nexus trade-offs and strategies for addressing

# the water, agriculture and energy security nexus in Africa

The Infrastructure Consortium for Africa

IUCN

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nexus trade-offs and strategies for addressing

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# Executive Summary

The "Nexus", as understood in the context of this document, can be defined as the place where water, energy and agricultural security intersect. At its heart is a strong understanding of the interdependencies between these three systems. As a concept, the Nexus is being promoted as a process for allocating and using resources to ensure water, energy and food security for an ever-growing population at a time of climate change, land use transformation, economic diversification and the need to make development pay.

The study reported below was commissioned by the International Water Association on behalf of the Infrastructure Consortium for Africa. The International Union for Conservation Nature were also a partner in development of the study. It was originally intended to apply a structured analytical process to Africa's Volta and Lake Victoria basins and using this information i) provide an overview of selected regional challenges and opportunities for multipurpose (water infrastructure); and based on that ii) to design a Rapid Assessment Framework with which to assess how current and upcoming infrastructure projects deal with nexus challenges.

A major element of the analytical process comprised an extensive review of the "Nexus" literature. The review itself suggested that a suitable point of departure for the study would be an acknowledgement that the Nexus itself can be thought of as a response to perceptions of insecurity on the part of various classes of stakeholders. In order to take this idea forward, the study posits four stakeholder classes as follows:

State Entities, which are concerned about:

- secure factors of production and output markets in order to maintain economic growth and in the case of Africa, to catalyse socio-economic transformation;
- securing peace and stability in order to avoid military confrontation;

Populations, which are concerned about:

- secure family lifestyles in terms of shelter (homes and warmth), water supply and sanitation;
- income security based on a choice of sustainable livelihoods and equitable and reliable access to the means of production.

The Private Sector, which is concerned about:

- secure access to the factors of production;
- secure markets and opportunities.

The Environment, managers of which are concerned about:

- secure biodiversity, as a result of sustainable habitats;
- sustainable ecosystem services.

A key assumption at this point of the study was that the nexus provides an approach by which to broker a suite of trade-offs, compromises and synergies that increase the security of its three elements when defined as follows:

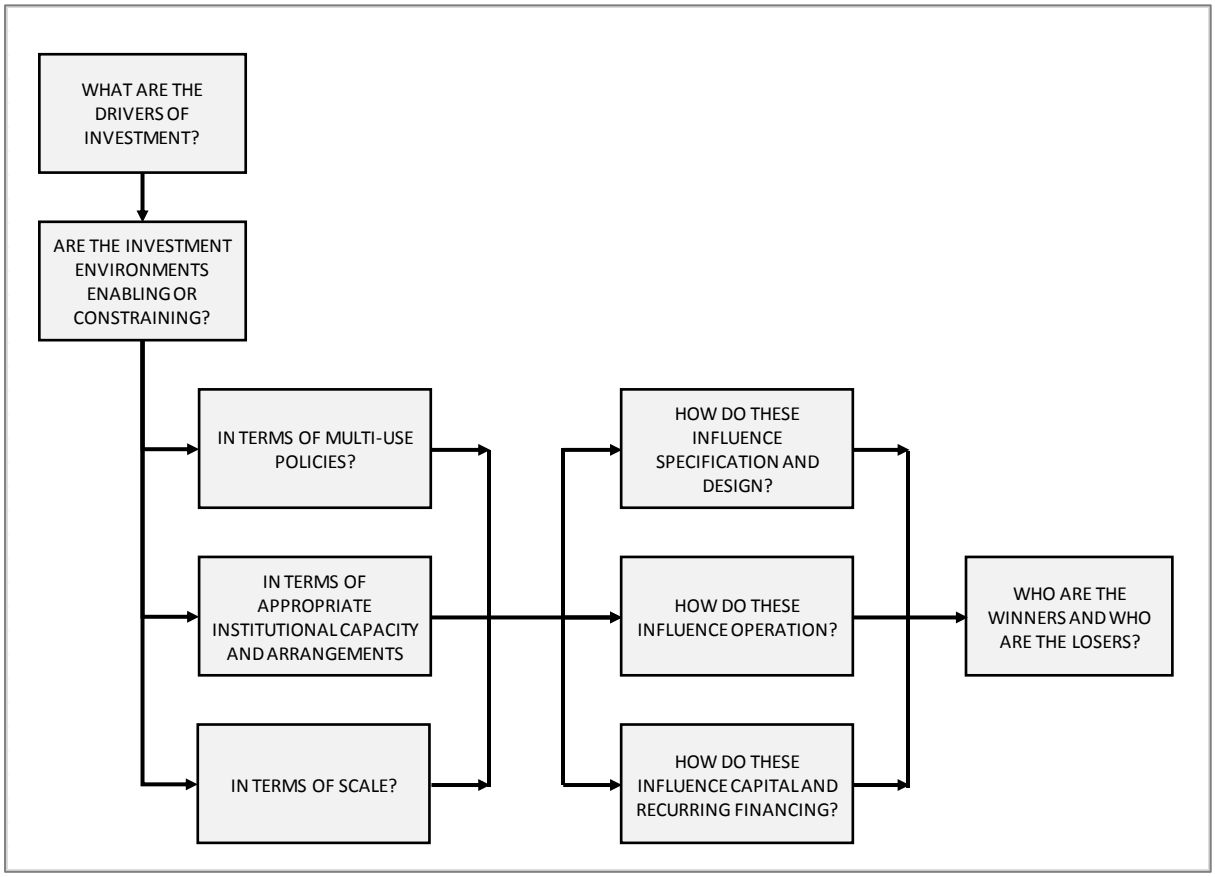
Water Security: is "the availability of and access to sufficient water for human and ecosystem use."

Agricultural security: is "the availability of affordable agricultural commodities necessary for healthy, productive lives and profitable agricultural value chains."

Energy security: is "access to clean, reliable and affordable energy for cooking, heating, lighting, communications and productive uses."

In keeping with the objectives of the study and notwithstanding the fact that a nexus approach could involve political or institutional initiatives (and as such is not limited to infrastructure), a range of possible infrastructural measures was compiled for each nexus sector and assessed with respect to the security expectations of the stakeholder classes. This provided an intervention and impact typology which identified the winners and losers for each measure while suggesting analytical frameworks for a literature review and for a questionnaire survey of key stakeholders involving both institutional representatives and individual experts.

However, the literature review and stakeholder survey were not the only components of the research phase of the project which actually began with a brief overview of the two target basins and of selected case studies. These confirmed i) that perceptions of water, agricultural and energy insecurity is increasing in both basins; and ii) that nexus opportunities for fixing this remain very much under addressed.




The framework used for the literature review itself, was as shown in the figure above. It was applied to a wide range of sources which included learned papers; project reports; professional journals; institutional records web sites etc.

Seven case studies were then reviewed. Four of them revisited cases presented and discussed during the African Nexus Conference in May 2013, and three were suggested by the Consultant and focus on the Blue Nile, the Volta and Zambezi rivers.

A stakeholder consultation questionnaire was developed and sent out to some 29 institutional stakeholders and 41 individual experts. It had 3 sections. The first simply provides details of a respondent's work and affiliation. The second captures the kind of nexus challenges faced by the respondent and his/her institution (where appropriate). The third section deals with specific examples of water sector infrastructure of which three classes were assumed: i) in progress; ii) under appraisal or iii) infrastructure for which a need has been identified, but no actual infrastructure specified as yet. For each of these, the questionnaire then captures general details about the infrastructure and its expected impact before asking about the selection process; the selection criteria; the financing modalities for both capital and recurring costs and finally the functionality.

Although only around 17% of those invited to participate in the survey actually did so, their responses were highly consistent both with each other and with a perspective suggesting that solutions to pernicious institutional and policy problems must be found before a nexus approach can be mainstreamed. The research revealed or confirmed that although perceptions of water, agriculture and energy insecurity lie behind most – if not all – searches for a nexus solution, of the three, water can be thought of as being the most cross cutting nexus element and hence that water sector infrastructure (both engineered and natural) provides the best opportunities for multi-functionality. Also, scale is a crucial nexus determinant which transcends IWRM's need for hydrological boundaries.

From an institutional perspective, political choices for addressing nexus challenges are limited without suitable multi-purpose infrastructure. And this problem is exacerbated by persistent silo thinking on the part of regional authorities, national authorities and their development partners. As a result, copious dialogue and analysis has yet to convert concepts and philosophies into multi-function infrastructural investments or operations. The combination of physical and institutional issues means that there is no "one-size-fits-all" nexus approach. This, the research showed, is problematic when development partner funding and/or policy cycles lag behind promising reforms at the national level.

The wide ranging factors contributing to these conclusions can be conveniently clustered into the following themes:

Silos and Linear Thinking: which is encountered both within and across national or regional boundaries and even within the walls of heavily departmentalised institutions, including Development Partners - remains a significant obstacle against the kind of lateral thinking needed to identify and promote nexus style solutions. Agricultural policies for instance continue to be drafted in isolation of water policies and vice versa while institutions with higher level objectives in common (such as food economic growth or socio-economic transformation) fail to cooperate, and instead compete for resources, both financial and natural.

This has three implications, and they are related:

- Single solutions to multiple problems remain elusive.
- Efforts to solve watershed problems are usually limited to watershed solutions. But this may already be impossible in some cases and will almost certainly become impossible in many more.
- Although value chains for water and energy increase the unit productivity of both while increasing employment opportunities in the problemshed, mono-linear planning and poor institutional coordination at the policy and planning level continues to constrain nexus style thinking.

Political Economy: whereby the underlying problem here is that a typical politician is unlikely to expend scarce and hard-won political capital that will make him or her unpopular in the short term in order to make someone else look good in the long term! As with silos and linear thinking, this also has implications:

- Politicians and planners that could work together towards common solutions to their problems avoid relinquishing control over limited budgets and resources.
- In addition to the well described concepts of economic and physical water scarcity, the rejection of productive comparative advantage in favour of political economy introduces a third manifestation of scarcity: namely political scarcity

Which is best? Trade-off, compromise or synergy: about which the stakeholder consultation suggested that in the absence of a paradigm shift in the way that politicians and planners think, compromise will remain a distant, unfulfilled dream. Yet were it not for the need for political capital, compromise between politically cheap mantras about agricultural self-sufficiency and politically expensive but economically advantageous agricultural sector makeovers involving a shift towards comparative advantage might actually represent the low hanging fruit in terms of total factor productivity; regional solutions to local problems and socio-economic transformation. But as explained in the text, compromise may be perceived as being politically hazardous.

Donor Drag, which is manifested in three ways:

- According to stakeholders, the policy cycles of various donors and development finance institutions either lag behind the promulgation of promising new policy frameworks in client countries or fail to adapt to them.
- Donors and/or development finance institutions operating in a particular country sometimes have incompatible and even opposing objectives.
- Finally, it is sometimes the case that donors and development finance institutions are unable or fail to adapt their philosophical products to the challenges and opportunities of real life: tending instead to stick with a "one size fits all" approach.

## Watersheds and 'Problemsheds'

The term "Problemshed" is being increasingly used among water management professionals. It refers to the possibility that problems accruing to the management, availability or productivity of water within a catchment might be solved outside of the catchment or in a non-water sector. The broader conceptual realm in which such solutions can be found is the "problemshed". Three examples might help clarify this:

- If a water scarce country imports irrigated produce from a wetter location, that location is part of the problemshed; or
- Where a value chain increases the productivity of water and virtual land sizes within a catchment by responding to demand (and indeed investment from) elsewhere, that demand is in the "problemshed"; and,
- Where pressure on land and water resources is relieved by non-water dependent livelihoods, even within the same catchment, these new livelihoods fall within the "problemshed"

In other words, the problemshed is the realm within which location specific water related problems can be solved in a non or indirectly watery way.

According to the Terms of Reference, this study has two deliverables. One is this document itself, the other is a Rapid Assessment Framework (RAF) intended to assess how current and upcoming infrastructure projects adequately deal with nexus challenges in the Lake Victoria and Volta River Basins. In particular, the RAF should i) provide general information about current and future investments in infrastructure; and ii) include a suite of criteria capturing financing, costs and benefits, policies, benefits and trade-offs. Clearly, in order to be "rapid" such a framework should be simple to use; but if it is also to be of optimal utility, certain elements could also be used as the basis for multi-criteria analysis (MCA) or comparison with alternatives or other examples. Accordingly, the proposed RAF provides users with a simple fiche setting out summary details of the infrastructure and its geo-political context along with a weighted scoring system capturing its expected performance, benefits and trade-offs – see below. The weighting factors are basin/region specific, and should be fixed by stakeholders prior to any MCA.

# Project Profile

| **Topic Cluster** *(from the ToR)* | **Question** | **Response** |
|---|---|---|
| ***geography and politics*** | **Where is the infrastructure?** | Lesotho |
| | **What is the development status of the country in terms of:** | |
| | political system and stability? | Functional democracy, disrupted from time to time by political turf wars and protectionism |
| | level of development? | Low to moderate, but with certain advanced elements such as state of the art resettlement modalities (where needed) |
| | economic development trajectory? | Sub-optimal, not well defined and heavily constrained by silo thinking and political economy |
| | main economic sector? | Agriculture, livestock, manufacturing, mining and remittance incomes (largely from miners in South Africa) |
| | **What is the natural resource endowment of the country in relation to:** | |
| | water? | Large quantities of unallocated renewable water resources |
| | agricultural potential? | Vast and undeveloped, at least in terms of non-traditional crops and value chain inputs |
| | energy? | Considerable undeveloped potential in terms of both hydropower and bioenergy |
| ***general information*** | **What kind of infrastructure is it/will it be?** | A combination of natural and built infrastructure increasing bulk water supply and contributing to a value chain approach to catchment restoration, management and productivity |
| | **What sectors does/will the infrastructure serve and how:** | |
| | water? | Increased supply of water for households, industry, agriculture and transboundary trade |
| | agriculture? | The investment will increase the availability of water for small-scale, high value crop production, including irrigated fodder to take the strain off natural grazing areas |
| | energy? | By increasing the supply of water for hydropower, and by mobilising the considerable bioenergy potential in the country's agriculture and rangeland management sectors |
| | **What were/are the drivers of investment?** | Economic growth, socio-economic transformation driven by catchment restoration and management, and investments in non-traditional value chains |
| | **What were/will be the attributable costs in terms of:** | |
| | finance and economics? | Currently unallocated budget of €78 mill in grant aid, and up to approximately € 300 mill in soft development bank loans |
| | social issues? | Small and highly localised if any |
| | the environment? | Small and highly localised if any |
| | **What are/will be the attributable benefits in terms of:** | |
| | finance and economics? | Yet to be determined |
| | social issues? | Increased and diversified livelihoods, especially in the rural areas |
| | the environment? | Urgently needed, major benefits by securing the sustainability and productivity of the Southern Africa water tower |
| | **What were/will be the sources of finance** | European Union grant aid and leveraged European Investment Bank soft loans |

## Multi-Criteria Analysis

| Topic Cluster (from ToR) | Question | Response | Score -1 0 +1 | Weight | Result |
|---|---|---|---|---|---|
| ***policies and institutions*** | **Was or will the investment be enabled or constrained in terms of:** | | | | |
| | multi-use policies | Enabled as a result of the proposed demand driven, district level disbursements proposed will avoid the problems of silo thinking and limited multi-purpose investment appraisal capacity that is typically characteristic of many ministries at the central level | 1 | 0.75 | **0.75** |
| | appropriate institutional capacity and arrangements? | Enabled because of the decentralised approach, which includes comprehensive capacity building | 1 | 1.20 | **1.20** |
| | scale? | The programme is multi-scale as opposed to scale defined | 1 | 1.50 | **1.50** |
| | **How did or will these factors influence:** | | | | |
| | specification and design? | Not significantly because of the heterogeneity of the programme | 0 | 0.50 | **-** |
| | operations? | Potentially beneficially because of the decentralised approach | 1 | 1.00 | **1.00** |
| | capital financing? | Favourably because of the ability of the grant support to lever and indeed soften the loan financing | 1 | 1.50 | **1.50** |
| | operational financing? | Too soon to tell | 0 | 1.50 | **-** |
| ***benefits and trade offs*** | **What is the actual or target cost/benefit ratio** | nominal > 1.0 | 1 | 0.50 | **0.50** |
| | **Who are or will be the winners and losers?** | | | | |
| | state entities? | Depends on the amounts of political capital that is willingly expended, there may be some losers | 0 | 1.50 | **-** |
| | populations? | Increased, diversified livelihood opportunities | 1 | 1.50 | **1.50** |
| | the private sector? | Potential winners, but this depends on response to new opportunities and the appetite of potential investors and any significant benefits are only assumptions at this stage | 0 | 1.00 | **-** |
| | the environment? | In macro terms, the environment is the principal beneficiary | 1 | 1.50 | **1.50** |
| | | | | **Total Score** | **9.45** |

