

Directorate of Water Resources Management
Ministry of Water and Environment
Uganda

EAST AFRICAN COMMUNITY
LAKE VICTORIA BASIN COMMISSION
One people, One Destiny

International Institute for Applied Systems Analysis
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List of listening perspectives:

In essence, a good story told in a presentation needs a listener to unlock its full potential. We often fail to get the opportunity to listen well, especially with a specific purpose, and to provide a necessary feedback loop to those telling the story. In this workshop we address this challenge by equipping each participant with a "listening perspective" for the presentations on day 1 of the workshop, which is intended to support you to focus on relevant key messages. Towards the end of day 1 you will have the opportunity to discuss your insights and learnings with participants having the same listening perspective before these are shared in plenary. What can we hear from the presentations and what thoughts emerge in the group discussions on the following broad topics? What successes, weaknesses, opportunities and threats can be identified? Please pick your listening perspective!

1. Capacities: Modeling of mid-to long term water availability and demand to inform policy making does not only depend on the availability of software tools and corresponding hardware requirements. Knowledge and capabilities of individuals and institutional arrangements matter a lot. *How can we harness all this knowledge for strengthening our mutual capacities? How can we help each other in order to make initiatives in the region successful? Where can you see synergies which are yet to be used?*	Successes Weaknesses Opportunities Threats
2. Development scenarios: Models help us to support decision making in water management for an unknown future. Drivers and data describing future development pathways (scenarios) which impact our water demand (e.g. population growth, economic growth, irrigation development etc.) and water availability (climate change) underpin modeling parameters and underlying assumptions. *How can we refine our information on likely future developments in East Africa? What does it take to bridge the gap between scenario developers and modellers (planers, researcher) and scenario users (practitioners)?*	Successes Weaknesses Opportunities Threats
3. Uncertainty / input data: Decision makers wish to have accurate and exact prediction of the future status of the water resources and behaviour of the hydrological cycle when implementing certain development measures. As scientists and practitioners we know that we can only make such prediction and projections within a range of uncertainty. There are various sources of uncertainties to be considered. Some uncertainties can be reduced by better input data, some uncertainties are intrinsic (e.g. climate) and have to be communicate in a better way. *Which are the key sources of uncertainty and how can they be managed best in the modeling frameworks? How can we communicate uncertainties? How can we work best with policy makers to be sensitive to uncertainties and consider them in policy decisions?*	Successes Weaknesses Opportunities Threats
4. Water for agriculture: Agriculture is the largest water user in East Africa and will likely remain to be in the coming decades. How well do we understand current and future agricultural water demand? What is East Africa's comparative advantage and what are current best water management practices employed in the agricultural sector? Which farming systems and supply chains are critically dependent on water supply (separate for rain-fed and irrigated) and what are the main challenges ahead? What are key driver's for agricultural water use and how well are we able to describe future water requirements?	Successes Weaknesses Opportunities Threats

Report on sub-thematic group: Socioeconomic trends (population, GDP and domestic water demand)

This sub-sector group was quite small in size and the area tackled can be difficult to assess given the available data and strategies that will drive and govern the responses. As with other sectors considered the starting point was the information used and presented in the EAC Vision 2050.

Drivers:

In this session the key drivers were identified which underpin trends in socioeconomic factors (such as population and per capita GDP and domestic water demand may change in the Lake Victoria Basin between current day and 2050.
The following key drivers were identified:

1. **Population and Gross Domestic Product:**

- Population growth in both rural and urban areas
- The rate of growth may vary significantly between rural and urban areas, with the possibility of lower growth rates in urban areas
- This is also reflected in GDP, with growth occurring largely in urban areas
- Less resilience in rural areas may also drive migration to cities

Implications for water use: With increase in population it is inevitable there will be an increase in demand for water. This increased use of water will give rise to increased production/discharges of waste water. The group were very explicit on the influence of the polarity and difference between rural and urban settings and consequences for water use and water quality and this can be seen in the subsequent notes on other drivers.

2. **Urbanisation:**

- Biggest driver of change in demand for water and discharge
- Unclear what rural development might look like

Implication for water use: In urban areas people will demand more water and greater consideration (and investment) will have to be given to how best to treat/utilize it. In rural areas water sources still poorly managed and used for multiple purposes resulting in poor water quality also may give rise to conflicts.

3. **Water Access and Domestic per Capita Water Consumption:**

- Easier to provide access in urban areas and likely to be more cost-effective and easier to manage than in dispersed rural settlements at low densities
- Wealthier people use more water
- Need to consider water quality and waste production
- In rural areas poverty may persist with low capacity to address poor access to water (little change from current situation)

Implication on water management: Large and significant differences between rural area (little change from current) to urban areas where there will be large and significant increases in consumption and demand for greater access to water.

4. **Other drivers:**

- Migration, predominantly of younger men to cities and away from rural areas leaving rural areas dominated by older less skilled.

Implication on water management: With migration of younger skilled people poverty trap in rural areas re-enforced. Therefore communities will not be self sustaining and will continue to need external support. Water infrastructure and services remain basic.

Preliminary story line which can be derived from the group discussion summarized above:

1. Population will increase, this will provide a significant increase in demand. However, the significance of the population increase is likely to have strong spatial dimension to it through both differences in growth rates as well as migration in rural and urban areas. It is possible population rates may be lower in urban areas, but this may be offset by inward migration from rural to urban areas. The overall increase in population will lead to an increase in water demand.
2. Urbanisation will increase and as a result will lead to both a higher demand. This was suggested to be the largest driver both in demand and consequent discharge of waste waters. At the same time with this increase in population density it will become more cost-effective to provide both water access and sanitation services. People in urban areas are increasingly likely to be able to afford. In contrast rural areas are not envisioned as being significantly different from today. Although it is possible that with outward migration there will be a loss of culture and traditional values which may be lost to the next generation and result in leas indigenous knowledge relating to natural resource management.
3. Domestic consumption per capita will be higher in the growing urban areas with increasing prosperity. In contrast it is likely rural areas will not change significantly from current usage.
4. Across all drivers the increasing consumption of water also has implications for the quality of water in rural areas from conflicting needs of multiple uses. In urban areas the generation of waste water.

Quantification of drivers:

In the second session, based on the key drivers identified above which determine future developments in socio-economic drivers and trends the following steps towards quantification were made as assessed against the numbers given in the background documentation and specifically the EAC 2050 Vision and SSP information. The following quantification clue cards were discussed:

1. **Population.**

Population Clues (Projection)

Population development – Scenario SSP1 (Sustainability)

Million people	2015	2030	2050	Change 2015-2050
Burundi	10	13	16	+ 67 %
Kenya	45	59	73	+ 60 %
Rwanda	12	16	21	+ 71 %
Uganda	39	56	79	+ 104 %
UR of Tanzania	51	69	88	+ 73 %
EAC	157	213	277	+ 76 %

Source: IIASA/Wittgenstein Centre

For comparison, the population projections in the EAC Vision reach 184 and 278 million in 2030 and 2050 respectively.

- There will be an increase in population in the region under all scenarios considered (SSP1, 2) and the EAC Vision).
- The group suggested due to increasing education, development and decreasing acceptability of polygamy that all of the estimates of population growth may be too high.

- There may be significant differences in growth rates both between countries and urban /rural populations. The former reflecting different cultures and rates of development. Tanzania was specifically identified as having a slower reduction in birth rates.

2. Urbanisation

Discussion was based on the following EAC and SSP quantification clue cards:

Urbanization Clues (Projection)

	GAEZ (SSP1)				
[1000ha]	2010	2020	2030	2040	2050
Burundi	201	235	263	285	302
Kenya	923	1065	1179	1271	1331
Rwanda	203	243	275	305	327
Uganda	753	913	1070	1220	1345
Tanzania UR	1421	1693	1923	2109	2239

Urbanization Clues (Projection)

	2010	2030	2050
Urbanization Rate (EAC)	30%	51%	70%

Source: EAC Vision 2050

- Urbanisation was deemed to be a very strong driver of change in the region and will continue to provide a strong driver.
- The consequences were felt to be that developing appropriate infrastructure to keep pace with this development will be difficult impacting on demand and water quality (Move to drivers??). In turn this was linked to loss of biodiversity and increasing risk to human health and well being (e.g. flooding).
- The group did not feel in a position to comment on the given figures and wanted more information and data relating to how there were generated and on what basis.

3. GDP:

Discussion was based on the following EAC quantification clue card:

GDP Clues (Projection)

	2010	2030	2050
GDP per capita, constant 2009 prices [USD]	812	3,000	10,000
Average annual GDP growth rate (%)	5.8	10	9.9
Share GDP Agriculture	24%	18%	10%
Share GDP Industry	16%	27%	40%
Share GDP Service Sector	36%	43%	50%
Total GDP (Note: there is a discrepancy in the EAC vision document)	76%	88%	100%

Source: EAC Vision 2050

- Participants felt that GDP will continue to increase in the region but not as rapidly as projected in the EAC Vision 2050.

- There was a particular discussion on the Share of GDP from the service sector growing from 36% to 50 % current day to 2050. Participants debated this unless tourism strongly included and promoted.

4. Education:

Discussion was based on the following EAC quantification clue card:

Education

	2010	2030	2050
Net enrolement rate - Primary [%]	90.8%	98%	100%
Net enrolement rate - Secondary [%]	30.1%	65%	96%
Literacy rate [%]	69%	86%	100%

Source: EAC Vision 2050

- The group felt that whilst education levels would continue to increase, the education figures in the Vision were overly ambitious. Participants question the reality of secondary education to move from current levels of 30 to 96% in 2050.
- The group were also wondering the primary sources of the current baseline data which may also contain uncertainty and significant within region variability.

5. Water Access:

Discussion was based on the following EAC quantification clue card:

Water Access

Access to (piped) water and safe sanitation	2010	2030	2050
Access to safe drinking water [%]	72	81.7	92.9
Basic sanitation [%]	40	60	90

Source: EAC Vision 2050

- Participants agreed access to water would continue to improve but that this should be qualified by considering differences in urban versus rural areas.
- Secondly the group questioned the Figure of 72% access to safe drinking water as the baseline. This was felt to be overly optimistic and high, as was the figure for 2050 of 92.9%.

6. Domestic per Capita Consumption:

Discussion was based on the following EAC quantification clue card:

Domestic Per Capita Consumption (Projection)

	2010	2030	2050
Domestic per capita demand [l/c/d]	35	58.5	128.7

Source: EAC Vision 2050

As reflected in the earlier quantification cards the group felt there were some questions on the data and importantly that using a single regional figure masked considerable spatial variability e.g. rural urban differences.

- Reduce excessive water consumption per capita growth in cities. Consider growth from 35 to 65 litres per capita per day (as opposed to 130).

Challenges and trade-offs

The third group work session focused on the discussion of major water challenges that need to be overcome in order to achieve the EAC vision 2050 concerning socio-economic drivers. A number of challenges relating to water demand and supply, water access and water quality were the main discussion topics.

1. **Challenge 1: Water Demand and Supply**

- Under all population scenarios there is an increase. This increase in population will create an increase in demand for water resources and access.
- In the future demand will be more geographically focused in urban areas.
- Currently there is a lack of awareness about value and use of water which gives rise to considerable wastage/mis-use.
- There exist a poor linkage between evidence, policy and implementation relating to water.
- Investigate and implement alternative water sources (particularly in cities) such as rain water harvesting

Trade-off: How to utilize existing water resource more efficiently to reduce need to increase water resource availability.

2. **Challenge 2: Water Access**

- Water access for domestic consumption should be prioritized. How will this work financially? It could be argued that it is more beneficial and cost effective to provide to industry first?
- Domestic water supplies need to be of a very high standard for consumption and therefore incur higher costs than for other sectors with lower water quality requirements.
- Rural challenges of water access are very different to urban challenges
- Challenges are also less for communities near to (surface) water than those at a long distance/remote from water.
- There is a need to distinguish and consider constraints generated by physical scarcity and access to water versus those where economic scarcity may be the principal challenge.
- There are different country legislation and rules regarding legal water, particularly around land-use and management and under private/ public interests

Trade-off: Conflicts due to different access constraints, sectoral interests and ability/capacity.

3. **Challenge 3: Water Quality**

- How to deal with multiple sectoral needs and interaction, challenge of pollution from industrial activities impacting on water sources used for domestic supply.
- In rural areas water sources are used for multiple purposes- livestock, washing and human/domestic consumption. These all compromise water quality.
- With increasing urbanization there will be increased production of waste water and faecal material. How to deal with this to minimise water quality impacts and to safeguard human and ecosystem health? Opportunity to use as input to agricultural fertilizer, a resource?
- Increasing agriculture not well managed can lead to land degradation and pollution (soils, nutrients, etc.) to water resources used downstream for domestic use. This increases costs and reduces utility.

Trade-offs: Managing and allocating water between sectors that maximizes positive use and minimizes waste, pollution and excessive use.

Solutions and synergies:

In the final session the group looked at solutions and possible synergies which seem to be useful and realistic to address the challenges identified above.

1. The group suggested that a 'roll-out' of pilot programmes, such as **self-supply** might be an effective solution for rural communities. This might be more effective and quicker if government agencies worked with the private sector possibly using subsidies.
2. The potential of cost-effective programmes of **rainwater harvesting** could also contribute to increasing supply.
3. Equally (at suggestion via message from the water resource group) utilization of **sand dams** for use in rural areas.
   We might classify these first three interventions as 'non-conventional' or rather novel/new approaches.
4. In relation to water quality the group suggested regulations that recognized specific water sources and these be protected through the introduction of **zoning to protect drinking water**.
5. Programs to **build capacity and raise awareness** of water issues would likely to be effective in the region.
6. To ensure a **minimum requirement** and implementation that all domestic residences connect to **waste water** treatment plant
7. There should be more **strict and effective regulation** of waste water discharges.
8. Technical improvements to domestic waste water through, for example, separation at source (liquid/solid). This might provide a **business opportunity to produce fertilizer** (message to agriculture group).
9. On the water demand side the group suggested (message from water resource group) than rather than prioritise increasing water resources more effort should be given to **reducing demand** through, for example, fixing leaks, which was reported for Uganda to be in excess of 50%.
10. More attention should be given to **family planning**
11. One member of the group suggested, in relation to population, that the current practice of giving all women maternity care and free health care for all children there should be a threshold, say up to 3 children, there after (>3) no free health services.

Summary of messenger cards (trade-offs and synergies):

Through an exchange of messages with the industry group a number of benefits, conflicts and trade-offs were identified

a. Higher demand from industry may give rise to conflict if unable to meet domestic needs (latter is government priority/human right).
b. Industry creates employment and products that enhance quality of life.
c. Potential to consider where conflicts arise re-locate population or industry.

Report on sub-thematic group: Surface and Groundwater

This sub-sector group discussed mid- to long-term water management implications from the perspective of future surface and groundwater supply development assumed for the EAC.

Participants:

- Peter Burek, IIASA, Austria
- Balthazar Barutwanayo, Ministry of Water, Environment, Land Management, Burundi
- Dennis Kimera, Uganda Burea of Statistic, Uganda
- Elisée Gashugi, University of Rwanda, College of Science and Technology, Rwanda
- Peter Macharia, Kenya Country Water Partnership, Kenya
- Phillip Nyenje, Makerere University, Uganda
- Richard J. Kimwaga, University of Dar es Salaam, Department of Water Resource Engineering, Tanzania
- Vincent Omondi Odongo,Egerton University, Department of Agricultural Engineering, Kenya
- Pamela Agaba, Directorate of Water Resources Management, Uganda
- Ahmed Khalid Eldaw, Global Water Partnership, Eastern Africa

Surface and Groundwater: 2050 EAC future envisioned

In this short brainstorming action it was ask:

- What is the bigger picture of the EAC vision concerning surface water and groundwater?
- How important is this sector to the overall vision of EAC?
  - Water has to be a key driver up to 2050
  - More efforts on water resources quantification are needed
  - Water resources are not explicitly mentioned in the EAC vision
  - Even if the term “Water is a catalyst” is frequently used e.g. “Water: A Social and Economic Catalyst That Deserves Better”[16]. It is important to mention that the term “catalyst” is misleading as water does not work in most cases as catalyst. A catalyst is not consumed or changed during the catalyzed reaction, but water will be polluted or consumed.