As the research clearly showed, any talk of radical multi-purpose infrastructure intended to establish water, agriculture and energy security would be significantly premature and risk-laden in absence of prior reform at the policy and institutional levels. In accordance with the Terms of Reference requirement that a suite of high priority responses should emerge from the research, three were found to be of immediate concern. The following table lists them, along with options to address them, their relevant themes and associated challenges.

| Priorities | Options | Relevant Themes | Associated Challenges |
|---|---|---|---|
| **Institutional Problems** | | | |
| A range of institutional issues constrain the mainstreaming or achievement of trade-offs, compromises or synergies as a means by which to resolve competition between the three nexus elements.<br>• These issues include: institutional and policy silos;<br>• national and development partner institutional arrangements that do not favour integrated thinking;<br>• limited technical capacity, especially with respect to lateral thinking;<br>• slow institutional evolution;<br>• rigid development plans and associated milestones that are unable to adapt to new policy frameworks;<br>• the fact that even the best economic or technical approaches may be inadequate to fix problems of political economy; and<br>• power relationships (between national institutions and transboundary interests) that are unlikely to be softened in the short to medium term. | Institutions, including development partners need common objectives, and new metrics such as the economic efficiency of water or power use. | **silo and linear thinking** | Institutions might resist the introduction of common objectives and metrics as a result of perceived reputation risks, especially with respect to "non-traditional" business. An example would be an institution that is used to being monitored on the basis of say, how much irrigation infrastructure it has constructed being evaluated on the quality of the service it provides with that infrastructure. Thus instead of metrics such as irrigated commands areas, the agricultural productivity, or impact on rural livelihoods would be more relevant. |
| | Policy makers and planners need capacity building that goes beyond their day-to-day remits. This includes a new type of capacity building, including curricula at single subject university need massive diversification | **silo and linear thinking** | Expert professionals in one particular field are likely to resist being seen/perceived, or even failing as "amateurs" in another. |
| | Improve employment packages at public institutions | **political economy** | Improved employment packages will be perceived as being unaffordable, but if implemented could mitigate the challenge immediately above. There is also a risk that political economy will constrain options for enforcing improved service cost recovery or tariff based cross-sectoral subsidies. |
| | Acknowledge importance of scale and go for decentralised planning and implementations | **political economy** | Smaller scales, decentralised approaches may reduce budgets and influence and hence may be resisted by large incumbencies. |
| | | **donor drag** | Although scale advantages might be consistent with donor policy, they might be questioned if they reduce disbursement flow rates. |
| | Enforce regulations and cost recovery mechanisms | **political economy** | Politicians are tempted to see political advantage if they reduce fiscal and/or increased operational demands on their electorate |
| | Look for compromise | **political economy** | Planners may not see any advantage in the yielding of influence implicit in a compromised based solution, even if they understand the rationale involved |

| Priorities | Options | Relevant Themes | Associated Challenges |
|---|---|---|---|
| | Establish well regulated market mechanisms that allocate costs and benefits while being independent of institutional palisades | **political economy** | Pricing mechanisms may (wrongly) be perceived as anti-poor, or where the private sector is powerful and influential, there may be reluctance to regulate markets. |
| **Cost/benefit sharing challenges** | | | |
| Difficulties with respect to cost and benefit sharing are in some respects self-explanatory, except to suggest that they may accrue to both silos and technical difficulties in how costs and benefits should be shared between co-developers and co-users of infrastructure. Since these are essentially institutional capacity building issues, they are partially addressed by the measures proposed for solving the institutional problems.<br>In addition however:<br>• a lack of understanding and/or political capital limits opportunities for compromise or market based solutions that would allocate costs and benefits differently and to mutual advantage; and<br>• it may well be that collateral but nonetheless (…) significant societal and environmental benefits are not acknowledged. | Build equitable value chains based on compromise | **political economy**<br>**which is best – trade-off, compromise or synergy** | Politicians might want a piece of the action, or the enabling environment might be considered too costly from a political perspective, and hence that investors cannot be attracted and or producer participation may prove difficult to finance, hence limiting the social benefits (but not catastrophically so) |
| | Market based approaches | **as above** | As above |
| | Regional solutions to local problems | **political economy** | Which is best – trade-off, compromise or synergy |
| | Institutions, including development partners need common objectives, and new metrics such as the economic efficiency of water or power use | **political economy** | As above. |
| | Acknowledge importance of scale and go for decentralised planning and implementation | **political economy** | As above. |
| | Cross sector financing (tariffs from one sector support development in another) | **silo and linear thinking** | This might be perceived as an erosion of revenues |
| | Understand the benefits<br>Look for the compromise | **which is best – trade-off, compromise or synergy** | With adequate capacity building there should not be any major challenge. |
| | Reduce competition for finances, increase service cost recovery | **political economy** | Although competition for financial resources would be reduced by increased revenues, there would be a political price to be paid (see above) and institutions/departments with increased revenues may want to keep them in their entirety. |

| Priorities | Options | Relevant Themes | Associated Challenges |
|---|---|---|---|
| | Natural infrastructure, not concrete monuments | **political economy** | Natural infrastructure does not produce concrete "monuments" and may require cooperation institutions or departments (in the case of development partners) that have hitherto not cooperated or that have sector specific budgets and objectives. |
| **Transboundary disagreements** | | | |
| This again and at first sight, is largely self-explanatory: there are geopolitical ramifications to transboundary infrastructure and powerful countries will tend to win out over weaker riparians: or, territorial turf wars at the national level may compromise transboundary agreements that favour one institution over another. In addition however, such problems are exacerbated by:<br>• inabilities to craft regional solutions to local problems that, by mobilising comparative productive advantage invest water and/or energy into value chains that expand and diversify livelihoods; and<br>• ignore the transboundary benefits of simple inventions involving natural infrastructure.<br>Regional solutions to local problems and investments in natural infrastructure both have the potential to increase supplies of water and/or energy, while contributing to increases in the economic efficiency of both. | Natural as well as built infrastructure | **silo and linear thinking**<br>**which is best – trade-off, compromise or synergy** | As above. |
| | Regional solutions to local problems. | **silo and linear thinking**<br>**political economy** | Regional solutions to local problems may require retreats from politically cheap mantras concerning self-sufficiency in terms of agriculture and energy. There may also be perceived and indeed genuine concerns about national security. |
| | Acknowledge importance of scale and go for decentralised planning and implementations | **political economy** | As above. |
| | Self-sufficiency vs comparative advantage | **political economy** | As above re: regional solutions to local problems. |
| | Understand the benefits<br>Look for the compromise | **silo and linear thinking** | Although in this context the options would address transboundary disagreements, the associated challenges would be as above. |
| | Trade-offs should reflect economics not institutional territory. | **which is best – trade-off, compromise or synergy** | Broad based capacity building would provide the necessary skills; but data availability and consistency might present a problem as might data sharing protocols and objectives. |
| | Regional solutions to local problems | **political economy** | As above. |

The penultimate step before recommending some next steps, involved crafting basin profiles for the two target basins (Lake Victoria and Volta) based on assessments of the following:

- geography, politics, demographics and development
- water, agricultural and energy security
- current initiatives
- investment opportunities for natural and built infrastructure
- resource mobilisation.

The important point to note is that despite an encouraging degree of agricultural security overall, there are localised cases of persistent insecurity. These are expected to increase in these 2 basins due to climate change and population growth rates which are among the highest in the world. Irrigation development in the basins is small in comparison with potential; but this does not represent a quick fix, because energy demand exceeds supply in both. To solve this with hydropower might compromise the availability of water for a major increase in equipped areas; while resorting to fuel crops may have a negative impact on the area available for food production. This does, however, suggest investment opportunities in compromises that allow hydropower and irrigation to be developed on a multi-sector basis. And where the political economy of agricultural self-sufficiency is rejected in favour of total factor productivity and regional solutions to local problems, value chains benefiting from increased energy availability and supplied from higher value farming systems irrigated at levels of precision and/or loss reduction made possible by the increased energy availability will contribute to economic growth and socio-economic transformation. These opportunities are significant, but have yet to be formulated.

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# Table of Abbreviations and Acronyms

| | |
|---|---|
| **ADB** | African Development Bank |
| **AIIF** | African Infrastructure Investment Fund |
| **AMCOW** | African Ministers' Council on Water |
| **AWF** | African Water Facility |
| **BAGC** | Beira Agricultural Growth Corridor |
| **CAADP** | Comprehensive Action Plan for African Agricultural Development |
| **CRIDF** | Climate Resilient Infrastructure Development Facility |
| **DBSA** | Development Bank of South Africa |
| **DSS** | Decision Support System |
| **EAC** | East African Community |
| **EAPP** | East African Power Pool |
| **ECOWAS** | Economic Community of West African States |
| **EIB** | European Investment Bank |
| **FAO** | Food and Agriculture Organisation (of the UN) |
| **GDP** | Gross Domestic Product |
| **GWP** | Global Water Partnership |
| **ICA** | Infrastructure Consortium for Africa |
| **IFC** | International Finance Corporation |
| **IFPRI** | International Food Policy Research Institute |
| **IUCN** | International Union for Nature Conservation and Natural Resources |
| **IWA** | International Water Association |
| **IWMI** | International Water Management Institute |
| **IWRM** | Integrated Water Resources Management |
| **LVBC** | Lake Victoria Basin Commission |
| **MCA** | Multi-Criteria Analysis |
| **MW** | Megawatt |
| **NBA** | Niger Basin Authority |
| **NBI** | Nile Basin Initiative |
| **NELSAP** | Nile Equatorial Lakes Subsidiary Action Programme |
| **NEPAD** | New Economic Plan for Africa Development |
| **OECD** | Organisation for Economic Cooperation and Development |
| **ORASECOM** | Orange-Senqu River Commission |
| **PPP** | Public Private Partnership |
| **RAF** | Rapid Assessment Framework |
| **SADC** | Southern Africa Development Community |
| **SAGCOT** | Southern Agricultural Growth Corridor for Tanzania |

| | |
|---|---|
| **SAIF** | Southern Africa Infrastructure Fund |
| **SAPP** | South African Power Pool |
| **SRBDA** | Senegal River Basin Development Authority |
| **TARDA** | Tana and Athi River Development Authority |
| **VBA** | Volta Basin Authority |
| **WACDEP** | Water, Climate and Development Programme |
| **WAPP** | West African Power Pool |
| **WB** | World Bank |
| **WBCSD** | World Business Council for Sustainable Development |
| **WEF** | World Economic Forum |
| **ZAMCOM** | Zambezi Water Course Commission |

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# 1 Background and Introduction

## 1.1 Defining the Nexus

"The Nexus" can be defined as the place where water, energy and agricultural security intersect. At its heart is a robust understanding of the interdependencies between these three systems. As a concept, The Nexus is being promoted as a process[1] by which to allocate and use resources in a way that ensures water, energy and food security for an ever-growing population at a time of climate change, land use change, economic diversification and the need to make development pay. It was first suggested at the Bonn Nexus Conference in 2011 and in theory, could provide a crucial framework for sustainable development and/or economic planning across the board.

The Nexus has its problems however, and there is a vast and expanding body of literature examining them, explaining their provenance and attempting to solve them. They include: i) persistent sector silos which still constrain the identification of solutions that provide benefits for all types of stakeholder; ii) difficulties in applying essentially technocratic solutions to problems of policy or political economy; iii) a diversity of objectives; iv) elusive stakeholder agreement with respect to definitions of the most appropriate analytical boundaries which could be natural as in a river basin, or political as for instance in the case of a regional grouping like SADC or the EAC; and v) the need for greater trade-offs or compromise[2] between competing interests.

Although a brief review of these problems is unavoidable, this study focusses on the need for trade-offs, compromise and synergies with respect to the selection, financing and operation of water sector infrastructure in Africa, with special attention to the Lake Victoria and Volta River basins. Its objectives are stated in the next sub-section. But before proceeding, it would be both meaningful and useful to broaden The Nexus concept somewhat, by replacing "food", with "agriculture"[3].

This is for two reasons. First, there are at least two structural approaches to food security that have no nexus implications. These are reduction of food waste (post-harvest losses and the discarding of excess) and reformation of international terms of trade. Simplistically stated, our planet already produces enough food for everyone, but it is not getting everywhere it is needed due to perverse subsidies and other trade barriers. And if wastage could be reduced, at least some demands of a growing population could be met at current production levels. Second, there is a proven link between robust agriculture and strong economic growth – but robust agriculture includes energy and industrial crops, not just food. In addition, i) a shift towards renewables (energy and raw materials); ii) opportunities for carbon sequestration; and iii) proven and potential links between these opportunities and high agricultural value chains all point towards the need for The Nexus to accommodate agriculture as a whole.

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1 Although comparisons have been made with Integrated Water Resources Management (IWRM), The Nexus is quite different for at least four reasons. ***First,*** IWRM is only concerned with the allocation of water between competing uses. *Second,* IWRM is highly technocratic in nature and hence resides in the domain of the water managers and hence occludes key issues of policy and political economy. ***Third,*** IWRM does not address broader issues of security – as will be made clear in the text. ***Fourth,*** IWRM has tighter boundaries, i.e. river basins, than The Nexus which potentially transcends such boundaries.

2 For the purpose of this study: "trade-off" refers to a situation where one objective is sacrificed in favour of another; and "compromise" refers to a situation where a less than ideal result is accepted in order to achieve a better, common good.

3 A proposal which was suggested to and approved by the study's review team on 13th May 2015.

## 1.2 Objectives of the Study

According to the Terms of Reference, the overall Objectives of the study reported herein are as follows:

"An action oriented outlook for optimising multi-purpose water infrastructure and establishing the enabling environment to develop and implement such infrastructure."

The required outlook itself is intended to address:

"Nexus challenges, trade-offs, possible synergies and project opportunities relevant for Africa (and its regions) in general, and two selected river basins in particular."

In other words, what this study is intended to establish is a way to look at the selection, design, financing and operation of water infrastructure schemes that – by making the most of trade-offs, compromises and synergies – would reduce the conflicts of interest between the three Nexus components.

The Terms of Reference specify that the two river basins should be the Volta River Basin and the Lake Victoria Basin.

## 1.3 Study Stakeholders

Although the study has been commissioned by the International Water Association in collaboration with the International Union for the Conservation of Nature, its principle beneficiary is the Infrastructure Consortium for Africa (The ICA).

The ICA, which was launched at the 2005 G8 Summit, is intended to help improve the lives and economic wellbeing of Africa's population by encouraging, supporting and promoting increased investment in infrastructure from both public and private sources. Its role is largely catalytic and seeks accelerated and enhanced development of the continent's infrastructure. As such the ICA is not itself a financing agency but rather, it acts as a platform to catalyse donor and private sector financing of infrastructure projects and programmes in Africa.

In addition however, from a technocratic perspective the ICA helps with the removal of some of the technical and policy constraints on infrastructural investments while coordinating its members and other significant investment sources – notably (but not only) in China, India and the Arab countries.

The ICA's members include the G8 countries, South Africa as the first G20 member, the World Bank Group, the African Development Bank Group, the European Commission, the European Investment Bank and the Development Bank of Southern Africa.

It has four investment foci: water, energy, transport and information/communication technology, and hence no direct interest in agriculture sector investment. However, given i) agriculture's overwhelming demand for water; and ii) Africa's vast undeveloped agricultural potential it is clear that the ICA's water sector efforts must – *inter-alia* – be expended in favour of improved and expanded service delivery to the agriculture sector.

## 1.4 Approach Taken

The substantive work began by establishing whether or not "The Nexus" is emerging as a response to an underlying, cross cutting theme  And if so, whether or not it is meaningful to cluster stakeholders to that theme into stakeholder classes and examine what that theme means to each of them.  It quickly became clear that there is indeed an underlying theme.  It concerns security, which is a common concern of all four stakeholder classes, namely: state entities, populations, the private sector and the environment.  However, the need for and nature of security is perceived differently by each stakeholder class depending on their relationship to the three nexus elements: water, agriculture and energy.

The next step involved listing measures that could be taken to increase security with respect to each of the three nexus elements.  This allowed the various available measures to be mapped onto stakeholders' perceptions of security to see where some would be winners and others, losers, thereby resulting in an intervention typology and the possibility of an analytical framework on which to build the research.

The research itself had four elements:

- an overview of the two target basins – the Volta and Lake Victoria Basins – which was based on a combination of i) the consultant's own familiarity with them; and ii) material supplied by the client;
- stakeholder surveys using a questionnaire developed specifically for the study;
- a literature review;
- case studies of specific issues arising in seven basins, including the two target basins.

As it happened two analytical frameworks suggested themselves.  One was used to design the stakeholder questionnaires; the other was used for the purpose of the literature review and later, along with other material, as the basis of the Rapid Assessment Framework called for in the Terms of Reference.

# 2 An Intervention and Impact Typology

## 2.1 Security Expectations and the Nexus

This study is not intended to contribute yet another learned discourse to the vast body of literature that the Nexus continues to generate. Its objective after all, is an "action oriented outlook". Nonetheless the need for selective reference to the literature has been unavoidable and is covered in more detail in section 3.3 below. At this point however, it is useful to note that much of the literature suggests that The Nexus itself can be thought of as a response to perceptions[4] of insecurity on the part of various classes of stakeholder. Clearly therefore, any system intended to increase stakeholder security by mobilising trade-offs, compromise and synergies along The Nexus must be based, at least in part, on a consideration of the issues at stake.

With this in mind, four classes of stakeholder can be identified:

- State Entities, which are concerned about:
    - secure factors of production and output markets in order to maintain economic growth and in the case of Africa, to catalyse socio-economic transformation;
    - securing peace and stability in order to avoid military confrontation;
- Populations, which are concerned about:
    - secure family lifestyles in terms of shelter (homes and warmth), water supply and sanitation;
    - income security based on a choice of sustainable livelihoods and equitable and reliable access to the means of production;
- The Private Sector, which is concerned about:
    - Secure access to the factors of production;
    - Secure markets and opportunities;
- The Environment; managers of which are concerned about:
    - secure biodiversity, as a result of sustainable habitats;
    - sustainable ecosystem services.

For the purpose of this study water, agricultural and energy security are defined as follows:

- Water Security: is "the availability of and access to sufficient water for human and ecosystem use."
- Agricultural security: is "the availability of affordable agricultural commodities necessary for healthy, productive lives and profitable agricultural value chains."
- Energy security: is "access to clean, reliable and affordable energy for cooking, heating, lighting, communications and other productive uses."

Table 1 demonstrates the relationship between water, agriculture and energy security and these stakeholder security concerns.

[4] The term "perceptions" is used advisedly here because people have a tendency to look at symptoms not causes – in "development speak" this used to be described as "perceived needs versus the macro-forces". For instance nomadic pastoralists with starving, thirsty cattle may perceive the problem as poor pasture and inadequate water, whereas the real reason might simply be too many cattle. The Nexus provides a useful lens through which to look at things different – exactly as per the ToR's "..action oriented ***outlook***...".

TABLE 1 STAKEHOLDERS, OBJECTIVES, SECURITY DIMENSIONS MAPPED ONTO A NEXUS FRAMEWORK

| Stakeholder | Objectives | Security Dimension | Relative Nexus Issue Or Opportunity | | |
|---|---|---|---|---|---|
| | | | water | agriculture | energy |
| **state entities** | economic growth | secure markets and factors of production | water needs to be economically mobile (i.e. allocated as close to its opportunity cost as possible) | there is a positive correlation between a strong agricultural sector and a growing, diverse economy | expanding and diversifying economies need increasing amounts of reliable energy |
| | | | increased agricultural trade flows and hence virtual water flows make better use of local water by mobilising regional solutions to local problems | | |
| | | | water is a major building block for economic growth in a Donor Dependent Developing Country | | |
| | | | flood risk can be a major constraint on economic growth | | |
| | | | multiple use infrastructure should be the default approach rather than be planned on the basis of separate solutions for separate sectors | | |
| | | | economic growth and water security are interlinked | | |
| | socio-economic transformation | | water needs to be economically mobile within a rights based system that rewards wise use rather than punishes bad use | | |
| | | | water needs to be invested in agricultural value chains not into household self sufficiency | | |
| | sustainable commerce | | | | hydropower diverts attention away from other renewables which may have more commercial interest and potential |

| Stakeholder | Objectives | Security Dimension | Relative Nexus Issue Or Opportunity | | |
|---|---|---|---|---|---|
| | | | water | agriculture | energy |
| | | | state entities see the nexus as creating a potential market for privatised water utilities and/or Public Private Partnerships | | state entities see the nexus as a potential market for privatised and other energy providers |
| | avoidance of military confrontation | peace and stability | riparian rights needs to be honoured and the costs and benefits of transboundary water infrastructure must be shared in a mutually agreeable and transparent fashion | | the costs and benefits of transboundary energy infrastructure must be shared in a mutually agreeable and transparent fashion |
| **populations** | shelter | family and lifestyle | | affordable housing can be made from renewable materials, which themselves have high carbon sequestration characteristics | |
| | | | | | people need energy for warmth and cooking (energy security is not the same as energy for all) |
| | water supply and sanitation | | reliable and convenient access to safe water increases family health and frees up time for education and/or production | | |
| | a choice of sustainable livelihoods | income | given the African focus, agriculture will continue to underpin employment for the foreseeable future but water needs to be invested in agricultural value chains not into household self sufficiency | | high dependence on energy for sustainable livelihoods in a diversifying economy |
| | equitable access to the means of production | | given the African focus, agricultural production will need a combination of more water and better water use (in terms of both management and productivity) | | energy is needed to make the needs of production available |

| Stakeholder | Objectives | Security Dimension | Relative Nexus Issue Or Opportunity | | |
|---|---|---|---|---|---|
| | | | water | agriculture | energy |
| **the private sector** | expanding turnover and sustainable profits | access to the factors of production | water can be both a consumable input to a value chain - beer or soft drinks being examples, or unconsumed as part of the added value process such as in the washing of silicon disks. | investors in agricultural value chains need sustainable and secure supplies of raw materials in terms of both quantity and quality | investors in any kind of energy dependent enterprise will expect secure supplies of energy |
| | | markets and opportunities | investors require policies that leave room for or even catalyse approaches which maximise commercial benefits. Examples could be commercially developed wind farms instead of large public sector hydropower dams; or private water banks instead of large publicly funded reservoirs | | |
| **environment** | sustainable ecosystem services | landscape productivity | There is a considerable range of natural infrastructure solutions for increasing water availability | agriculture is the biggest cause of landscape degradation and compromised ecosystem services | carbon sequestration and bio-energy production can be part of well managed landscapes |
| | sustainable habitats | biodiversity | | agriculture is the biggest cause of biodiversity loss | |

The figure is clearly not an exhaustive treatment of the subject, but it does indicate that it will not always be possible to obtain a nexus "win-win-win" result when addressing stakeholder concerns. Nonetheless potential conflicts along the nexus do not necessarily question its potential utility; instead they suggest that the only way forward will involve various combinations of:

- Trade-offs whereby a preferred objective is traded for another
- Compromises whereby a result which is less than perfect for one or more stakeholders is accepted by all; and
- Synergies where one intervention covers multiple Nexus objectives and as such would be the way that a "win-win-win" can be achieved[5].

Note that trade-offs and compromise will always have "winners" and "losers" whereas with synergistic approaches, everyone is a winner.

The next sub-section describes measures that could be taken to achieve water, agricultural and energy security, and is followed by a sub-section that establishes a typology of the trade-offs, compromise and synergies suggested by these measure.

[5] An example might be natural infrastructure such as a manufactured wetland that increases the supply of water for crop and energy production while contributing to biodiversity and water quality.

## 2.2 Measures to Improve Water, Agricultural and Energy Security

### 2.2.1 Water

Water security – see Box 1 - can be achieved either by increasing supply or by improving demand management. As far as infrastructure is concerned available measures are described below where water for irrigation seems to dominate the discussion. But this is justified because agriculture represents by far the biggest demand.

**Box 1 – Water Security**

Water Security can be understood as being "the availability of, and access to water for human and ecosystem use": Leese and Meisch 2015

Methods to increase water security include:

- large storage dams; not involving hydropower and which are largely self-explanatory except to note that as well as storing surface water, they can also contribute to groundwater recharge and can be used to "reinstate" annual hydrographs that have already been compromised. It is also important to note that - depending on location - large dams can have transboundary implications.
- water harvesting; is often rolled out as a "soft" alternative to large dams; but although the approach brings the benefits of bulk water management closer to rural communities, it does not create new water! It is possible in fact, that a multitude of local water harvesting schemes may cause greater streamflow reduction than a single large dam[6].
- increased irrigation water use efficiency[7]; which certainly has the potential to save water, but without mechanisms to reallocate the saved water, there is a danger that physical efficiency increases are an end in themselves – which they often are to water resource departments looking to spend money. But they are not, they are merely a building block of economic efficiency. Unless savings are reallocated wisely there is a danger that the saved water is reinvested in the same location as it is saved, and hence that return flows decrease. Research carried out by IFPRI and IWMI in the 1990's and early 2000's respectively showed that this actually reduces both the amount of water available for productive and/or ecosystem uses in a basin. As a consequence, it also reduces the productivity of water at the level of the economy or of the river basin. There is also the issue that the water saved through efficient irrigation practices in one farm may end up being "wasted" by other farms. Therefore, no savings are achieved at a large scale; large irrigation areas might use efficient technology but use water from other watersheds into which savings are impractical to return.
- irrigation on demand; may seem counter-intuitive, but its water saving benefits are predicated on the demonstrable likelihood that when a farmer is convinced that water will always be available when needed, he or she is less likely to grab more than they need when it is their turn.
- longitudinal rather than transverse water allocation for irrigation; which is all about where irrigation infrastructure is located, not what it comprises. This is because irrigation schemes that expand transversely across the landscape compound the risk of loss in both the distribution and return flow (drainage) systems. In addition, when water is allocated in a longitudinal fashion, there are more opportunities for non-consumptive uses on the way.
- natural infrastructure; which uses existing, restored or installed landscape features such as watersheds, wetlands, forests and terraces to increase water availability.
- There are also the possibilities of increasing reliance on virtual water; the adoption of supplementary deficit irrigation and soil moisture management methods such as mulching and the restoration of organic content. But since these have no infrastructural implications they are beyond the scope of this study.

[6] Consider for instance, the Indian movement "not a drop shall leave our village" which seeks to use roof catchments to intercept every drop of water that falls from the sky and prevent any water from flowing downstream.

[7] Which actually needs a combination of improved distribution infrastructure, more precise irrigation equipment and capacity building in on-farm water management

**Box 2 – Agricultural Security**

Is achieved when there are adequate and sustainable supplies of agricultural commodities for industrial use and energy production without compromising all peoples' *"…physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life"*: adapted from Leese and Meisch 2015.

### 2.2.2 Agriculture

Agriculture is by far humanity's largest water consuming activity. A much cited statistic suggests that 70% of all water withdrawn from the natural system for human use goes into agriculture. That however, is misleading because a great deal of the remaining 30% returns to the natural system, where very little of the agricultural water does. It has been estimated in fact that of all the water abstracted that does not return, agriculture accounts for some 92%! It has already been explained that this study is looking at all forms of agriculture, not just food production. Box 2 suggests an appropriate definition.

A significant proportion of agricultural water demand arises from poor management. Sometimes there is an infrastructural reason for this, other times it may be inadequate farmer capacity with respect to on-farm water management which is of course beyond the scope of this study. Infrastructure needed to increase the supply of water for agriculture was considered in the preceding sub-section. Here the analysis assumes that the supply is secure and proceeds to consider infrastructural approaches for improved agricultural production, productivity and hence security

- intensification; by which is meant the ability to reduce the spatial footprint of agriculture by increasing farming system productivity. As well as farmer capacity building and improved extensions services this often requires the construction of irrigation service infrastructure.
- spatial expansion; can of course apply to rain fed as well as irrigated agriculture; but in this context it means the provision of irrigation service and unlike intensification, refers to the development of hitherto unused land.
- crop diversification; may require new or improved irrigation infrastructure and is listed here separately to intensification and spatial expansion. This is because as population growth persists; climate change becomes more intense; competition for water increases and rural/urban migration continues, it is important that water is invested in value chains, not household self-sufficiency if agriculture's contribution to economic growth and employment creation is to be maximised. Investors in value chains expect reliable supplies of quality raw materials which explains the role of irrigation infrastructure: but in addition there may also be a need for infrastructure that stores and conveys water to elsewhere in the agricultural value chain, such as a sugar factory or fruit cannery.

### 2.2.3 Energy

Unlike water for which there are only two meaningful renewable resources (green water and blue water) and one type of non-renewable source (fossil water), there are at least eight renewable energy sources (wood, hydro, wind, solar, wave, tide, bioenergy and animal power) and at least six non-renewable alternatives (peat, coal, oil, tar sands, natural gas, shale gas and nuclear – Allan *et-al* 2015). Box 3 restates the definition of energy security.

**Box 3 - Energy Security**

"Access to clean, reliable and affordable energy services for cooking and heating, lighting, communications and productive uses": Leese and Meisch 2015.

Infrastructural options include:

- large hydropower dams; which (including pumped storage) are self-explanatory except to note that modern, real time remote sensing of the water flowing towards the dam from upstream, means that a guaranteed level of power generation can be maintained without necessarily having to keep the dam as close to full supply level as possible. Not only does this free up water for other purposes, it also increases a dam's flood attenuation characteristics.
- thermal power stations; which – regardless of whether or not they are powered by fossil fuels, nuclear fuels or concentrated solar power - all need water for generation and cooling purposes.
- run-of-river schemes; which do not require large storage structures, but depending on the nature of the local topography, may divert water from one basin to another.
- mini-hydro; which may or may not require storage.
- tidal power stations; which are included here because of possible impacts on fishery[8] production by compromising the spawning runs of certain fish and the sustainability and biota of estuarine wetlands.
- Other options, but not relevant here, include bio-energy which is assumed to be included in agriculture, either in terms of crop residues or crop diversification – along with wave generators and photovoltaic installations or wind farms which do not have any implications with respect to water infrastructure.

## 2.3 A Possible Intervention and Impact Typology

Infrastructural measures to improve water, energy and agricultural security are assessed in Table 2 in terms of the need or opportunities for trade-offs, compromises or synergy between any or all of the three nexus elements: water, agriculture and energy. The same figure also considers the impact of potential nexus measures on the security concerns of the four classes of stakeholder.

The result can be thought of as an intervention and impact typology.

[8] It is assumed that fisheries are a subset of agriculture.