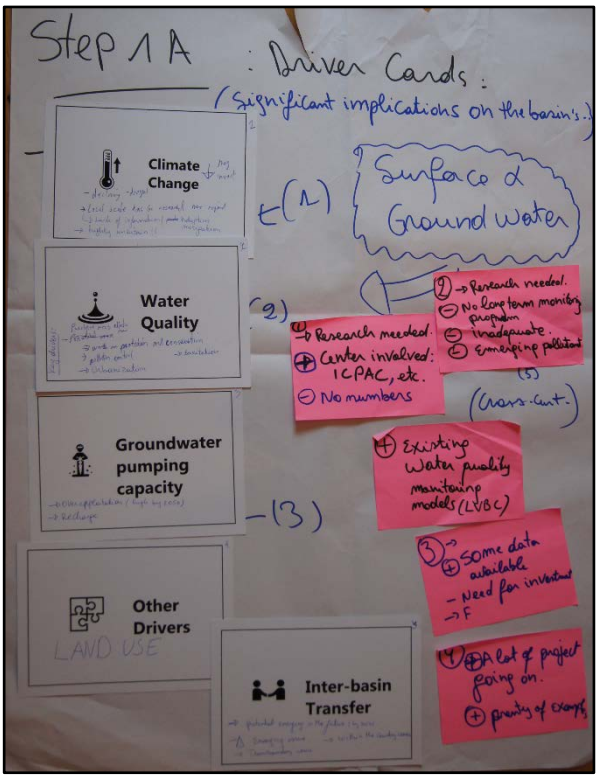
[16] https://www.huffingtonpost.com/patrick-lavarde/water-a-social-and-econom_b_9510004.html

- Water is a finite and vulnerable resource

Conclusion:
Water does not have the place it should have in the EAC Vision 2050.

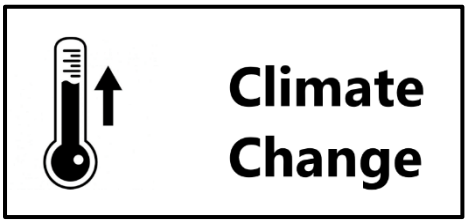
Drivers

In this section the key drivers were identified which respond to the question on how the surface and groundwater supply in the Lake Victoria Basin by 2050?



The following 5 key drivers were identified:

1. Climate change



- Research needed especially on the regional scale. Centre to be involved, ICPAC
  - Centres dealing with regional climate downscaling:
  - IGAD – ICPAC[17] has to be strengthen and supported as pan African climate centre
  - Makerere University, Department of Civil and Environmental Engineering
  - Climate Change Centre University of Dar es Saalam
- Expected to have negative impacts (more droughts), but lack of information
- Global results are highly uncertain
- Climate change will affect all the other drivers

2. Water Quality

- Water quality is an important driver and will become even more important
- Research needed on effects of population growth, urbanization and sanitation
- There are some existing water quality monitoring (LVBC), but no long-term monitoring program

[17] http://www.icpac.net

- No harmonized monitoring across countries
- Lack of data and inadequate data
- Emerging pollutant. Monitoring nonconventional pollutants is necessary
- Lake Victoria – Cyanobacteria problem will increase
- There is a need of more laboratories
- A Water Quality modeling report is available under LVBC funded by KfW

3. Groundwater

- Some data available:
  - Groundwater maps by the Ministry Water and Environment. Uganda
  - African Groundwater Network, Dr. Callist Ntumdimugaya
  - Unlocking the Potential of Groundwater for the Poor in Sub-Saharan Africa (UK's Department for International Development, Natural Environment Research Council,Economic and Social Research Council) [18]

- Need for investment
- Some region already exploited, expected to be more overexploitation till 2050 if no measurements taken
- **Clue cards**: No exact numbers, but groundwater use seems to be less than indicated on the clue cards

4. Land use (from a water resource perspective)

- Land use has to be considered by recharging water processes
- Problems of erosion, sedimentation leading to droughts, if land use is mismanaged

[18] http://skat.ch/portfolio-item/upgro-unlocking-the-potential-of-groundwater-for-the-poor-knowledge-broker/?pdf=691

5. Inter/Intra basin transfer

- Not now but it will be a raising issue till 2050
- Ideas for projects, Reports:
  - Tanzania: Idea to transfer up to 600 km from Lake Victoria
  - The New Release Policy – Study by CEH-UK
  - Gibe I &II Dam – Ethiopia & Kenya (Lake Turkana)
  - Burundi/Rwanda – displacing a lake
  - Kagera River, Kenya study on sedimentation and transfer

Challenges and Solutions

Challenge 1: Flood & drought

Flash floods in urban areas (urban areas are more affected because the risk is higher - these areas are more vulnerable). 2050: 50% of population will be living in urban areas, this will increase the risk. Informal settlements will be affected by poor sanitation, waterborne diseases.

Solutions:

- Resetting people from flood prone areas to safe areas. Problem: resettled people move back after a flood or rent out their former places to newcomers
- Structural measures like e.g. river training, construction of dams, reforestations
- Non-structural measure: Flood mapping, creating awareness for floods
- For droughts: Water savings, rain water harvesting
- In future: desalination and purification of polluted groundwater, water from Lake Victoria

Messenger from Socio-economic: Flooding in Urban areas:

- Install retention ponds in order to increase recharge of aquifers, flood protection management

Challenge 2: Waste Water and Faecal sludge management

- Domestic sanitation is one of the main sources of water pollution
- Groundwater contamination is an increasing problem

Solutions:

- On site system of treating waste water
- Faecal sludge waste management system is needed, centralising waste water treatment
- Re-use of waste water
- Monitoring stations atmospheric deposition

Challenge 3: Leakages

- For Tanzania 33%, Uganda 49%, Rwanda 40% is accounted for leakage of pipes or illegal abstraction of water
- One reason are old infrastructure systems (old pipes)
- Non-harmonized planning of electricity, water, infrastructure (e.g. companies which put in cables for electricity are damaging water pipes and vice versa)

Solutions:

- Harmonize planning of infrastructure
- Share cost between water users
- Improve infrastructure
- Improve techniques to detect leakage
- Regulations/Sanction e.g. higher punishment for illegal abstraction

Messenger from Socio-eco: Shared cost from water users

Challenge 4: Groundwater over pumping

- E.g. Lake Naivasha reversed flow due to over pumping of groundwater for flower irrigation around the area

Solutions:

- Improve planning
- Regulate abstraction

Challenge 5: Seasonal Variability

- Affect water quality and quantity

Solutions:

- Crop and livestock insurances
- Adaptation to water use, water savings
- Afforestation

Challenge 6: Paucity of data

- Adequate monitoring programs needed
- Harmonized data needed

Other messenger cards:

From Socio-Eco: How to stimulate alternative Water-Harvesting Technologies:

- Some policies already in place
- Guidelines for rain water harvesting needed
- Roof rain collection
- Sand dams in rural areas, for improving ground water infiltration and to protect from evaporation

From Industry: Increased demand for water will deplete groundwater and surface water

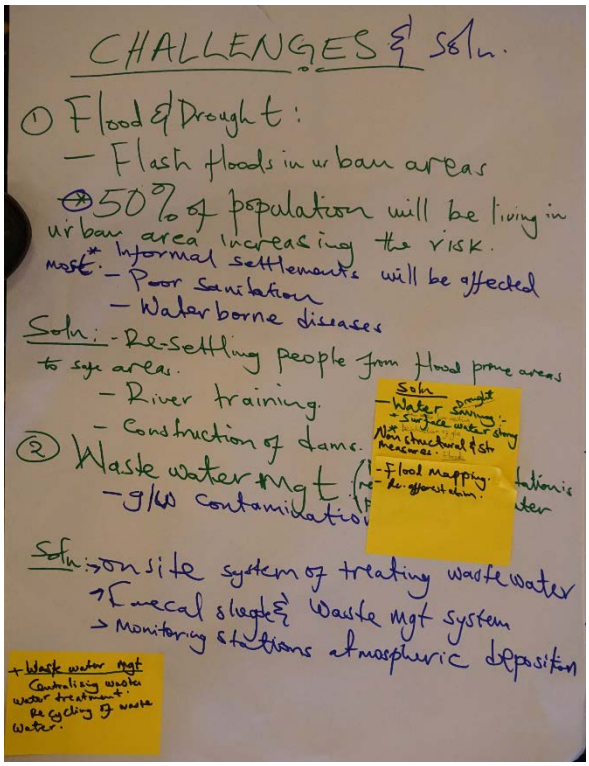
- Circular economy
- Instituting water efficiency
- Regulations: e.g. water tariffs for industry

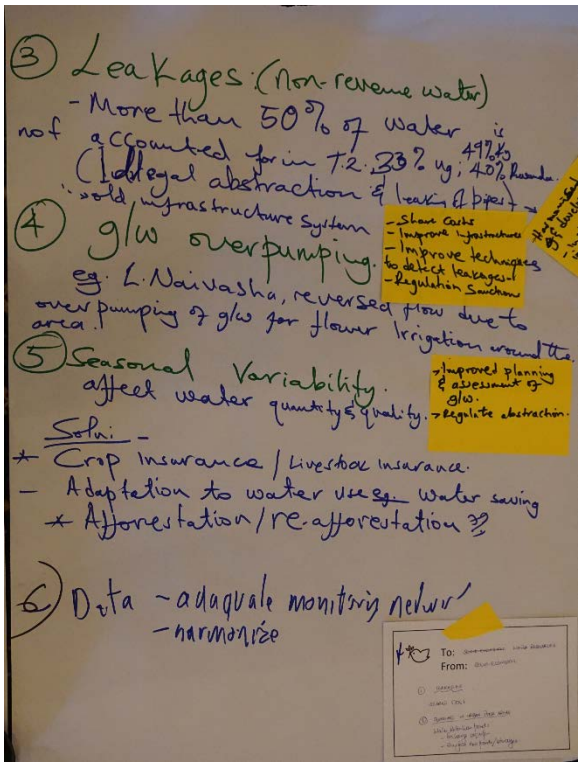
From Industry: Need to make informed decisions when setting up industries. Guidance on availability of water is needed.

- Carry out assessment studies before issuing abstraction permit to the user

From Agriculture: availing adequate water where it is needed

- Improve supply technologies
- Sustainable groundwater use and recharge
- Re-use of waste -water





Preliminary story line which can be derived from the group discussion summarized above:

1. Climate change will put additional pressure on all sectors. Temperature increase and increasing number of hot days will lead to increasing water demand and to increased evaporation loss. Precipitation change is highly unknown at the moment but more droughts and more flooding are expected. Climate change might also affect seasonal variability by changing the grow periods of crops. By 2050 water demand might be reduced by using more efficient methods of irrigation, decrease losses due to leakages, increase decentralized water storage. Crop and livestock insurance will reduce the risk of harvest failures.
2. Water quality will be a major issue in the next decades. Increasing waste water from domestic and industrial use and increasing use of fertilizer and pesticide will put pressure on environment and water resources. By 2050 waste water treatment and water recycling has to be implemented. Land use planning has to involve water resource planning from large scale (e.g. natural reserves) to small scale (e.g. sand dams, roof rain collection). Faecal sludge waste management system and centralized waste water treatment will be put in place.
3. Groundwater use will increase. By 2050 monitoring and sustainable groundwater use is in place. Abstraction rules and planning will prevent over pumping and destroying groundwater aquifers.
4. Leakage of pipes because of old infrastructure or illegal abstraction is a major problem. By 2050 the planning of infrastructure will be harmonized and improved.

5. Paucity of data is another major problem. By 2050 data on surface water quantity and quality, and ground water will be accessible, harmonized and adequate monitoring programs are installed. Remote sensing will play a more and more import role.

Report on sub-thematic group: Scenario Building, Agriculture and land use

Step 1 – Incasting to the EAC vision

Part A: Qualitative Storyline

Selection of driver cards

To develop a qualitative storyline the group started to select driver cards

1. Increase agricultural production and productivity
   1a. Rain-fed production – Aim for yield gap closure
   1b. Irrigated production – Develop more irrigation schemes
2. Education
   Focus on education along whole supply chain
   Strengthen extension services. They were originally community driven, now they are organized in a top-down manner.
   Consider increased use of modern dissemination methods, e.g. SMS, Radio, Snowball sytems
3. Supply chain planning
   Improve approaches which focus planning on covering the entire supply chains from 'field to consumption (food & non-food products)'
4. Technology
   Aim for technological improvements for both rain-fed and irrigated production, consider differences for small-scale and large-scale production systems.
5. Climate change
   Foster climate smart agriculture as a key strategy of climate adaptation and achieving water sustainability
6. Land use planning
   Aim for integrated land use planning including agro-forestry, sustainable use of wetlands, forest management plans, etc.

Draft summary of qualitative storyline

East Africa's decision makers recognize the importance of the agricultural sector and integrated land use planning and management for achieving by 2050 the vision of food security and sustainable use of land and water resources while safeguarding the environment. Although over time the contribution of agricultural production to economic growth and output declines, especially in the first decades the sector is critically important for boosting the economy and providing employment. Against the background of three forth of the population employed in agriculture today (2017), agro-industrial production is aggressively developed by relying on two cornerstones. First food- and non-food industries using crops, livestock and fish products generate demand for agricultural products. Second, farmers gradually increase productivity and are closing yield gaps towards achieving sustainable biophysical production potentials. Irrigation development is a key strategy to protect against climate variability. The agricultural sector is perceived along its entire supply and value chains. Accordingly, support and management strategies encompass all elements from 'field to consumption'. This leads to the development of agro-industries based on increasing production of crop and livestock products.

Part B: Quantifying key drivers

1. Driver – Capacity development
   - Improve market analysis
   - How cooperatives can best be developed
   - Extension services especially for small-scale farmers
2. Driver – Increasing agricultural productivity
   - Increase irrigation infrastructure
   - Develop farmer groups and cooperatives
   - Regional development plans for productivity increases exist, they should be consulted
   - Increase aquaculture
3. Driver – Land use planning
   - Integrated land use planning
   - Set-up a zoning system in support of defining 'optimal' land use systems
4. Driver – Technology
   - Increasing use of modern technologies
   - Categorize technology improvements a) by small-scale versus large-scale farms and b) by type of landscape
5. Driver – Electricity
   - Irrigation infrastructure requires reliable electricity supply
   - Modern agricultural technologies need reliable electricity supply

Step 2A – Challenges and trade-offs

1. Water quality (Agricultural runoff and erosion are detrimental for water quality; Irrigation needs adequate water quality)
2. Temporal variability of water supply often causing water scarcity during critical periods for crop growth and livestock water requirements. Climate change is anticipated to exacerbate the problem.
3. Knowledge gaps (e.g. how best increase yields and productivity, high-quality market information, data lacking and/or not harmonized, where are non-point sources of water pollution)
4. Data quality and availability (often data exist only for some areas, lack of complete spatial and temporal coverage)
5. Spatial distance between water source and location where water is needed, often exacerbated by lack of energy
6. Environmental, agricultural, land use and water policies / plans are NOT harmonized
   6a. National level, i.e. within a country (e.g. contradicting plans/policies; communication between institutions needs improvements; conflict between crop & livestock farmers; water storage systems are put in one place but farmers are only consulted afterwards)
   6b. International level, i.e. transboundary issues (e.g agreements on fishery; international agreements like the NBI still face protectionism of individual countries)
7. Enforcement of policies / plans
8. Water hyacinth, an invasive species causing eutrophication. Increasing temperatures will further exacerbate the problem.
9. Market variability and price fluctuations (e.g. vanilla, coffee)

10. Farmers often are poor and have little means for investments
11. Conflicts between cropland and livestock farmers

Step 2B – Solutions and synergies

Solutions were discussed vis-a-vis the challenges listed above. Therefore there is a corresponding numbering in 2A and 2B, i.e. point 1 in 2B shows solutions to the challenges discussed in point 1 of 2A.