TABLE 2 A DRAFT INTERVENTIONS AND IMPACT TYPOLOGY FOR NEXUS WATER INFRASTRUCTURE[9]

| Measure | Trade off, compro-mise or synergy | Relevance to nexus component | | | Impact | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | State entities | | | Population | The private sector | | Environment | |
| | | | | | Comment | Security dimension | Comment | Security dimension | Comment | Security dimension | Comment | Security dimension |
| | | Water | Agriculture | Energy | | | | | | | | |
| ***Measures to increase water security*** | | | | | | | | | | | | |
| ***large storage dams*** | trade off | **winner** | potential **winner** if the water is used for irrigation, and even better if the dam increases fishery opportunities | **loser** if no power is generated, or if power is only a collateral benefit | increased water for production | positive | increased water for domestic use | positive | sustainable access to adequate quantities of water of suitable quality is a prerequisite for investment in any water dependent industry | positive | **loss of landscape and streamflow, and possible morphological problems downstream** | negative |
| | | | | | **potential threat if downstream riparian rights are not honoured, or if any transboundary costs and benefits are not properly shared** | depends on governance | increased water for production means increased and more secure livelihood | positive | | | **biodiversity threat due to possible gene pool limitations, spawning runs and disrupted terrestrial migration routes** | negative |

9

economic growth and socio economic transformation
peace and stability
family and lifestyle
income
factors of productivity
markets and opportunities
landscape productivity
biodiversity

| Measure | Trade off, compro-mise or synergy | Relevance to nexus component | | | Impact | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | State entities | | | Population | The private sector | | Environment | |
| | | | | | Comment | Security dimension | Comment | Security dimension | Comment | Security dimension | Comment | Security dimension |
| | | Water | Agriculture | Energy | | | | | | | | |
| ***water harvesting*** | trade off | **winner** | potential **winner** if the water is used for irrigation | **loser** as bulk water opportunities are foregone | increased water for production | **positive** | increased water for domestic use | **positive** | | | could increase landscape productivity | **positive** |
| | | | | | | | increased water for production means increased and more secure livelihoods | **positive** | | | **but equally, could reduce streamflow** | **negative** |
| | | | | | | | | | | | could provide a habitat benefit | **positive** |
| ***increased irrigation efficiency*** | trade off or synergy | **winner**, but only if saved water is reallocated wisely (i.e. longitudinally not transversely) | potential **winner** if the saved water is used for irrigation, and if the more efficient use of water leads to yield increases and improved uniformity of distribution | **loser** because increased precision needs more energy (trade off), but potential **winner** if the saved water is reallocated via hydropower installations (synergy) | increased water for production | **positive** | increased water for domestic use | **positive** | if increased energy efficiency increases the reliability of supply, energy dependent commercial entities will benefit; but only if the costs of their own efficiency increases do not compromise profits | potentially **positive** | if saved water is reallocated wisely stream flows will increase and riverine/wetland habits will thrive (subject to water quality issues) | **positive** |
| | | | | | possible increase in transboundary flows | **positive** | increased water for production means increased and more secure livelihoods | **positive** | | | | **positive** |

| Measure | Trade off, compro-mise or synergy | Relevance to nexus component | | | Impact | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | State entities | | | Population | The private sector | | Environment | |
| | | | | | Comment | Security dimension | Comment | Security dimension | Comment | Security dimension | Comment | Security dimension |
| | | Water | Agriculture | Energy | | | | | | | | |
| ***irrigation on demand*** | trade off | **winner**, because withdrawals for irrigation will be minimised | potential **winner** because more water is available for irrigation expansion and every farmer gets the water he or she needs and has independent choice of farming system | **loser**, because irrigation on demand needs more energy | increased water for production | **positive** | increased water for domestic use | **positive** | "irrigation on demand" is another way of saying water security to any agribusiness dependent on irrigation directly or indirectly | **positive** | | **positive** |
| | | | | | possible increase in transboundary flows | **positive** | increased water for production means increased and more secure livelihoods, and for the irrigating farmers, there is more control over farming system choices | **positive** | | | | **positive** |
| ***longitudinal water allocation*** | trade off | **winner**, because distribution losses will be reduced and more water will remain available for non-consumptive uses in-stream | **loser**, because irrigation development potential will be sacrificed | potential **winner**, because more water will be available for energy generation | depends on the trade-off weighting between water and agriculture | neutral to positive | increased water for domestic use | **positive** | increases water availability for industrial parks/areas in or adjacent to urban areas that have developed around rivers | **positive** | reduced landscape change but not increase in productivity | neutral |
| | | | | | significant possibility of increased transboundary flows | **positive** | depends on trade-off weighting between water and agriculture | neutral to positive | | | stream flows maintained | **positive** |

| Measure | Trade off, compro-mise or synergy | Relevance to nexus component | | | Impact | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | State entities | | | Population | The private sector | | Environment | |
| | | | | | Comment | Security dimension | Comment | Security dimension | Comment | Security dimension | Comment | Security dimension |
| | | Water | Agriculture | Energy | | | | | | | | |
| ***natural infrastructure*** | synergy | **winner**, because supply of water is increased | **winner**, because there is more water available for agriculture, including fisheries | potential **winner** because - depending on local hydrology, there may be more water for energy production | increased water for production | **positive** | increased water for domestic use | **positive** | sustainable access to adequate quantities of water of suitable quality is a prerequisite for investment in any water dependent industry | **positive** | possible increase in landscape productivity | **positive** |
| | | | | | possible increase in transboundary flows | **positive** | increased water for production means increased and more secure livelihoods | **positive** | | | possible habitat enhancement and new habitats such as manufactured wetlands | **positive** |
| ***Measures to increase agricultural security*** | | | | | | | | | | | | |
| ***intensification*** | trade off | **loser**, because agricultural intensification usually involves irrigation | **winner** | potentially a **loser**, because there is less water for energy production, although a net gain in biomass may offset this somewhat | intensification could lead to export possibilities and investment in value added | potentially **positive** | better incomes and higher labour productivity for rural households, plus possibility of employment in new value chains | **positive** | intensification of production may reduce the costs of producing and transporting raw materials | **positive** | if intensification is well managed the landscape can produce more with less spatial impact | potentially **positive** |
| | | | | | | | | | intensification could introduce new markets for equipment and inputs - or, if crop diversification is involved, new value chain investment opportunities may emerge | **positive** | the possibility of "eco-islands" and reduced need for expansion represent habitat benefits | **positive** |

| Measure | Trade off, compro-mise or synergy | Relevance to nexus component | | | Impact | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | State entities | | | Population | The private sector | | Environment | |
| | | | | | Comment | Security dimension | Comment | Security dimension | Comment | Security dimension | Comment | Security dimension |
| | | Water | Agriculture | Energy | | | | | | | | |
| ***spatial expansion*** | trade off | **loser**, because agricultural intensification usually involves irrigation | **winner** | potentially a **loser**, because there is less water for energy production, although a net gain in biomass may offset this somewhat | strong economic growth is generally associated with, and results from a strong agricultural sector | **positive** | increased employment opportunities for smallholders, estate workers and workers in any resulting value chains | **positive** | increases the supply of raw materials | **positive** | **loss of natural capital may reduce overall landscape productivity** | **negative** |
| | | | | | | | | | increased potential demand for equipment and inputs | **positive** | **habitat loss and increased farm run-off is likely to have a biodiversity cost** | **negative** |
| ***crop diversification*** | trade off or synergy | potential **winner**, because crop diversification can reduce agricultural water demand and/or increase the economic efficiency of water used in agriculture | **winner** | potential **loser** because high added value crops may need more energy along the value chain (trade off), but potential **winner** if diversified crops include bio-energy crops | strong economic growth is generally associated with and results from a strong agricultural sector, a benefit which will be compounded when the water is invested in agricultural value chains | | | | new value chain opportunities | **positive** | crop diversification introduces possibilities of comparative productive advantage and hence the best use of natural resources | potentially **positive** |
| | | | | | | | | | | | examples can be cited where crop diversification (and indeed modified farming systems) improve habitats | potentially **positive** |

| Measure | Trade off, compro-mise or synergy | Relevance to nexus component | | | Impact | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | State entities | | | Population | The private sector | | Environment | |
| | | | | | Comment | Security dimension | Comment | Security dimension | Comment | Security dimension | Comment | Security dimension |
| | | Water | Agriculture | Energy | | | | | | | | |
| ***Measures to increase energy security*** | | | | | | | | | | | | |
| ***large hydropower dams*** | trade off or compromise | **loser**, because of the dead water behind such a dam | **loser** unless the operating rules can accommodate flexible supply levels behind the dam, but **winner** if there are fishery possibilities | **winner**, especially if pumped storage is involved | expanding sources of renewable energy enable economic growth | potentially **positive** | large hydropower dams could increase domestic supplies with little effect on power generation | **positive** | potential benefits for energy intensive industries | **positive** | **loss of landscape and streamflow, and possible morphological problems downstream** | **negative** |
| | | | | | risk of transboundary conflict is benefits not shared, or riparian rights are compromised | potentially **negative** | more energy should mean more jobs | potentially **positive** | lost opportunities to invest in more commercially advantageous alternative energy supply solutions | **negative** | **biodiversity threat due to possible gene pool limitations, spawning runs and disrupted terrestrial migration routes** | **negative** |
| ***thermal power stations*** | synergy or trade off | **winner**, because no water is lost to the system, although it may be lost to a particular catchment | **winner** because no water is taken from potential agricultural use and if agriculture adapts to or mitigates climate change (synergy), but **loser** if increasing climate change is an issue (trade off) | **winner** | there may be a long term economic cost due to climate change (droughts, flood, public health etc.) | potentially **negative** | more energy should mean more jobs | potentially **positive** | potential benefits for energy intensive industries | **positive** | hot return flows compromise habitats | **negative** |
| | | | | | | | | | lost opportunities to invest in more commercially advantageous alternative energy supply(..) | **negative** | | |

| Measure | Trade off, compro-mise or synergy | Relevance to nexus component | | | Impact | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | State entities | | | Population | The private sector | | Environment | |
| | | | | | Comment | Security dimension | Comment | Security dimension | Comment | Security dimension | Comment | Security dimension |
| | | Water | Agriculture | Energy | | | | | | | | |
| | | | | | | | | | solutions | | | |
| ***run-of-river schemes*** | compromise | **winner**, because no water is lost to the system | **winner** because no water is taken from potential agricultural use | **winner**, but optimal power production may be constrained by seasonal changes in flow (hence compromise) | expanding sources of renewable energy enable economic growth | **positive** | more energy should mean more jobs | potentially **positive** | potential benefits for energy intensive industries | **positive** | there could be minor, local disruptions to habitat | marginally **negative** |
| | | | | | | | | | lost opportunities to invest in more commercially advantageous alternative energy supply solutions, although run-of-river equipment could be a market opportunity | potentially **negative** | | |
| ***mini-hydro*** | synergy | **winner**, because no water is lost to the system | **winner** because no water is taken from potential agricultural use | **winner** | | | | | increases energy security, especially for enterprises that install their own hydropower facilities | **positive** | | |

| Measure | Trade off, compro-mise or synergy | Relevance to nexus component | | | Impact | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | State entities | | | Population | The private sector | | Environment | |
| | | | | | Comment | Security dimension | Comment | Security dimension | Comment | Security dimension | Comment | Security dimension |
| | | Water | Agriculture | Energy | | | | | | | | |
| | | | | | | | | | mini-hydro installations represent commercial opportunities for both supply and operation | positive | | |
| ***tidal power stations*** | possible trade off | winner, because no water is lost to the system | possible LOSER because productivity of estuarine wetlands could be compromised | winner | | | lost productivity of coastal wetlands could affect local livelihood and along with compromised connectivity could affect economically important marine food chains | potentially negative | potential benefits for energy intensive industries | positive | significant risk of reduced landscape productivity | negative |
| | | | | | | | | | lost opportunities to invest in more commercially advantageous alternative energy supply solutions | negative | significant risk of habitat loss | negative |

# 3 Research and Results

## Preamble

The approach adopted for the research has involved four steps. The first has been to develop diagnostic overviews of the two target basins – namely the Volta River and Lake Victoria Basins - teasing out the key issues that could be addressed or resolved via trade-off, compromise or synergy along the Nexus – see sub-section 3.1.

The second step comprised the design of an analytical framework and its subsequent application to a literature review, the results of which are reported in sub-section 3.2.

The third step concerned the preparation of a suite of seven case studies. Four of these simply revisited case studies undertaken during the Africa Nexus Workshop, while three have been introduced specifically for the purpose of this study – see sub-section 3.3.

The fourth step was to prepare a stakeholder questionnaire and send it to:

- officials of relevant international agencies and/or institutions;
- officials of relevant regional bodies both within the target basins and elsewhere;
- and selected individual experts.

Where necessary or useful, the questionnaire survey was followed up with one-on-one interviews with specific respondents - see sub-section 3.4.

## 3.1 The Target Basins

The two sub-sections which follow provide the reader with a simple introduction to the two target basins. The information provided is revisited later along recommendations concerning possible ways forward in the Basin Concept Notes presented in sub-section 5.3.

### 3.1.1 The Volta River Basin[10]

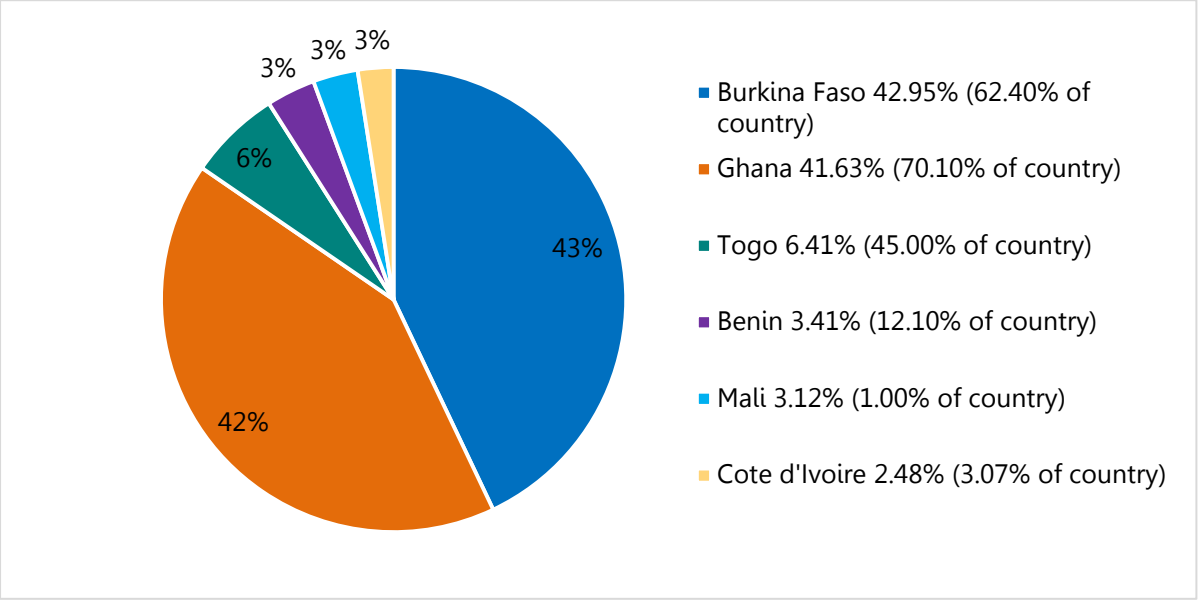
The Volta River basin, at around 400,000 km$^2$ is the 9$^{th}$ largest in Sub-Saharan Africa and is home to a little over 23 million people. Of these, over 75% subsist in the rural areas of the six countries occupying the basin: Benin, Burkina Faso, Cote d'Ivoire, Ghana, Mali and Togo – see Figure 1 which indicates the percentage of the basin occupied by each country along with the percentage of each country occupied by the basin. The river itself comprises a main stem and four main tributaries: the Black Volta, the White Volta, the Oti River and the Lower Volta which flow primarily through Burkina Faso and Ghana – see Figure 2.

[10] Much of the material presented in this Sub-section is taken from Hassing, 2013 a.

In climatic terms, the basin extends from sub-humid conditions in its Southern reaches to semi-arid in the North, where the basin drains part of the West African savannah zone. In all, it is estimated that due to high evaporation rates (ranging from 1500 mm/yr in the South to 2,500 mm/yr in the North), less than 10% of the overall precipitation actually makes it to the river system. Even so, the basin's average annual discharge is estimated at 38 $km^3$.

Rain fed, and to a lesser extent, irrigated agriculture provides the livelihood of most of the Basin's population. Rain fed production, already vulnerable because of its dependence on the spatial and temporal variability of rainfall, can be expected to become more so as a result of climate change. High levels of population growth in the basin (2.5% to 3.0% annually) suggest that significant increases in its irrigated area will be necessary to meet food and possibly other kinds of crop production requirements. Burkina Faso in fact, has reportedly pledged some $1.855 billion for an irrigation based "green revolution" based on rice (Riddell 2014). This, and initiatives like it, could massively increase demand for water. According to 2011 figures from the Volta Basin Authority, irrigation already accounts for over 70% of water abstracted from the Basin (both surface and groundwater), with drinking water demand accounting for just under 8% and 16% for rural and urban areas respectively. These figures, like irrigation demand, are also expected to increase dramatically in the coming years.