1. Sustainable land management resulting in pollution control from agricultural and urban areas; Conserve wetlands as natural purification system
2. Irrigation development to attenuate impacts of drought and dry spells
   Terracing to attenuate impacts of flooding
   Develop insurance schemes
   Foster 'climate smart agriculture' as adaptation strategy for climate change
3. a) Personal of extension services (i.e trainers) should be better trained and equipped (e.g. often they lack basic equipment like projectors or have no facilitation training). It is important that they can also reach the most vulnerable (e.g. small-scale farmers). b) more research
4. Data collection and harmonization supported by monitoring schemes and data sharing policies
5. Improve technology for water supply, foremost irrigation development including sustainable groundwater use
6. Integrated Water Resources Management (IWRM)
7. Existing plans/policies should be communicated to all institutions affected using tools like workshops, joint operations of e.g. monitoring schemes, data harmonization efforts resulting in joint data collection and reporting. Building trust is a key aim of all these activities. These efforts should be developed for both the national context and the international context.
8. Sustainable land management for reducing the level of pollution loads into water bodies and thereby reducing the growth rates of hyacinths. Where hyacinths are extensive and detrimental to water quality and fishing well planned removal of plants by mechanical harvesting or chemical removal is necessary. The latter is more effective but also more expensive.
9. Improved market research; Farmer cooperation's; Supply chain improvements (e.g. storage needs); Value addition (e.g. tinned tomatoes instead of fresh vegetables)
10. Farmer cooperation's
11. Land use planning and zoning

Messengers from other groups

The agriculture/land use group received the following notices from other groups.
To: Agriculture
From: Socio-economic trends & domestic sector
We would like to alert you of potential pollution from domestic water use affecting water quality and thereby your irrigation water
To: Agriculture
From: Industry sector
We would like alert you of potential pollution from industry, which will affect aquatic life in lakes, rivers and ponds.

To: Agriculture
From: Industry sector
We can provide products which serve as cheap animal feed and fertilizer.
To: Agriculture
From: Surface & Groundwater
Consider re-use of treated waste water
To: Agriculture
From: Surface & Groundwater
Be aware that the seasonal water availability may change due to climate change. Consider crop insurance schemes and adaptation with the aim to save water
To: Socio-economic trends & domestic sector
From: Agriculture
Agriculture is concerned that
i) population explosion will increase urban areas, infringe on agricultural land and reduce available land for agricultural production; and
ii) Poor management of domestic waste water can lead to pollution of land and water which supports agriculture

Report on sub-thematic group: Industry incl. energy, manufacturing and commerce

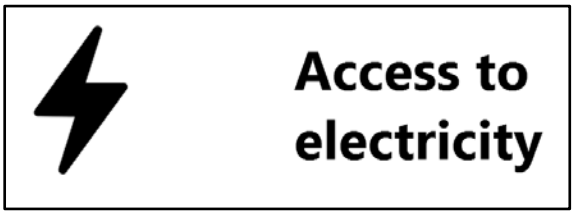
This sub-sector group discussed mid- to long-term water management implications from the perspective of future industrial development assumed for the EAC which includes aspects of the energy sector.

Drivers:

In this section the key drivers were identified which respond to the question on how the industry and commercial sector (energy/manufacturing etc.) will be changing in the Lake Victoria Basin by 2050?

The following 3 key drivers were identified:

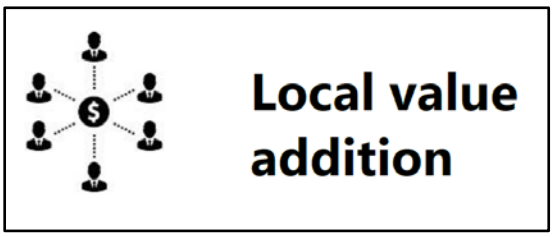
1. **Access to Electricity:**



- It will increase
- It will become cheaper and affordable
- It will be stable and possibly cleaner
- Increase in renewable energy (e.g. solar, wind, geothermal)
- Interconnectivity of power will increase (Kenya, Uganda, Rwanda – EAC)
- Improve livelihoods and employments
- Reduction in environmental degradation
- Increase in local productivity

Implication on water management: There is a possibility of scarcity of water in case of diversions (inter-basin exchange) which might lead to conflicts between countries.

2. **Local value addition:**



- Increase/improved household incomes
- Less imports
- Reduced post harvest losses
- Increase employments
- Using opportunities of carbon credit and payment of environmental services as an opportunity to add value to local value addition.

Implication on water management: Increase in demand, pollution risk and possible water use conflicts.

3. **Industrialisation:**

- Fish processing
- Flower exporting
- Mining (oil & gas)
- Oil refinery

Future industrialization will strongly depend on the investment climate in the EAC countries and the related enabling environment to attract investors.
Implication on water management: Increase in water use and pollution, risk of conflict with local water use.
Preliminary story line which can be derived from the group discussion summarized above:

1. Access to electricity will increase, and is seen as the most important driver of change and key to achieving the EAC Vision 2050. Energy will become cheaper/affordable and will be more stable (no cuts, stable voltage). Electricity will be produced more and more by renewable energy sources (solar, wind, geo-thermal). Power will be supplied for the whole basin, i.e. the inter-connectivity will increase. Impacts will be improved livelihoods, more employment. The environmental degradation will decrease as people will have employment other than those impacting directly on the environmental natural resources (i.e. brick making, local brewing etc.). Also electricity will be used for cooking, reducing deforestation for firewood and charcoal production. Finally, electricity will be used to increase local productivity and promote manufacturing. There may be scarcity of water locally, when water is diverted to other basins resulting in conflicts.
2. The percentage of local value addition will increase, as the second most important driver of industrialization and commerce in the basin. These improvements in value addition processes will lead to higher incomes, also on a national level greater wealth will be achieved as less needs of products to be imported. Other expected benefits are reduced post-harvest losses and a higher employment rate. It will lead to a higher water demand, increased pollution and therefore indirectly to higher risk of water use conflicts.
3. The third most important driver towards industrial growth is industrialization itself. Man industrialization is expected in the fish processing, mining, oil & gas exploration/production and refining. Expected impacts on water in the basin include an increase in water consumption, increased water pollution and an increase in related conflicts.

Quantification of drivers:

Based on the key drivers identified above which determine future developments of industrialization and commerce in the Lake Victoria Basin their quantification was discussed based on clue cards for these drivers which provide some kind of preliminary quantification.

1. **Access to electricity, electricity production mix.**

The following quantification clue cards were discussed:

Electricity Production Mix (Renewables incl. Hydro)

	2010	%	2030	%	2050	%
Total electricity generation capacity [MW]	**4,909**		**70,570**		**122,569**	
of which						
Thermal capacity [MW]	1,616	33%	1,450	2%	1,960	2%
Hydropower capacity [MW]	2,203	45%	3,900	6%	5,001	4%
Bagasse (Biomass) capacity [MW]	86	2%	500	1%	1,500	1%
Geothermal capacity [MW]	573	12%	800	1%	1,500	1%
Natural Gas capacity [MW]	431	9%	2,600	4%	5,640	5%
Total generation excluding nuclear power	**4,909**	**100%**	**9,250**	**13%**	**15,601**	**13%**
Nuclear [Number of plants]	0		1		2	

Source: EAC Vision 2050

Electricity Production Mix (Renewables incl. Hydro)

By 2050, the Regions targets to transform the energy landscape to be characterised by the following:

- 100% access to modern energy services with more 50% supplied from renewable and clean energy sources

Flagship initiatives and projects that will contribute to the realisation of the Vision 2050 include: i) Generation projects: a) Stieglers Gorge Hydropower Plant 2,100 MW (Tanzania); b) Ayago Hydropower Plant 600 MW (Uganda); c) Rusizi III Hydropower Plant 147 MW (Burundi, DRC, Rwanda); d) Rusumo-Falls Hydropower Plant 81 MW (Burundi/Tanzania/Rwanda); e) Rusizi IV Hydropower Plant 287 MW (Burundi, DRC, Rwanda); f) Karuma Hydroelectric Power Project – 600 MW (Uganda); g) Isimba Hydroelectric Power Project – 183 MW (Uganda); h) More than 2000MW from various geothermal projects; and i) More than 1440MW of natural gas powered projects.

Source: EAC Vision 2050

Access to electricity

Access to electricity [% of population]	2010	2030	2050
Urban population	28	63	94
Rural population	10	37	62

- There will be an increase in electricity production but the targets of the EAC Vision 2050 are too high.
- In terms of energy mix the following provide large scale potential:
  - Solar energy (e.g. Karamoja in case of Uganda)
  - Wind energy (e.g. Northern Kenya, Karamoja in Uganda)
  - Nuclear energy
- Promotion of energy efficiency seems important

2. Local value addition:

Discussion was based on the following quantification clue cards:

Local value addition

	2010	2030	2050
Raising local value addition [%]	8.2	40	60

Source: EAC Vision 2050

- The targets are realistic and achievable considering activities like Buy Uganda Build Uganda (BUBU)
- Implications on water: Higher water demand in the area of manufacturing etc. higher pollution of water resources.
- Baseline data is not available to determine further requirements.

3. **Industrialisation:**

Discussion was based on the following quantification clue cards:

- Participants felt that increased industrialization would take place, but could not confirm whether the rates were realistic.
- There will be an increase in
  - Mining
  - Agro-processing (e.g. sugar increase by 30%)
  - Oil & gas production
- Services:
  - Information and Communication Technologies
  - Tourism
  - Eco-tourism based and dependent on intact natural resources

Increase in industrial water consumption (e.g. Ugandan oil & gas industry is projected to consume about 44,000 m3/day in full exploitation, soft drink industry in 2017 consumes 1,600 m^3/day)
There will be an increase in cleaner production options / technologies.

Challenges and trade-offs

A further group work session focused on the discussion of major water challenges that need to be overcome in order to achieve the EAC vision 2050 concerning the industry and commercial sector. Two main challenge areas were identified including related trade-offs.

Challenge 1: Increased sectoral water demand

- Change in weather patterns causes need for irrigation
- Increased industrialization leading to more water consumption
- Urbanization due to increased industrialization
- Inefficient water usage in industries (standards/targets)

Trade-off: Conflicts due to water demand (e.g. local communities, agriculture)

Challenge 2: Industrial pollution

- Increased water pollution due to high loading of COD, BOD, toxicity (e.g. tannery, paper, beverages, soaps, milk, tea, coffee, mineral processing, oil production, etc.)
- High costs for effluent treatment
- Disposal of sludge from treatment plant
- Loss of aquatic life
- Impact on human life

Trade-offs:

- Due to high costs of treatment of effluents profit margins are reduced (polluter pays principle)
- Destroying the natural environment
- Increased water treatment for domestic use
- Decreased productivity of workers due to health related illnesses

Solutions and synergies:

In a final session the group looked at solutions which seem to be useful and realistic to address the challenges identified above.

For addressing water demand challenges:

- Demand side management (e.g. efficient irrigation techniques, cooling water efficiency etc.)
- Infrastructure expansion

For addressing pollution issues:

- Treatment of industrial wastewater
- Demand side management (minimizing polluted water)
- Regulation
- Treatment through artificial wetlands
- Tariff systems for waste water
- Sludge waste to be used as manure for agriculture
- Recycling of wastes (glass, PET etc.)
- Use of clean energy sources (natural gas instead of diesel)

Synergies:

- Environmental degradation will be minimized since people are employed by industries (e.g. brick making, charcoal burning, etc.)
- Food from agricultural sector will be used by employees from industry
- Services sector like hospital, banks, shall be enhanced
- Products from industries can be bought by the community around (e.g. sugar)
- Some industrial wastes can be used by agricultural sector (e.g. breweries)
- Energy can be produced from by-products from agro-processing (e.g. methane co-generation from bagasse)
- CSR measures like health services, schools, roads, etc.

Ideas for further research: Enhancing Capacity

The facilitator (Simon Langan) asked participants from the region what their needs and priorities were for enhancing capacity. The starting point for the discussions were a round table of opening comments, these focused on exiting projects and initiatives, impressions of gaps and needs. Out of this, the following points were raised and discussed.

- Modelling (and more general) capacity in relation to water and water resources exists.
- PROTEOS has done some work for Uganda in terms of a capacity needs assessment
- Capacity is considered to be rather fragmented across sectors and between planning and implementation organisations
- Capacity needs to go beyond technical capacity needs also in project management, operation and maintenance, quality control, quality assurance (of data and records)
- There are plans/discussions around the establishment of both a Water Management Institute (Uganda) and a Centre of Excellence for Water (LVBC).
- Is there potential for consideration and development of professional certification for individuals or organisations?
- There is a need for a mix of skills to meet any given assignment
- More needed on data management
- Further development of competencies in terms of what currently exists and what will be needed in the future
- What are the opportunities to co-learn?
- Are the biggest gaps at individual or organisational level?
- What can be done to enhance organisational

Figure 1 supplements this by a summary of the overall positives (☺) and weaknesses (☹).

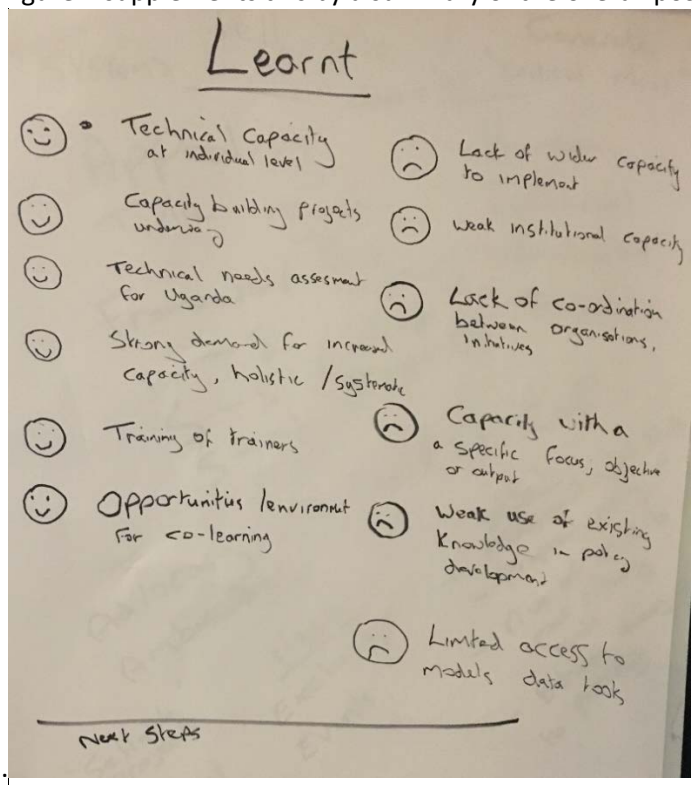


Figure 1: Summary of main points of discussion on capacity enhancement in Uganda and LVB countries

We followed this by consolidating some of the ideas to build a framework which considered: what exists; what is missing? Next Steps and beyond the end of the current phase of the work (end of 2018)? A significant number of ideas were put forward from the participants. See Table 1.