FIGURE 1 SPATIAL CHARACTERISTICS OF THE VOLTA RIVER BASIN

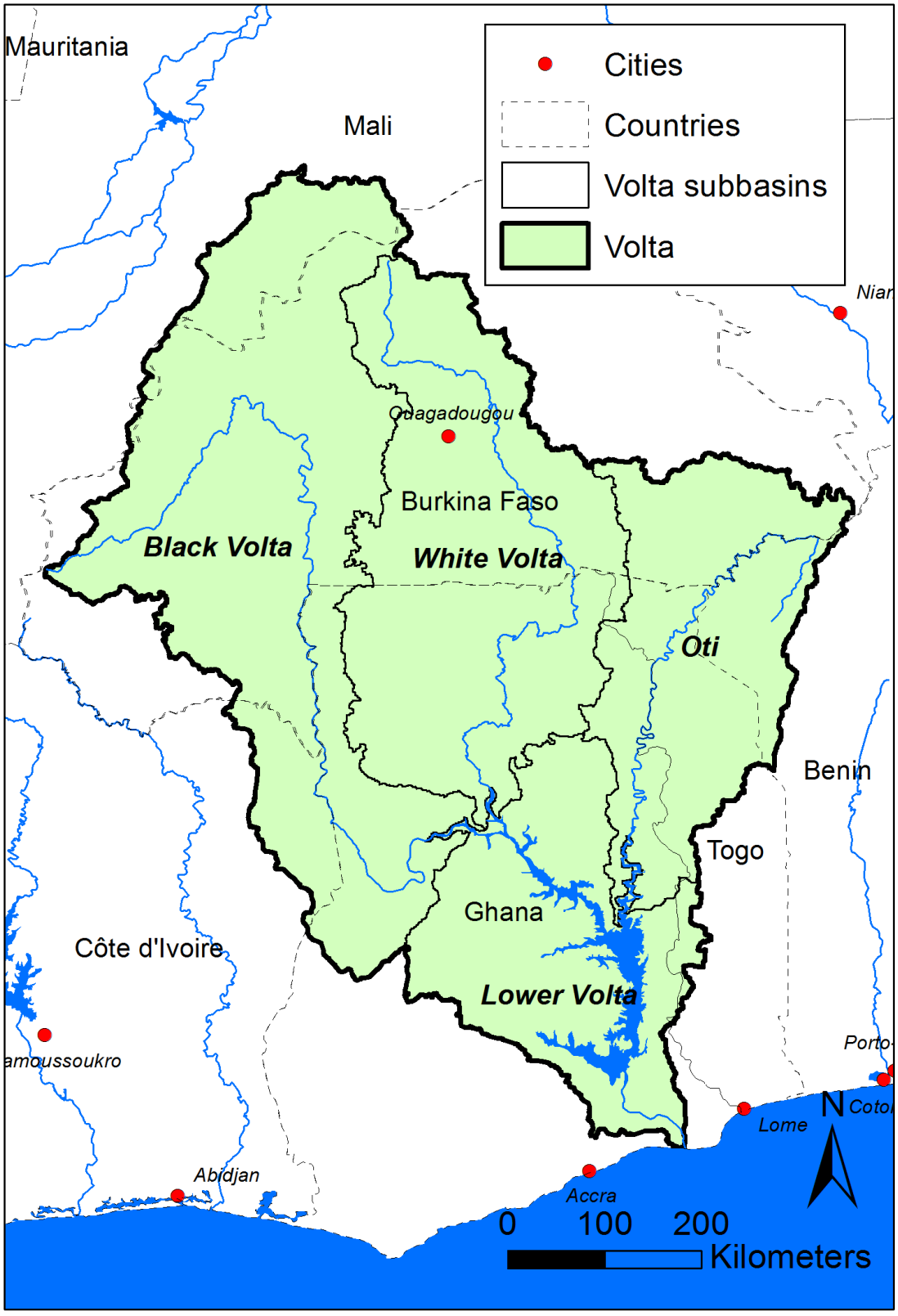



Urbanisation in the Basin is limited however, hence so too is industrial demand for water, except as a means to dispose of effluence – although a threat, this of course is a non-consumptive use of water.

Hydropower on the other hand is of great importance, especially for Ghana for which the Akosombo and Kpong Dams remain its greatest source of electricity. Demand for energy is already exceeding supply, and the ongoing construction of the Bui Dam confirms the country's continued commitment to hydropower as an engine of growth. However, the Akosombo dam is already being used at unsustainable rates, because its operators (The Volta River Authority) allow too much water through the dam in the hope that future inflows will be enough to replenish the reservoir. There is also the potential difficulty to be expected when trying to operate dams for both hydropower and irrigation, as is evidenced by the difficulties in reconciling the competing demands of the Accra Plains Irrigation Project and the operating rules of the Kpong Dam (a few kilometres downstream of the Akosombo) where regular drawdown of water levels for hydropower generation means that no water is able to

enter the gravity fed offtake to the irrigation scheme (BRLi *et-al*, 2013). Under current arrangements this would call for a trade-off in terms of power production, or lost irrigated production (and most likely productivity).

FIGURE 2 THE VOLTA RIVER BASIN



Alternatively, the problem of irrigation water supply could be solved by means of pumping, but this would increase the demand for energy (and since the irrigation scheme covers 9,600 ha and is predicated largely on wetland rice this would be considerable).

Given that urbanisation and industry are of secondary importance in the Basin, it is clearly the case that the conflicting interests of irrigated agriculture and hydropower production are the most likely to call for trade-offs, compromises and synergies along the Nexus in the Volta River Basin.

According to the FAO[11] *"....the total annual flow to the sea, 38 km$^2$, exceeds the total annual irrigation water requirements for the whole basin[12], 28.5 km$^2$. Comparing the water requirements in different parts of the basin with water availability, the balance remains positive everywhere..."*. This bold statement is somewhat questionable however. According to IWMI (Molden *et-al*, 2001) a basin begins to experience physical water scarcity when abstractions exceed 60% of the annually renewable resource, whereas here, FAO is saying that 75% is ok (without accounting for urban demands)! Even so, there are various ways to reduce this, including production innovations (see footnote 13); crop diversification; irrigation on demand; precision irrigation and an emphasis on longitudinal water allocation rather than transverse.

The most likely types of conflict can be expected to concern incompatibilities between the operating rules for hydropower dams which reflect diurnal demand cycles and the seasonal demand cycles of irrigation which may be more economically served by larger volumetric drawdowns than are feasible for hydropower; in addition, even in water rich portions of the basin there may also be increasing competition for water at the local level/point of use.

Dams and reservoirs of all sizes have already been constructed throughout the Basin to meet the needs of agriculture, industry and energy, and their number continues to increase as the populations in the riparian countries continue to grow. This growth along with the impacts of climate change and the impoundment of ever more water can be expected to threaten the benefits of water management. Irrigation and other consumptive uses already compete with hydropower, and although attention has been drawn to the Kpong/Accra Plains irrigation problem, the problem is reportedly worse in the mid and upper reaches of the basin.

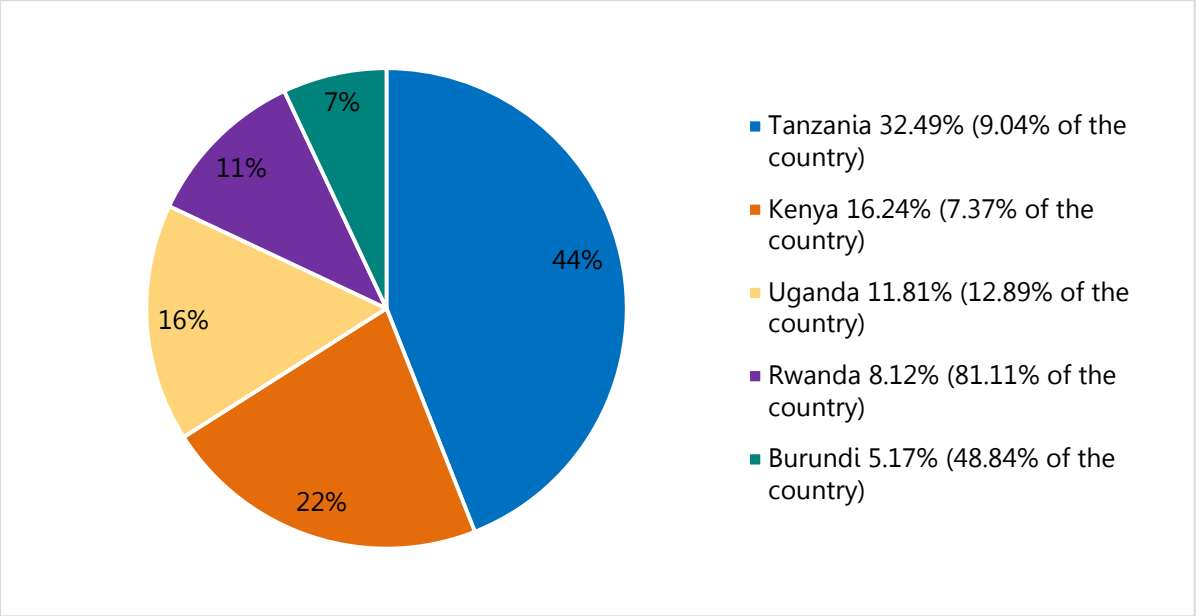
[11] http://www.fao.org/docrep/w4347e/w4347e0u.htm

[12] Based on the most likely cropping systems for each of the riparians. This is very conservative however as the figures assume that a large percentage of the potentially irrigable area within the basin is planted to wetland rice. But innovations such as the System of Rice Intensification have the potential to greatly reduce the water requirements of rice.

### 3.1.2 The Lake Victoria Basin[13]

The Lake Victoria Basin comprises the uppermost sub-basin of the Nile and occupies a land area of 194,000 km$^2$ (263,000 km$^2$ if the lake itself is included) and is home to some 35 million people (2005) of which around 60% live in the rural areas (90% if Kampala is disregarded). The basin occupies parts of five countries: Burundi, Kenya, Rwanda, Tanzania and Uganda – see Figure 3 which indicates the percentage of the basin occupied by each country along with the percentage of each country occupied by the basin.

FIGURE 3 SPATIAL CHARACTERISTICS OF THE LAKE VICTORIA BASIN




As is clear from Figure 4, the basin itself is dominated by Lake Victoria, which is supplied by various sub-basins of which three are transboundary:

- The Kuja/Mgori (Kenya and Tanzania)
- The Mara (Kenya and Tanzania)
- The Kagera (Burundi, Rwanda and Tanzania)

In climatic terms the basin enjoys an equatorial hot and humid climate with a bi-modal rainfall pattern within which annual rainfall varies from a maximum of 2,400 mm/yr in Uganda to 1,350 mm/year in the North East of Kenya's portion. The basin's high population density which averages around 350 persons/km$^2$, but goes as high as 1,200 persons/km$^2$ in parts of Kenya is explained by its favourable conditions for agriculture, fishing and other economic activities. The vast majority of the population depends directly on natural resources with small land holdings typically 1 ha. or less, and agriculture and fisheries are the most important livelihoods. But livelihoods along the agricultural value chain – specifically in agrochemical production and food processing – are also important.

[13] Much of the material presented in this Sub-section is taken from Hassing, 2013 a

A wide range of water management and utilisation challenges were identified by riparian stakeholders at workshops convened during the analytical phase of the Nile Basin Decision Support System outline design study in 2008. See Table 3 where the order in which the challenges or problems is presented reflects how many countries cite them as relevant whereas the numbers in the columns represents the ranking at country level, of a particular challenge or opportunity. In other words it reflects the priority given to the issue by the country concerned.

FIGURE 4 LAKE VICTORIA BASIN

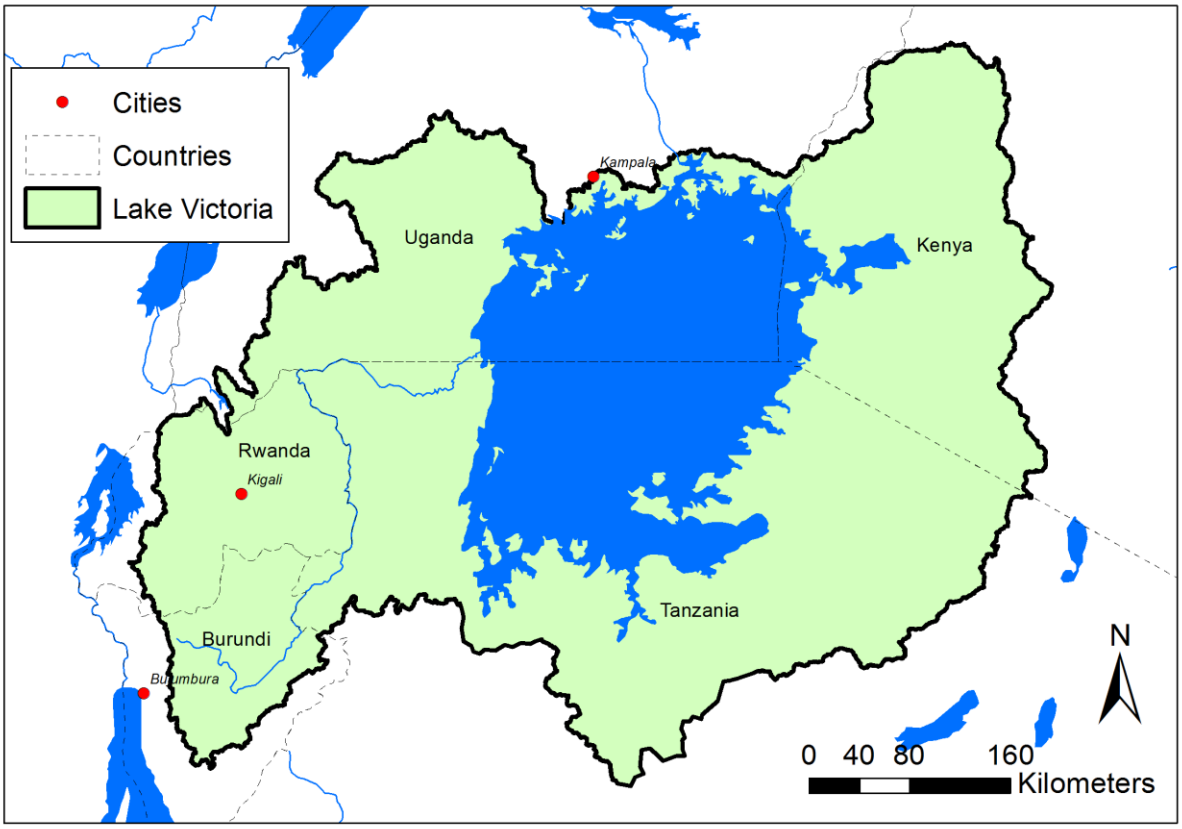


TABLE 3 RIPARIAN NEEDS ASSESSMENT RESULTS (2008) AND THEIR RELEVANCE TO THE NEXUS

| Challenge or problem | Problem in[/1] | | | | | Nexus relevance | |
|---|---|---|---|---|---|---|---|
| | Burundi | Kenya | Rwanda | Tanzania | Uganda | | |
| Water supply & sanitation | **6** | **4** | **4** | **9** | **7** | low | Because this is simply an investment issue as the bulk water needed is presumed to be covered by water resources availability below. |
| Increased energy demand | **10** | **5** | **3** | **11** | **1** | high | Largely because of the nexus between agriculture and energy. |
| Water Quality - pollution | **8** | **8** | **9** | **3** | **3** | medium | Because pollution levels are dependent on streamflow. |
| Irrigation | | **3** | **10** | **7** | **10** | high | Largely because irrigation would be by far the greatest consumer of water. But also, given the prevailing topography, much of the irrigation potential would need pumped supplies (especially in the case of Uganda – PEM Consult 2012). |
| Biodiversity conservation | **7** | **2** | | **6** | **6** | medium | Because habitat sustainability is dependent on streamflow. |
| Wetland degradation | **11** | | **7** | **12** | **8** | high | Because wetlands comprise natural infrastructure that has a significant potential role to play in a Nexus solution. |
| Watershed degradation | | **6** | | **10** | **2** | medium | Because pristine or well managed watersheds increase the manageability and hence supply of water. |
| Coping with droughts and floods | | **10** | **8** | | **9** | high | Because of the infrastructural solutions available for this. |
| Water resources availability | **9** | | | **1** | **4** | high | Because of the infrastructure possibilities for increasing supply, either by storage or better use of water. |
| Optimal utilisation of available water resources | **3** | | **5** | **4** | | high | Because of the possible need for trade-off, compromise and synergy, and for infrastructure that reduces losses and inefficiencies. |
| Drought and/or Flood Forecasting and Preparedness | **2** | **9** | | | | medium | Because this is essentially a capacity building issue, but it may also involve infrastructure to attenuate flooding (storage is covered above in water resources availability. |
| Improving / developing navigation potential | **13** | **12** | | | | high | Because navigation can be an important, but often overlooked benefit of improved management of stored water, or new investments in infrastructure. |

| Challenge or problem | Problem in[1] | | | | | Nexus relevance | |
|---|---|---|---|---|---|---|---|
| | Burundi | Kenya | Rwanda | Tanzania | Uganda | | |
| Population structure/settlement pattern | **12** | | | | **11** | low | There are issues of water availability and pollution control. But these are supply side issues covered above in water resources availability. |
| Tourism | **14** | | **6** | | | low | Tourism is merely another stakeholder in water resources availability (re: biodiversity and amenity). |
| Declining water levels in lakes and rivers | | **1** | | **2** | | high | It is partially covered by water resources availability, but there are likely also to be management and allocation implications. |
| Water use efficiency demand/management | **1** | | | **5** | | high | High water use efficiency has infrastructural implications and demand management has investment policy implications. |
| Intra- and inter-annual fluctuation | **5** | | **2** | | | medium | Could be construed as a water resources availability issue, but there may also be management and allocation challenges. |
| Soil/Bank erosion | **4** | | **1** | | | medium | Dam lifetimes can be compromised by soil erosion, while the dams themselves could be the cause of bank erosion. |
| Rain fed agriculture | | | | | **5** | nil | Self-explanatory. |
| Conflicts in water use (pastoralists etc.) | | | | | **12** | medium | This is supply issue covered by water resources availability, but with allocation and management implications.. |
| Land use, cover change, impacts on runoff | | **11** | | | | low | These are important issues, and while there may not be any implications for formal water infrastructure there are clear opportunities for investment in natural infrastructure. |
| CC adaptation/mitigation by rain water harvesting | | **7** | | | | medium | Because some approaches to rain water harvesting improve catchment yields (seepage tanks and troughs) while others reduce the possibilities of synergies and compromise between agriculture and energy. |
| Water Quality - eutrophication | | | | **8** | | nil | This is largely a farm run-off issue. |

*Source: Riddell 2008*

## 3.2 The Literature Review

### Preamble

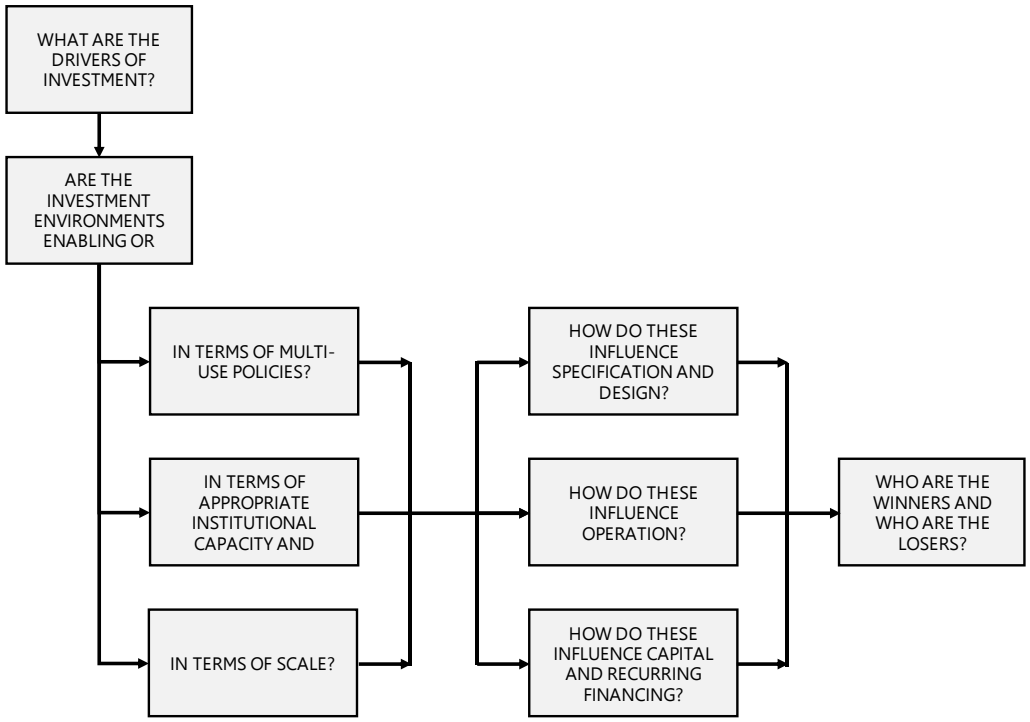
There is a vast and rapidly expanding body of literature concerning the nexus. Authorship varies from scepticism, through neutral commentary to strong support. Equally, different sources with different agendas and interests each treat The Nexus in different ways. This diversity is clear from the list of references provided at the end of the Main Text. Luckily, this study is not intended to produce a detailed and comprehensive exegesis about The Nexus. Rather, it is intended - along with the case studies and stakeholder consultations - to identify opportunities for trade-off, compromise and synergies with respect to water infrastructure and based on these opportunities to propose a Rapid Assessment Framework and apply it to current and upcoming infrastructure projects in the two target basins. Unfortunately and as will be seen, the literature does not as yet provide a consolidated picture of how the nexus approach is performing, neither does it contain a great deal of commentary on its infrastructural aspects. Instead, the nature of the debate is more concerned with the type of problems that the nexus could solve and the ways that it could do so. This suggests that among the myriad, sometimes overlapping themes and sub-themes that do actually emerge from the literature, the review itself should concentrate on those suggested by the framework presented in Figure 5, looking to answer the cross cutting questions of:

i) what is working and what is not; and

ii) what is known and what is not.

It will be seen in sub-section 4.2 that the framework itself has been developed into the Rapid Appraisal Framework that the study is intended to produce.

FIGURE 5 FRAMEWORK OF KEY THEMES ADDRESSED IN THE LITERATURE REVIEW




Before proceeding to examine them, it is helpful to lay the foundation by examining certain general issues raised in the literature.

### 3.2.1 General Issues

The first sub-theme to emerge from the literature review concerns security, mention of which has already been made in sub-sections 2.1 and 2.2 where water, agricultural and energy security were considered and defined. At a more fundament level of security however, it is useful to begin this literature review by noting that "resource scarcity is a threat to the security (for which read: survival[14]) of mankind once planetary boundaries have been crossed" and "As has been outlined, there have been multiple claims to tackle environmental issues and security within a framework that acknowledges their interconnectedness. However, we seek to explore a different register of this more recent emphasis on a 'nexus': the effects of reframing sustainable development under the paradigm of security" (Leese and Meisch 2015 ibid). Accordingly, although every country faces the water-agriculture-energy challenge differently (Brabeck-Letmathe 2015), a way to enhance a nexus approach could therefore be "to more strongly stress security" (Benson et-al 2015).

While still on the subject of security, but looking at the future, we note that while security is "predominantly framed as a matter of distributional justice, it is now being transformed into a priority for survival" and yet "The analysis of the political choices, however, reveals that the agenda that was created by the nexus approach still very much remains one that is driven by economic choices" (Leese and Meisch ibid). This is substantive because regardless of what conceptual approaches are adopted, the demand itself is pretty much fixed. As stated by Professor John Beddington, former Chief Government Scientist of the UK "By 2030 the world will need to produce 50% more food and energy, together with 30% more available fresh water, while mitigating and adapting to climate change. This threatens to create a 'perfect storm' of global events." (cited in Pegasys 2014); and the FAO puts this figure at 70% - see Table 4 below! And as if this is not enough, a variety of other issues arising will have to be taken under advisement. Urbanisation for instance will mean that increasing demand and consumption along with changing socio-economic profiles changing profiles will more commonly be encountered among urban dwellers meaning that "… the challenge of resource scarcity is more acute and more complex than simply providing for the food, water and energy needs of a growing world population…" (Pegasys ibid). These changes will increase pressure on land and water availability beyond those merely needed to keep up with basic agricultural security at the global level. Trends like this matter because "they challenge the assumption that today's development strategies which have delivered impressive poverty reduction and growth in prosperity over the past two decades, will continue to deliver into the future" (Pegasys ibid). And all this is before macro-economic challenges such as collapsing petrol prices which "have yet to impact on the framing of the nexus debate" (Allouche et-al 2015) are taken into account. In order to pull all this together into a coherent and convincing future the literature suggests that a suitable philosophy is needed, and that this in turn may need some lateral thinking.

The first issue that needs to be clarified under the philosophy sub-theme concerns the efficacy and relevance of Integrated Water Resources Management or IWRM. For instance, is the "nexus" no more than a rebranding of IWRM and/or is there anything new about the Nexus (Allouche et-al 2015)? In addressing this question, the same writers make it clear that IWRM and the Nexus are different because the "nexus is a multi-centric concept, (while) IWRM is on only water centric". It is possible to take this idea further by noting that nexus promoters view water resources as being dependent on "consideration of multiple sector, namely energy, trade, national security, cities, people, business, finance, climate change and economic frameworks" (Benson et-al 2015, citing the WEF in 2011). This means that water itself can be dependent on some of the sectors which in turn depend on it. According to the same writers, as a paradigm IWRM does not acknowledge the dependence of water resources on such sectors but rather is limited to aiming "…at integrating and coordinating public policies, particularly water management and cognate policies such as agriculture.."; but even this

[14] Parentheses included in the original statement.

limited integration is falling very short (Riddell 2014); while "outsiders could see no benefits flowing from IWRM and consider major advocacy events to be talk shows" (Muller 2015). Accordingly "the nexus provides a polite way to move past Dublin IWRM's detailed processes – it enables actors with practical problems such as water security for communities or enterprises to find way forward" (Muller ibid).

Even so, there is no overall nexus consensus, it "….seemingly varies according to the focus of sectoral integration studied in a geopolitical context" (Benson et-al ibid). This is important because "the problem is not limited to developing countries". Any technical debate tends moreover, to ignore "…the political economy of resource inequality…" (Brabeck-Letmathe ibid and Allouche et-al ibid respectively)[15] and the "…emergent framing of the nexus leads to demand-led technological and market solutions that ignore supply side limits and political dimensions.." (Allouche et-al ibid).

Tensions such as these introduce the need for lateral thinking because "issues of political economy cannot be fixed by economic or technological solutions" (Allouche et-al ibid). By framing the challenge differently, different approaches emerge. Poor terms of trade, trade barriers and perverse subsidies all increase the cost of food, create shortages and produce poor returns on the factors of productivity. While such problems may have a nexus solution, the nexus itself is an "immature concept and needs a more critical approach" (Allouche et-al ibid) and the problems can be solved by political measures, by increasing factor productivity[16] and reducing waste[17]. Similarly "financial instruments can be applied to reduce risks" (IUCN 2015) especially ones which reflect a monetised concept of environment risk and ecosystem services (Smith 2015).

### 3.2.2 Drivers of Investment

Three drivers of investment are considered: i) security; ii) climate change; and iii) economic growth/socio-economic transformation. Before considering how they drive or should drive investment it is first useful to show investment patterns with regard to water, agriculture and energy (see Table 4).

TABLE 4 INVESTMENT PATTERNS AND FOCI

| Nexus element | | | Source |
|---|---|---|---|
| **Water** | **Agriculture** | **Energy** | |
| Water consumption is likely to increase by 55% worldwide between 2000 and 2050. Some industries will increase their water use by 400% (manufacturing) and by 140% (electricity) | | | Allan et-al 2015 citing OECD 2012 |
| OECD predicts a 55% increase in water demands by 2050 | FAO projects that food production will need to increase by 70% by 2050 | IEA expects energy demand will increase by 40% in 2030; | Bellfield 2015 |
| By end 2012, water was the only one of the four main foci (energy, transport, water and ICT) to have received steadily more investment commitments. | | | ICA secretariat 2012 |

15 The resource inequality aspect of "political economy" is captured very well in Wikipedia's definition of political economy as being "how political forces affect the choice of economic policies, especially as to distributional conflicts".

16 *"current rate of growth for agricultural total factor productivity (land, labour, inputs and energy - BUT NOT WATER) is 1.69%, but needs to be 1.75%"* (Woteki 2014)

17 *"wastage in the value chains have to be taken into account"* (Allouche et-al ibid)

| Nexus element | | | Source |
|---|---|---|---|
| **Water** | **Agriculture** | **Energy** | |
| Only 2.5% of investments monitored by the ICA in 2012 comprised multi-purpose projects | | | ICA secretariat 2012 |
| | | Natural gas accounts for a lot of the energy investments, but hydropower is also significant | ICA secretariat 2012 |
| Of all the primary infrastructure sectors, it is the development of water related infrastructure projects that arguably best tracks the global community's desire for an improved standard of life across the continent. | | | ICA secretariat 2012 |
| To address competing water needs, cities and utilities….will need to optimise water infrastructure for multiple purposes, including investing in watersheds as natural infrastructure | | | IUCN/IWA 2014 |
| It is estimated that the 16 large-scale coal power plants in China need at least 9.975 billion $m^3$ water to meet the goal of 2.2 billion tons of coal output in 2015. | | | IUCN/IWA 2014 |
| Water neutral processes are of limited use in managing external water risks such as drought related food shortages or flood damage to economic or commercial infrastructure | | | Muller 2015 |
| It is generally argued that multi-objective; large-scale water development is economically efficient and beneficial. Countries are aware that the demand for energy will continue and that the cleaner (i.e. Hydro) the energy, the better. In addition, it has long been accepted that, due to costs, maturity, and returns of other water outputs, it is beneficial to develop projects able to jointly satisfy energy, irrigation, water supply, irrigation and flood control needs at the same time. | | | Solanes 2015 |
| | | It is estimated that two-thirds of the world's economically feasible hydropower potential remains to be exploited | Villamayor-Thomas, *et-al* 2015 |

The seemingly excessive emphasis on the left hand column – i.e. water – invites the interesting question: "if the nexus were a hierarchy would water occupy the top layer?" This is after all a study of infrastructural trade-off, compromise and synergy. A working hypothesis at this stage therefore is that water is the senior nexus element because:

- "…water infrastructure is at the heart of the nexus debate…" (Smith and Bergkamp 2013)

- Provision and operation of appropriate water infrastructure – including natural infrastructure – could directly increase the security of ecosystem services; agricultural production and energy.
- Investments in agricultural infrastructure could only increase agricultural security and contribute to energy security – other than possible natural infrastructural benefits accruing to improved land management, investment in agriculture would not present an infrastructural option for increasing water security.
- Investments in energy infrastructure would increase energy security and contribute to increased agricultural productivity (right along the value chain from seed to spoon); but they would not contribute to bulk water security – although energy could establish local increases in water security where pumping is needed[18].

This is not an academic question because of climate change. Since water availability is vital for climate change adaptation in the agricultural sector and contributes to mitigation in the energy sector while itself being vulnerable to climate change, it is essential to get this right. After all *"….water security is now the biggest societal and economic risk and is expected to remain so for the next ten years….."* (Brabeck-Letmathe 2015 *ibid* quoting the WEF).

If the Nexus is indeed an "…urgent matter for the survival of all humanity…" (Allouche et-al ibid, 2015) and if a nexus approach is the best way to invest in water, agricultural and energy security, then "…another way of enhancing the nexus worldwide could therefore be to more strongly stress security…" (Benson et-al ibid, 2015). Other commentators are concerned however, that to focus investment onto water ignores the fact that "…food security is an overriding nexus concern at this stage…." (Pegasys 2014 ibid) and that "…energy is required for the entire food system including food production, harvesting, transport, processing, packaging, and marketing. This has received limited attention in the water-energy-food nexus discourse so far, but is an important factor that needs to be considered…" (Bellfield 2015). However, present trends in water security "…suggest massive shortfalls in cereal production, especially where groundwater has been over used[19]…." (Brabeck-Letmathe). Clearly, investments are needed for increased physical efficiency of water and for institutional mechanisms that reallocate the saved water in an equitable and economically efficient fashion. But it is also pertinent to note that where increases in agricultural productivity have been achieved and are being sustained, the agricultural sector "…..has emerged as a significant energy consumer. Going forward it is clear that energy will be a fundamental input to ensure universal food security. These energy inputs however, need to be decoupled from the fossil fuel" thereby requiring investments in "….a three-pronged approach: improving access to modern energy services, enhancing energy efficiency and a gradual increase in the use of renewable energy…." (Ferroukhi et-al 2014). Given these interdependencies, investment that increases "… the efficiency of water-energy systems in domestic and industrial supply and irrigation is therefore an important priority for the decade ahead…." (Bellfield 2015).

[18] Unless, as in India, free energy for pumped irrigation actually reduces water security.

[19] An unpublished, semi-empirical study carried out by the FAO in 2011 suggested that wherever 55% or more of a country's cereal production is irrigated, then groundwater drawdown is unsustainable. Although the data supporting this conclusion was sparse and inconsistent, there are nonetheless grounds for significant concern.

Investment in increased water, agricultural and energy security would be of limited benefit unless it resulted in economic growth and socio-economic transformation. Growth is needed not least, so that employment opportunities can keep up with population growth, while socio-economic transformation is increasingly needed to diversify livelihood options now that urban populations are growing faster than rural populations. With this in mind, the Nexus "…..offers a distinctive, descriptive and prescriptive approach to present and future challenges of sustainable growth" (Leese and Meisch ibid 2015). But for this work, the Nexus itself needs "….to be framed in the context of sustainable economic growth" (Allouche et-al ibid 2015)". It also important to note that investment in even the most efficient, multi-purpose ventures is not of itself a guarantee of both economic growth and socio-economic transformation. For instance, the political economy of energy security tends to be more concerned with energy for economic growth which is "…not the same as energy for all…" (Allouche et-al 2015, ibid).