What Exists?

- Capacity within institutions, state agencies and academia
- Lots of technical capacity- mainly at individual level (@Ministries and Departments)
- Often existing capacity not well utilised (particularly in Ministries)
- UNDP support programs
- Ongoing research to establish capacity needs (Uganda) by 2018
- Different NGO's supporting water use
- Limited capacity in modelling mostly focussed in NBI, LVBC, Govt. bodies)
- Limited capacity in data and information management
- Various projects like Eurecca aiming at doing training/trainers of trainers (3 watersheds in Uganda)
- The Northern Corridor Information Project (NCIP) is conducting skills gap audit in the region with a view to selecting 8 follow on projects

What is Missing?

- Appreciation of science in decision making
- Information packaging for easy access to data and information
- Capacity to produce information products for the public, other sectors etc.
- Modelling courses/programs at university level/Centres of excellence
- Limited access to tools e.g. modelling tools, equipment, high processing computers
- Limited access to data e.g. climate change data from IPCC
- Mechanisms to guarantee institutional memory
- Broad view on capacities to include management, communication….
- Harmonisation of models among the different players
- Lack of data to compare notes for future projections
- Co-ordination amongst govt. institutions in sharing knowledge and skills
- Currently not well documented and not aware who does what.
- Operation and maintenance of facilities after construction to ensure functionality
- Farmers to be strengthened (technical capacity building)
- Capacity in management
- Live communication and monitoring and evaluation of water related projects (to enhance skills and awareness on how to manage water resources)

Next Steps 2018

- Document modelling capacity available at national level (MWE/DWRM) and regional level (NBI, LVBC, LVEMP, GWP etc.) including, capacity building program for International Water law (GWP)
- Capacity mapping within institutions in the region
- Identify the capacities
- Bring different groups together
- Harmonise data and come up with best tool
- Create awareness on EAC Vision 2050 with regard to sustainable water use
- Capacity for the use of wedge approach
- Utilise the capacities in the nations and regions fully to enhance water resources management

Next Steps beyond 2018

- Country exchange programs
- Smart Phone apps. To ease access to information
- Real time data acquisition and dissemination
- Integrate various tools and models used by institutions and governments within the region
- Develop capacity to have 'sellable' cases
- International co-operation (partnerships)
- Land tenure system should be looked into as it hinders project implementation- through calls for compensation and eventually affects implementation
- Build more capacity thru:
  -summer schools
  - Coaching and mentoring
  - support to water resources institute
  -Online courses
- Develop catchment management plan as focus for capacity building across different sectors and organisations

TABLE 1: Participant input on existing and future needs of capacity enhancement in Uganda and LVB countries

Potential actions and way forward

Arising from this are the key points to frame a) What can be done in 2018 and b) what could form the core of a proposal(s) beyond 2018 (see Table 2). In reporting this back at plenary to all participants in the workshop the following points were made:

- In 2018, under the existing project, are there further opportunities for exchange program(s) and/or events such as this?
- Are there other opportunities to consider exchanges- North to South; South to South and South to North as skills and experiences differ and which may benefit others.
- In the medium term (beyond 2018), there was a need to generate a proposal that was 'sellable' in terms of impact. This might be considered to be a mix of skills to meet differing needs and at the interface between theory and practice.
- Enhancing capacity needs to be considered in the widest terms: human, financial and in terms of infrastructure.
- A proposal to enhance capacity was vital to slow the 'brain drain' particularly from government organisations and ministries to private sector and international organisations.
- A key outcome from a successful proposal and project would be to generate a self sustaining 'critical-mass' of individual and organisational capacity in the region.
- That the proposal and work should connect and relate strongly to needs raised in the other focus groups (for example under scenario development it was suggested there is a need to build capacity on scenario development. The cross connections with the potential establishment of the planned LVBC centre of excellence on IWRM, Uganda Water Resources Institute and the need to build and strengthen partnerships within and across countries in the region both academically and in terms of water management.

Next Steps

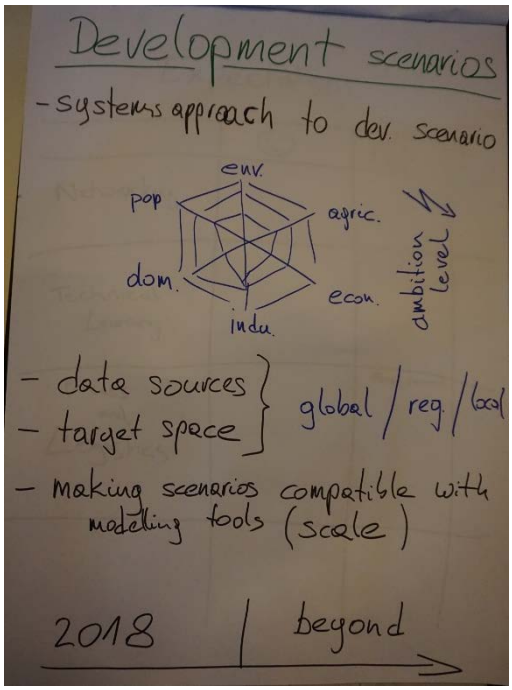
At the end of the discussion it was agreed that once the report was produced of the workshop. Organisations and individuals from the region would review and identify potential champions to develop a proposal.

Ideas for further research: Development of Scenarios

The caller (Clarissa Mulders) proposed the following research collaboration project for discussion with workshop participants.

Project title: Advancing water resources relevant development scenarios to 2050 for the East Africa Community countries.

The project idea:



Background and need: There are considerable activities being undertaken in the East African Community and its member countries which use hydrological and hydro-economic modeling for understanding and addressing challenges and opportunities in regard to mid- to long term water resources management and planning (e.g. Development of the National Water Resources Strategy for Uganda based on the Nile Decisions Support System, Strategic water resources analysis undertaken by NBI etc. - see presentations done on day 1). Most of the current modeling efforts undertaken in the region understand development scenarios as building block components. Ambitions in development of the domestic water sector, water for industrial development including the energy and mining sector, water for agriculture, water for the environment etc. are handled as rather isolated components of water users. Models are used to simulate the implications on water resources under different combinations of these building blocks (components of water users) and essentially inform on the implications on the water balance if these building blocks are being implemented according to various development visions (national, regional and basin wide development visions).

Discussions on day 2 of the workshop revealed that there is a systemic interrelation between these building blocks and components of water users which highly depend on socio-economic drivers. E.g. the future pattern of population growth, which is the main driver for future water demand, is highly dependent on per capita GDP and education opportunities for the population. This again has effects on future food demands and food production capacities (i.e. yields) which determine agricultural water use.

Aim & objective: Advance a systems approach for development scenarios relevant for mid- to long term water management and planning.

What can be done within 2018?

- Establish preliminary development scenarios affecting and affected by water resources:
    - Quantifying of main drivers at EAC level (baseline and vision targets for each sector / water user).
    - Framing the data requirements based on key drivers
    - Exploiting existing work/documents at EAC level (e.g. East Africa Centre for Renewable Energy and Energy Efficiency)

    - Triangulation with country data
    - Identify key institutions and persons which can provide required information
    - Identifying gaps
- Quick analysis of 2050 water availability and demand based on preliminary scenario at regional scale
- Resource mobilization for further follow-up work beyond 2018 (see some building blocks below)

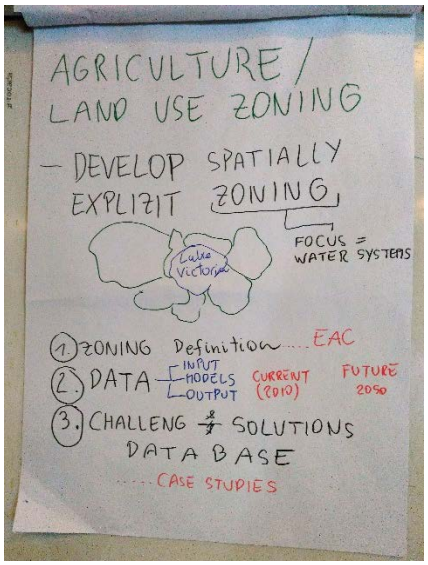
Issues for a project proposal beyond 2018:

- Refine targets and solution options regionally and per country based on further document studies and interaction with stakeholders from the region.
- Up-scaling from 2018 scenario work: Collection and analysis of further data (primary and secondary), groundtruthing where necessary
- Capacity building on scenario development
- Linking science to policy: How to convey scenario analysis?
- Refining partnerships, participation, ownership, trust building among academia, LVBC, NBI, and LVBC member countries for effective collaboration.
- Contributing to the planned LVBC centre of excellence on IWRM, Uganda Water Resources Institute etc.