For countries that remain highly dependent on donor support "…water is a component of national development…" (Muller 2015) whereas "…Countries under transition have distinct and competing nexus challenges. These include national production and trade to support economic development; consistency of supply and pricing for urban consumers to support political stability; rural household access to support livelihoods; and rising expectations of environmental quality. At the same time, the traditional developing country focus on agricultural self-sufficiency in basic food cultivation is in tension with the requirements for reliable water and energy supply to the industrial economy… These trends matter for governments and businesses. They challenge the assumption that today's development strategies, which have delivered impressive poverty reduction and growth in prosperity over the past two decades, will continue to deliver into the future" (Pegasys 2014 ibid).

This is important because nexus priorities evolve.

Thus although a Less Developed Donor Dependent Country (LDDDC) may want to accelerate development by getting a firm grip on its water resources, energy is likely to become the priority once the economy starts to grow because it: "…still is a fact that energy is the sine qua non input to economic development….." (Solanes 2015 ibid).

It is clear therefore that the drivers of nexus investment will have to evolve as economies expand and diversify – there is no one-size-fits-all. There are also external factors that call for a nuanced and evolving nexus. These include such factors as terms of trade; political changes and the nascent restructuring of the global energy sector. But these require investments that respond to opportunity. climate change is rather more challenging however, because although it does introduce opportunities (such as crop diversification and the manufacturing of renewable energy technology etc.) it also represents a set of problems that must be addressed because "…global warming will adversely affect water, energy and food…" and "…mitigation and adaption to climate change will then interact, and impinge on water, energy and food…" (Leese and Meisch 2015).

Trade-offs, compromises and synergies would seem therefore to be essential because "…the impetus to militate against climate change has led to the search for renewable energy technologies, some of which increase the competition for land (biofuels, solar and wind farms) or water (hydropower)…" (Dupar and Oates 2015). In fact, this simple review of the literature confirms that to i) secure humanity's water, agriculture and energy and, ii) maintain economic growth and socio-economic transformation as climate change begins to bite will be extremely difficult to achieve without a nexus style approach.

### 3.2.3 Enabling Environment?

#### 3.2.3.1 Policies and Political Economy

The concept of political economy was defined in footnote 14 as being the process by which political forces affect the choice of economic policies, especially in conflicts over resource distribution. Policy on the other hand can be defined generally as an instrument that legitimatises the steps needed to move from an unacceptable present to an ideal future. In this more specific context *"…policies are understood as amalgams of interacting institutions that shape either directly or indirectly the use and production of water, energy and food resources and thus potentially mediate the emergence of trade-offs and synergies across different production chains…"* (Villamayor-Thomas, *et-al, 2015*). The importance of policy and political economy in the provision of an enabling environment for a nexus style approach to the planning and implementation of infrastructure will therefore be clear to the reader. A political economy that favours one sector over another (for whatever reason) is likely to prove counterproductive while a nexus style approach is more likely to produce the trade-offs, compromises and synergies needed in an ideal future. The intention of this sub-section is therefore to establish the extent to which nexus solutions are being influenced by political economy or legitimised by policy. It will be seen that the literature is fairly silent on actual policy landscapes, especially as regards infrastructure objectives. Rather, it is more concerned about what such landscapes should address and include.

The review begins by confirming the hypothesis that water somehow occupies a special place in both the Nexus and climate change adaptation/mitigation: "….the majority of Climate Change adaptation financing concerns water, yet water is poorly integrated into climate change policy, dialogue and funding proposals…" (Smith 2015). Similarly, "…water security is argued to be "at the heart of social, economic and political issues such as agriculture, energy production and human livelihoods…water security, economic development and GDPs are interlinked…" (Benson et-al 2015); and "…water security is arguably the arriviste issue in national security and global affairs. In the fast-changing world we can see stretching out to 2030, it is increasingly clear that our political, economic, and social stability into the 21st century will depend as much on how we manage our freshwater resources as it will on any of the other well-recognized 'hard power', global security issues of the 20th century, such as terrorism, nuclear proliferation, and fossil-fuel security…"; but despite water's obvious centrality to the nexus approach, from a policy diagnostic perspective the nexus approach is itself a way "…to change the political economy of the water agenda, from mostly an MDG-related 'access' issue to an issue of 'access in the context of wider resource security and economic growth…" (Leese and Meisch 2015 ibid).

To this end, the need for more robust integration of nexus relevant policies is stressed as a priority. For instance "…Nexus policy making is about designing resilient government or business strategies in ways that take account of the connections between food, water and energy systems. It starts by recognising the interdependence of those systems, and hence challenges single-sector approaches that can have substantial unintended consequences for a country's future development options.." (Pegasys 2014 ibid); and "…the emphasis of linkages among subsystems constitutes the theoretical core of the nexus approach which argues that although subsystems such as food, water and energy can be analysed independently, doing so would overlook the multiplicity of feedbacks and interdependencies that jointly affect the sustainability of the broader social-ecological system.." (Villamayor-Thomas et-al 2015 ibid). In fact, integration of multiple sector objectives at the policy level is what separates the Nexus approach from IWRM (Benson et-al 2015, Allouche et-al 2015).

Policies are intended to address priorities and achieve objectives, and usually specify the measures needed to do that. The literature however, itself suggests a variety of priorities. The IUCN in an undated text prioritises the establishment and sustainability of environmental stream flows in "….national legislation…" because "…environmental flows provide the means for integrated management of water resources to meet the needs of people, agriculture, industry, energy and ecosystems within the limits of available supply and under conditions of changing climates…". Other commentators see nexus policies as being essential for economic growth and to encourage development (Allouche et-al 2015). This requires policies that i) combine "…..appropriate technology, infrastructure and processes…" (IUCN 2015); ii) secure the resources needed for production "…After all, if resources that support production are not immediately rendered secure, then the overall consequences of such unique changes will substantially reduce the standard of living" (Leese and Meisch 2015) and iii) "…move the water-nexus construct beyond an input-output relationship into the realm of resource governance…" (Villamayor-Thomas et-al 2015). In reality however nexus style thinking "….still has to enter the remit of national governments…." (Allouche et-al 2015) and this may not be a simple matter because "…the alignment of environmentalism with the core economic priority has recently been facilitated ….. by the idea of ecological modernisation… but water objectives will often be secondary to the need to avoid direct conflict with activists who promote a protectionist approach to conserve nature and de-industrialise society…(and)… environmental NGOs like weak democracies where it is easier to influence a few powerful forces.." (Muller 2015).

Measures to be captured at policy level include operational, technical and economic opportunities. With respect to operations, many sources stress the need for regulatory frameworks that recognise the different interests of state entities, the private sector and civil society. This is because different value chains use very different proportions of embedded water and energy to deliver agricultural commodities and energy to consumers: "…separate supply chains have not engaged effectively over the potential benefits of adopting a wider understanding of competition and of mutuality…[with respect to resources] …As yet there are very few reporting rules and no accounting rules by which to steer. " (Allan et-al 2015). Disconnects noted in the literature are not limited to inconsistencies between the interests of water, agriculture and energy, they also include a lack of integration and/or consistency between policy, infrastructure and institutions (IUCN/IWA 2014) while calling for resilience rather than rigidity "….in ways that take account of the connections between food, water and energy systems…" (Pegasys 2014) so that infrastructure can have "…improved functionality for water, food and energy security…" (Smith and Bergkamp 2013). Finally on the need for better integration is the need to make sure that the nexus as a system approach engages adequately with the "…international political economy of food and energy…" (Allouche et-al 2015). This is very important because "…trade, regional integration and foreign policy…" have the potential "…to manage nexus trade-offs more effectively, and contribute further to resilience at both country and global levels…" (Pegasys 2014). In fact, the world system needs more trade flows in agriculture across more countries and virtual water flows (Allouche et-al 2015). These not only catalyse regional integration, they also mobilise the benefits of comparative productive advantage and hence increase total factor productivity while providing regional solutions to local problems. But for this to work requires policies that not only focus on comparative advantage; but also reallocate saved water longitudinally down an hydrological system rather than laterally across the landscape and that reward savings rather than punish waste (Riddell 2014). And although water "…cannot be traded easily as common pool resource.." (Muller 2015), policies that allow or even call for water savings to be tradable do not compromise issues of customary or common pool use; but it does require policy frameworks that acknowledge the difference between a service charge; a volumetric cost and a resource price (Riddell 2014).

When it comes to matters of political economy, it is noted first of all that "….resource allocations are political decisions which need more open and transparent decision…." (Allouche et-al 2015) and that "…different sectors have different objectives, frameworks, tactics and language…" (IUCN 2015). Accordingly the nexus is a useful way to frame a problem of political economy for policy makers looking for "….for trade-offs and open, transparent negotiation of resource trade-offs among concerned stakeholders at the appropriate scale…." (Dupar and Oates 201). The problem is however, that "…countries under transition have distinct and competing nexus challenges…" especially when the prevailing political economy prioritises agricultural self-sufficiency "…in tension with the requirement for reliable water and energy supply to the industrial economy…" (Pegasys 2014); and once development is firmly underway, new tensions appear in the political economy arena, in particular between the conservation and pro-business lobbies: "while sustainable development deploys ecological reason to argue for the need to secure the life of the biosphere, neoliberalism prescribes economy as the very means of that security" (Leese and Meisch 2015). Political economy is what you get when a politician does not have enough political capital for the long term resolution of such tensions.

In terms of the nexus elements, subsidies are often the result. For instance "…Those in power have judged that they can best stay in power by ensuring that their poorest citizens enjoy access to cheap food and stable energy prices. As a consequence, food supply chains are associated with a myriad of direct production subsidies, for example those of the EU Common Agricultural policy regime and of the US Farm Bill. In many low-income economies the subsidies are indirect, through the provision of subsidized diesel or electricity to pump water for irrigation…" (Allan et-al 2015); while "under-pricing of water has led to agricultural prosperity bubbles…" (Allouche at-al 2015). Smart subsidies with appropriate exit strategies that catalyse change may well be an appropriate component of a nexus approach, especially when they reduce the perceived risks associated with those changes – as for instance, with farming system diversification. However, perverse subsidies that perpetuate a downward spiral for political purposes are likely to compromise any possibility of nexus success (Riddell 2014).

#### 3.2.3.2 Institutional Arrangements and Capacity

It is very clear from the literature that different stakeholders have different understandings of the nexus (Allouche *et-al 2015*). This is important because food and energy are extremely emotional matters at all levels of society, "*..They are also deeply embedded in the social contract between society and those who govern. As a consequence, the tools available to states in intervening in these political economies – taxes and subsidies – feature very prominently in food and energy policies. Once in place they are even more difficult to remove than they were to install*." (Allan et-al 2015). It is essential therefore that objectives and scenarios should capture multi-stakeholder consensus going forward (IUCN, year not known). The problem though; is that "*…action situations can , however, be more complex involving multiple actors, governance systems, resource systems and units…"* which themselves can change seasonally (Villamayor-Thomas *et-al 2015*). In addition there are subtle power relationships: *"…trade-offs are often mediated by existing power dynamics - including access to information, influence and voice, and technical capacity…" (*Bellfield *2015).* For instance "*….those with power in private-sector food supply chains – the corporations – handle a very small proportion of the embedded natural resources. They have potential contractual leverage over farmers who do manage vast volumes of water, but they have as yet little incentive to engage outside the fence of their warehouses, silos, factories and wineries…*" (Allan et-al 2015). For this reason IUCN/IWA (2013) and Muller (2015) call for partnerships that include public, private, donor and civil society networks rather than "*…conventional institutional arrangements…".* It is also interesting to note that although scientists and economists assume that there is some rational and knowledge-based, potentially optimizable way to allocate water and energy, farmers, manufacturers and other stakeholders have

informally operated a nexus (water, agriculture and trade) for millennia. But in this modern era, the vast budgets demanded by infrastructural solutions stress the importance of a more different, more formal institutional concept – hence the comprehensive nature of the partnerships recommended by IUCN/IWA and indeed others.

Resource allocation goes of course, to the heart of The Nexus' institutional challenge – and this raises several institutional options and possibilities. Trade in "virtual water" for instance allows a water scarce region to import agricultural commodities from an area with sufficient water – the virtual water being the water needed to produce (and process) the commodity. As well as solving a supply side problem, it also increases the economic efficiency of water invested in the value chain involved. In fact, according to Pegasys (2014) it is possible to use "*…trade, regional integration and foreign policy to manage nexus trade-offs more effectively, and contribute further to resilience at both country and global levels..".* But this pitches the political economy of food self-sufficiency and limited-to-nil trade in basic foods at the comparative advantages of using the local resource endowment in the most productive and sustainable fashion to produce commodities that could be traded (Riddell 2014). With certain caveats in fact, trade *"…can be mutually beneficial in nexus terms, where a country with one kind of resource scarcity trades with another country with a different mix of resources…"* (Pegasys *2004*). Yet opportunities to use trade as 'a potentially very effective nexus tool' are compromised or limited by "…*weak international trade regimes and complex arrangements of tariffs and subsidies amplify the cost of food and create shortages*…" (Allouche *et-al 2015*).

This clearly has infrastructural implications, because a specific country or region's comparative productive advantage in a particular market or value chain will be a determining factor in what kind of infrastructure should be prioritised. An example would be Ethiopia's comparative advantage in terms of hydropower generation as compared with Egypt's comparative advantage in irrigated food production. Yet until early in 2015 for reasons of political economy, Egypt preferred to store its water in Lake Nasser from which estimated annual evaporation losses exceed 10 $km^3$ ( a widely accepted figure, but which current modelling says may be as much as 16 $km^3$). Ethiopia on the other hand, prefers to use its stored water for domestic irrigation, the unit costs of which are around 7 times that of Egypt because of topographic differences (Riddell and Thuo 2014).

But despite its obvious advantage, trade is not a silver bullet. It can for instance result in *"…externalities that exacerbate resilience challenges elsewhere: for example, the water-abundant UK imports soft fruits from more water-stressed countries such as South Africa…"*, while Singapore for instance, imports goods that would not be possible without nexus trade-offs which *"…occur in other countries…"* (Pegasys 2014) as is confirmed by Bellfield (2015) who states that water, energy and food supply chains in Latin America and Caribbean are *"… influenced by companies, investors and consumers outside the* region…". In addition, demand side measures such as tariff barriers and public procurement *policies "…can have major impacts on supply chains in producer regions..".*

Trade requires markets, hence its inclusion in this section on institutional arrangements which – if they are to increase resource use efficiency – must be based on *"….linkages and cooperation between actors of different value chains….."* (Villamayor-Thomas *et-al 2015*). But well-regulated markets don't only facilitate trade based distribution of commodities produced efficiently by means of a nexus approach, they can also distribute the means of production in an efficient fashion: *"…the multiple benefits of ….market instruments that promote resource-use efficiency include a resilience dividend…"* (Pegasys 2014). For instance, water saved in one location because of a shift to comparative productive advantage in agriculture, or alternatives to hydropower can be traded downstream to higher value uses, which themselves might also be nexus oriented. Water markets are a way to do this, the alternative being to re-invest the saved water laterally across the landscape in which it was saved, thereby increasing the chance of losses in both distribution and return flow systems (Riddell 2014). Examples of successful water markets can be found for instance in Israel and Australia. And

there is once again an infrastructure implication because of the investments needed in increased various combinations of water use precision, return flow and reallocation facilities. However, as Allan et-al point out (2015), efficient markets require a reliable pricing systems, yet water is *"…very frequently mispriced…"* and this is especially true of environmental stream flows which despite being increasingly *"…highly prized…their value is not yet captured…".* The same is true of fossil fuel consumption the costs of which do not reflect environmental externalities. Valuation of agricultural and energy products have not yet been shaped adequately by their scarcity value or externalities, and yet this is necessary to *"…operationalise the nexus…"* (All et-al 2015) and specify infrastructure that i) makes best local use of resources and ii) facilities the allocation/reallocation of resources towards their opportunity cost.[20]

According to Bellfield (2015) *"…Water-energy-food interactions are dynamic, taking place in the context of demographic, economic, political, social, technological and environmental change…"* which reminds us that nexus institutions need:

- a "…sound evidence base to improve local and regional understanding…." of the nexus (IUCN/IWA 2013);
- "…coordinated and harmonised, knowledge based indicators and metrics…" (Allouche et-al 2015), that "…cover all relevant spatial and temporal scales and planning horizons.." (Leese and Meisch 2015).

These require in turn, highly consultative investments in science, technology, decision support systems and other tools (IUCN/IWA 2013).

Before taking a closer look at what the literature tells us about institutions and their aptness in the context of the preceding paragraphs, it is useful to note *that "…the most resilient economic systems combine robust infrastructure,* flexible institutions *and functioning natural capital…"* (Pegasys 2014) and yet that although a number of tools have been used to study the nexus *"…few of these consider the role of* institutions *in mediating behavioural and environmental outcomes…"* (Villamayor-Thomas et-al 2015).