Ideas for further research: Water in Agriculture

The caller (Sylvia Tramberend) proposed the following research collaboration project for discussion with workshop participants.
Project Title: **East Africa Land Use - Agriculture – Water Zoning** (EA-LAW Zoning)
Background / Need: Day 1 & 2 revealed that for achieving a water secure East Africa there is a need for harmonized land use planning including agricultural development and sustainable water management. The hypothesis is that to achieve the overall vision of increasing agricultural production and thereby agriculture (and land use) contributing to economic development, development pathways will differ for each EA-LAW Zone. The study aims to develop EA-LAW zones, which help to identify different pathways towards achieving the regions stated development plans.
Aims & objectives: Develop spatially explicit EA-LAW Zoning in support of rational land use, water resources and agricultural development planning. The project includes three distinct research objectives:

1. Develop conceptual framework and definition for Zoning approach
2. Compile data for each zone describing variables defined in the zoning definition. First, data arcompiled for the current situation. Second, for selected scenarios and EA-LAW Zones development pathways until 2050 will highlight challenges and potential solutions towards achieving sustainable growth in agriculture.
3. Compile a case study database on current successful response strategies in East Africa to agriculture – water – environment systems. Link each case study to an EA-LAW Zone.



Discussion with workshop participants (.....)
Workshop participants generally endorsed the idea of regional zoning and reported of existing zoning studies and information at the national level. Examples include

i) Uganda: 9 ecological zones and plans for 5 priority crops (maize, cassava, beans, coffee, rice); Catchment water management zones exist
ii) Kenya: ecological zones for 47 counties; 6 river basins
iii) Rwanda: Zoning exists; For agricultural areas catchment protection zones were constructed
iv) Burundi: In the context of the Lake Victoria Environmental Management project buffer zones along water bodies were defined, farmers relocated and trees planted.

Moreover, in many areas the legal land use system foresees buffer zones along water bodies. However, often these buffer zones cannot be enforced.
Most of the discussion focused on the definition of an EA-LAW Zone and its potential use for policy making and identifying solution pathways. Discussions converged on defining an EA-LAW Zone as a combination of

i) *biophysical* information including land quality (climate, soil, terrain), land use, water resources (watersheds)

ii) *socio-economic-cultural* information including population, history of land use, farming system (commercial versus subsistence, food crops versus cash crops, rain-fed versus irrigated, livestock only, livestock – crops mixes,....), access to resources (irrigation, land tenure,....). The zoning should also include industrial activities and urban built-up land.

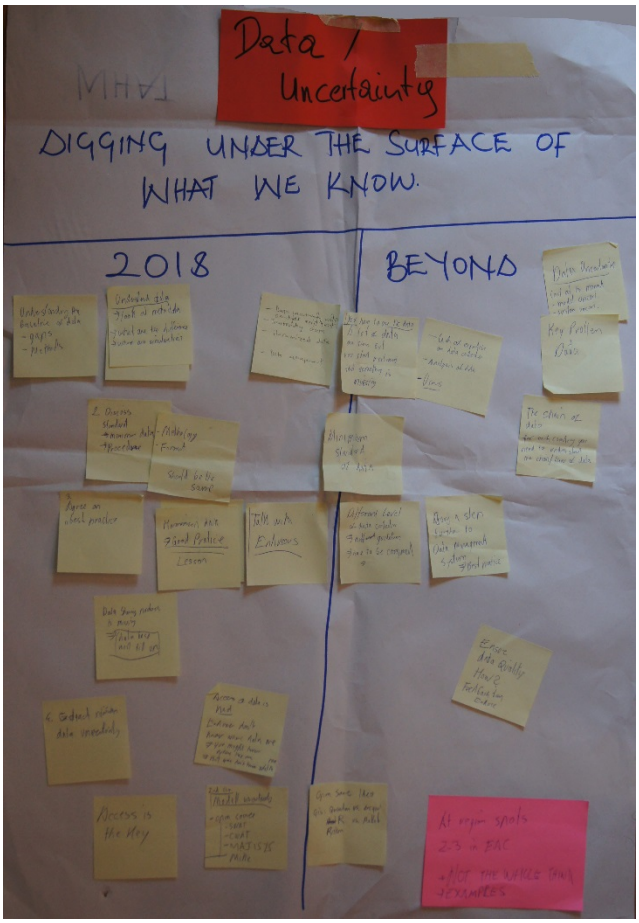
Other input: For Uganda in 2008 a project has been completed on Food Security and Water (Nebert Wobuzobozi))

Ideas for further research: Uncertainties and data

The caller (Peter Burek) proposed the following research collaboration project for discussion with workshop participants.

Project Title:
Improving data accessibility and harmonization at the example of a few pilot regions

Background / Need:
Day 1 and 2 revealed that some of the major challenges for the East African region are the changing climate, changing land use and the development of water quality. One of the important corner pillars to build up decision support systems and planning tools are ground based data on climate and water. There are a lot of activities ongoing to collect and archive data in the East African Community, either by the countries itself or by cross-country institutions (e.g. NBI, LVBC). Nevertheless the participants agreed that there are still gaps like paucity of data, inhomogeneous and uncertain data, not harmonized data across regions and countries and existing data are not accessible. This cannot be solve for EAC at once. But a smaller step would be to look at these problem at pilot location in different countries.



Project idea:
In 2-4 regions, initialized by local-regional institutes (e.g. master students or PhD students collect all available metadata and data on water, climate change, land-use change). Does not have to be transboundary data. Expertise from end-users of data are needed (e.g. modellers, practitioners)
For example:
Climate data: ICPAC, IIASA, Makerere University, Climate centre Dar es Salaam
Land use data: (e.g. population, urbanization scenarios from EAC, IIASA)
Water quantity and water quality (NBI, LVBC)

The workshop participants worked on steps to reach the project goal:

Step 1: Understand data in each region:
- Look at the metadata
- Where are gaps
- What are the methods are data gathering, storing, sharing
- What is the chain /flow of data

- What are the uncertainties in the data
- Understand where are the end users of this data, what they need this data for, how they use it

Compare the data from the regions:
- What are the differences / the similarities in the metadata / data
- What is the difference in uncertainty, gaps
- What are the differences in collecting the data, analysing the data

Step 2: Discuss different approaches, standards, formats
- Compare data from different regions
- Compare methods, procedures, data monitoring programs, chain of data ,

Step 3: Agree on "Best practice" (or disagree and have different ways)
- Talk with end users about their needs
- Agree / disagree on best practice
- Harmonize metadata /data
- Define a "minimum" standard
- Look at data sharing methods
- Look at data management systems
- Ensure data quality (by feedback from end users)

Result:
- Report on "best practice"
- Advice on data sharing protocols / procedures
- Overview who is holding data and what data (one metadata catalogue for 3 different regions in 3 different countries)

Step 4: Improve accessibility
Access is the key! Use open source tools (R, OpenGis, SWAT, CWATM, MAJISYS)
Result:
Show good practice of data harmonization and accessibility for the regions