It should be self-evident that a nexus solution needs trans-sectoral, resilient and collaborative institutional arrangements. Such arrangements should moreover, be integrated both vertically throughout institutional hierarchies and horizontally across institutional landscapes: the latter so that differing agendas of policy makers, investment decision makers, planners and service provides may also be aligned, which Benson et-al (2015) currently considers to be often not the case. Horizontal integration also remains constrained due to the tendencies for resources to be managed in silos as a result of which *"…market based solutions are limited…"* and *"…nexus approaches have yet to engage with institutions that mediate environmental outcomes…"* (Allouche et-al 2015). This was recognised as long ago as the Mar del Plata conference in 1977 which concluded – inter-alia – that *"…good water management must be part of broader governance and government at all scales* [see next section], *not a self-contained silo into which other parties are invited on sufferance…"* (Muller 2015). What is needed, but seems lacking at this stage are:

- "…resilient institutions (including mandates, policies and mechanisms) that enable efficient, predictable development and allocation of nexus resources within the economy…" (Pegasys 2014);
- A process approach such as the nexus which does not neglect the need and opportunity for institutional mediation ( Allouche et-al 2015); and
- Institutional innovations to both develop nexus based policies and catalyse their mainstreaming (IUCN/IWA 2013).

[20] Ground breaking research by the International Food Policy Research Institute showed that environmental stream flows and access to water by the poor both increase directly with increases in the economic efficiency of water use.

#### 3.2.3.3 Scale

A very important and compelling nexus narrative, frequently encountered in the literature and helping to differentiate the nexus from the IWRM paradigm concerns scale. This is not scale in any quantitative sense, but rather concerns the arena within which a particular nexus solution has to be found*: "…another variance concerns the scale at which interaction is anticipated…"* (Benson et-al 2015). For instance, although there is no alternative to food self-sufficiency at the global level there are in principle, myriad alternatives at the household level. As O'Rourke once pointed out (1994) there are a lot of landless people in Manhattan, but they don't all graze their goats in Central Park. Thus without a perception of scale, satisfaction of a global priority may exacerbate local concerns (Allouche et-al 2015); or as Dupar and Oates put it (2015) *"…framing the problem in a nexus way is useful…..if the approach calls for trade-offs and open transparent negotiation of resource trade-offs among concerned stakeholders* at the appropriate scale….".

Aptness and clarity of scale is fundamentally important *"….when responding to nexus challenges. In practice, the impacts of resource trade-offs occur primarily at the local level. The national level is where development objectives related to the nexus are conceived and managed. Climate change poses a risk to resilience at the global level…."* And actual interplays between water, energy and land resource are typically location specific so *"…location and scale matter in considering the associated development opportunities or constraints…"* (Pegasys 2014). For instance the *"….energy sector is more often linked to river basins (basin level infrastructure and power pools)…"* (IUCN 2015), whereas *"…water and its management are essentially local rather than global and local problems need global support not global rules…"* (Muller 2015). Because of this *"…managing trade-offs locally and nationally may become more important in future…..while making the most of the opportunities to manage nexus trade-offs at a national level, where the trade-offs may be less acute……"* (Pegasys 2014). Equally *"…each project should be evaluated on its own merits and demerits, and not blanketed under prejudice. It is difficult to accept that all dams have the same negative impacts at world level…"* (Solanes 2015). There are also socio-economic and/or demographic scale related issues that differentiate the agriculture and energy sectors *"…. In the oil and gas supply chains there is no equivalent to the half-billion or so farmers, mainly on small commercial farms and on subsistence farms. In the food supply chains there is no equivalent to the national oil companies in the major oil-exporting economies or the exploration and marketing companies of the OECD and emerging economies…."* (Allan et-al 2015).

Scale has clear infrastructural implications. For instance, because – just like food security - other than large dams *"…which are a state level issue…"* a continuum of storage options emerges the more that solutions are decentralised (Allouche et-al 2015), solutions that can be developed on a more ad-hoc, locally responsive fashion. The same is true of energy according to Ferroukhi et-al (2014): *"….local modern bioenergy resources, where available, can be used to improve access to modern energy services while also meeting on-site energy demand for electricity and heating in the rural economies…."*.

Application of the nexus at an appropriate scale also avoids complexity and the widely acknowledged problems encountered when trying to imprint an IWRM basin level solution across political and civil administrative boundaries (Muller 2015). Nonetheless as warned by the IUCN (date unknown) environmental flows achieved by localised nexus solutions will *"…only ensure a healthy river if they are part of a broader package of measures applied at river basin scale - this is at odds with the nexus understanding of scale - but in this context, scale should include natural infrastructure such as wetlands, floodplains and aquifers…."*. Accordingly *"…one answer would be better integration of sectoral policies with water management at different governance levels…"* (Benson et-al 2015).

### 3.2.4 Effect of Polices, Institutions and Scale

#### 3.2.4.1 On Specification and Design

According to Muller (2015) "…the alignment of environmentalism with the core economic priority has recently been facilitated in Northern Europe by the idea of ecological modernisation". The emergence of the nexus can be seen as an assertion of the modernists who accept the Anthropocene reality and seek to create a sustainable, albeit, different environment, surely a description of the 21st century's progressive businesses…". But in construing the nexus as a specification and design norm, it is necessary to recognise that "…there are different ways to understand a problem…" (Allouche et-al 2015) and that it can be applied more generally, not just as a developed country option, but anywhere so long as i) the country in question's "…development and sustainability goals…" are overlain "… on a distinction between the natural resource endowment and the infrastructure and institutional systems set up to supply water, generate energy and cultivate food…." (Pegasys 2014); and ii) political realities are not obscured by technical debates (Allouche 2015). According to Smith and Bergkamp (2013) for instance a "..more complete and broad cross-sectoral thinking is required to deal with the challenges around water, energy and food production efficiencies, trade-offs and cross-sectoral impacts…"; but which entity might be the best for doing this?

Notwithstanding that different stakeholders understand the nexus differently (Allouche et-al 2015)[21], according to Allan et-al "….major supply chain players would be the key agents that could most effectively analyse, and subsequently engage, to address the current contradictions that were becoming evident as a consequence of the attempts to develop a grand nexus approach….".

Nonetheless, and regardless of whose opportunity it might be, it is important to understand that nexus specification and design should address three core problems: i) over-used resources; ii) poor or inappropriate infrastructure; and iii) inadequate institutional capacities for the management of both (Brabeck-Letmathe 2015), added to which Dupar and Oates (2015) wonder if "….nexus thinking, and climate compatible development complement each other?…".

What then are the technical issues and options that have to be taken into account when specifying or designing a nexus response? By way of answering this, it is first noted that decisions that are not well informed with scientifically sound information "…..may lead to weak resilience at later stages. This is particularly seen in the evolution of both infrastructure and institutions for governing the use of natural resources….", and that "…the most resilient economic systems combine robust infrastructure, flexible institutions and functioning natural capital. Resilient economic systems will be those that benefit from and reinforce the preservation of the natural systems on which they ultimately depend….[and these]…require coherent and effective planning of water, energy and food that balances consumption, production and trade requirements against the country's natural resource endowments….Strategies to meet a country's development and sustainability goals are most resilient where they build on a clear analysis of the particular nexus resource challenges faced in that country context.." (Pegasys 2014). Specifications and designs should therefore be location specific. And because nexus solutions can be decentralised (Allouche et-al 2015) they should also be scale sensitive (sub-section 3.2.3.3 referred).

In addition, they should be innovative because according to Bellfield (2015) "….New and emerging technologies can …… improve resource management and efficiency across the water-energy-food nexus….". Despite this Allouche et-al (2015) have expressed concerns that nexus approaches so far have not been especially innovative, at least with respect to natural resource allocation and management.

[21] which surely underscores the need for a convincing nexus concept

Some commentators (such as Muller 2015) speculate that the nexus is a return to the principles of Mar del Plata – and suggest that if so it "…should be construed as an agenda for large scale infrastructure.." because as Allouche et-al (2015) point out, large infrastructure is generally a basin or state level concern whereas, alternatives can and have been approached on an ad-hoc basis at different scales.

In addition, the nexus approach to the specification and design of a solution "…evaluates dams against other alternatives…" (Solanes 2015) that could satisfy the same needs or objectives and as such could even confirm to differing systems of consuetudinary rights. In addition, for governments interested in generating or expanding opportunities for their industrial sectors "…hydropower diverts attention from other renewables which may have more commercial potential…" (Muller 2015).

The nexus approach also recognises that regardless of whether it is for agriculture or energy, there is i) a continuum of water storage options and ii) that water can be stored in systems that include several components, both natural and man-made, rather than single large entities in the form of dams (Allouche et-al 2015). In this context, Smith and Bergkamp (2013) remind us of the desirability of mixing engineered (man-made) and natural infrastructure which according to Smith (2015) "… includes wetlands…flood plains and marshes…". Equally, "…Nature can substitute, safeguard, or complement built infrastructure projects in ways that are proven to be effective and cost-competitive with business as usual. Natural infrastructure, such as forests, floodplains and riparian areas, can provide many of the same services as built infrastructure, including the ability to filter water, minimize sedimentation, and reduce the impact of floods, along with additional benefits, such as the ability to sequester carbon and even provide food…." (IUCN/IWA 2014).

Storage of water in linear systems has in fact, the potential to increase its productivity and the economic efficiency of its use (Riddell 2014). This is in part because linear systems open up more opportunities for water use planning to cover multiple sectors, while "….recognising interrelationships between rainfall, flows in streams and underground…" (Muller 2015).

Similar considerations can be applied to energy. Experience has shown that as an alternative to specifying and designing energy solutions based on hydropower "…energy produced from biomass can contribute to food security as long as it is sustainably produced and managed. The production of bioenergy in integrated food–energy systems is one such approach…. an integrated food-energy industry can enhance food production and nutrition security, improve livelihoods, conserve the environment and advance economic growth… In the United States, for example, nearly 840 gigawatt-hours (GWh) equivalent of energy was generated in 2013 by anaerobic digesters placed on farms, which utilise a wide range of agricultural crop residues, animal and food wastes to generate usable energy on-site in the form of electricity or boiler fuel for space or water heating." (Ferroukhi et-al 2014). Similarly "…Large-scale deployment of solar pumps can support the expansion of irrigation, reduce dependence on grid electricity or fossil fuel supply, mitigate local environmental impacts and reduce government subsidy burdens. Recognising these benefits, several countries have launched programmes to promote solar pumping. India, for example, has announced plans to replace 26 million groundwater pumps for irrigation with solar pumps" (Ferroukhi et-al 2014)[22]. However, it should be noted that India's experience of free energy for pumping has not been a happy one for its water resources and its natural environment!

[22] But it should be noted that solar power panels have been associated with freshwater pollution (http://news.nationalgeographic.com/news/energy/2014/11/141111-solar-panel-manufacturing-sustainability-ranking/) and where solar power is used for thermal power generation it uses a great deal of water and as such is not a silver bullet (http://blogs.worldbank.org/water/cutting-water-consumption-concentrated-solar-power-plants).

Finally on the subject of specifications and design are the associated matters of monitoring, feedback and replication. Smart suites of monitoring indicators can for instance "…capture the interests of other sectors…" (IUCN 2015) and thereby be used by managers to achieve multi-purpose benefits. This of course requires an acknowledgement of the "…theoretical core of the nexus approach which argues that although subsystems such as water, agriculture and energy can be analysed independently, doing so would overlook the multiplicity of feedbacks and interdependencies that jointly affect the sustainability of the broader social-ecological system…" (Villamayor-Thomas, et-al 2015).

Smart monitoring and cumulative feedback processes are not only essential for improved management, by confirming what is working and what is not, they also provide the building blocks of replication and scaling up.

#### 3.2.4.2 On Operational Matters

In this context "operational matters" refers to i) the extent to which infrastructure is being, or could be operated for multi-purpose benefits; or ii) the potential knock-on effects that operational approaches in one sector might have on another. The first thing to note is that beneficial multi-purpose use requires a commonality of understanding between stakeholders. But *"…different stakeholders…"* have *"…different understandings of the nexus"* and any possible cooperation, including any market based approaches, remains constrained by *"…institutional compartmentalisation…"* (Allouche *et-al* 2015).

That being said, there is some low hanging fruit concerning cooperation between stakeholders that can be picked with minimal challenges. The most obvious is irrigation water management. Agriculture accounts for 92% of the water consumed by humanity (Allan *et-al* 2015), but this could be significantly reduced either by increasing return from flows from irrigation schemes, or by increasing their distribution and on-farm water use efficiency. However, for the latter to work there have to be institutional mechanisms and perhaps physical facilities to reallocate the water longitudinally towards an appropriate nexus solution downstream rather than for expansion of the irrigated area where it was saved (Riddell 2014, Cai, Ringler *et-al* 2001). Reallocation mechanisms could involve the trading of saved water at its economic resource price (Riddell 2014) in other words by means of resilient economic systems *"….that benefit from and reinforce the preservation of the natural systems on which they ultimately depend…."* (Pegasys 2014). Such mechanisms, by introducing *"…economic and regulatory instruments to strengthen the incentives and requirements for building resilience into water, food and energy systems…"* (Pegasys 2014), not only have the potential to serve nexus interests, they also reward wise use rather than punishing bad (and hence would be politically cheap), and if built around rights based systems that include customary use, they are also pro-poor.

The problem is that increased irrigation water use efficiency comes at a price.

- Firstly, infrastructure is needed to increase return flows; ensure precise water management or provide irrigation on demand (which counter-intuitively saves water, because being assured of water when they need it, farmers tend not to panic fill their fields when water is available).
- Secondly, precise water management requires energy - obviously for pressured irrigation, but also for open channel systems where precision directly depends on head difference across management structures – (Bellfield 2015). But so does irrigation on demand because it is predicated on downstream level control and low level field channels from which water must be pumped. This is another reason why irrigation on demand works because farmers do not over irrigate if they are paying for the energy (Riddell 2014).
- Thirdly, increased irrigation efficiencies accruing to improved drainage/enhanced return flows can have a detrimental effect on groundwater recharge and the stream flows that depend on it (Bellfield 2015).

The wise reallocation of saved and/or recycled water - and indeed energy (excesses of which can be recycled by means of batteries or pumped storage schemes) - increases the productivity of both by using what might have been wasted when used as an input to a single use especially if the reallocations are catalysed by *"…economic incentives for efficient use.."* (Pegasys 2015) – that is another way to reward wise use.

Investment in the infrastructure which is needed to improve resource use efficiency and in the capacity building and institutional arrangements needed to operate the infrastructure an market mechanisms remains constrained by unhelpful *"….political decisions which need more open and transparent decision making based – in part – on an acknowledgement of uncertainties.."* (Allouche *et-al* 2015). Such approaches to decisions on investment currently perpetuate real time problems concerning *"…overuse, poor infrastructure and poor management…"* (Brabeck-Letmathe 2015). And these persistent problems are not helped by the prevailing silo mind-set which continues to characterise typical institutional landscapes, especially where certain line-ministries are more powerful than others.

Together these challenges clearly introduce a range of operational risks and opportunities of nexus relevance; *"…the vital challenge for policymakers is how to put in place a framework in which those risks and opportunities are engaged in a collaborative way by all who have a role to play. The alternative, competition to control resources, is one feature of today's incoherent responses to the water-food-energy nexus, which undermine resilience…."* (Pegasys 2014).

The extent to which the risks and opportunities have indeed been engaged in a collaborative fashion will be examined - drawing on the stakeholder consultations and case studies - in Section 4.1 "Emerging Themes" below.

#### 3.2.4.3 On Financing

The first issue to note with respect to the question of financing is that "…as basins become more crowded, as populations grow and climate change takes effect, more solution providers will be required, and increasingly this will involve many [of them] delivering for broad public service agendas…" (IUCN/IWA 2014). Although this comment may be construed as being more relevant to institutions than financing, it is included here because a multiplicity of diverse service providers within the nexus suggests the possibilities of equally diverse financing possibilities. Common to any investment in nexus infrastructure or service delivery is a "…comprehensive economic analysis to help decision-makers with water management.." for this, "…a step-wise process involving several stages is forwarded by the WEF, involving identifying demand and supply gaps over long temporal scales, examining efficiency improvements and technical options for addressing gaps, identifying implementation resources and then introducing suitable incentives…." (Benson et-al 2015). Thorough pre-investment appraisal along these lines will however, have to acknowledge not only the need for efficiency improvements and technical options, it will also have to allow for environmental and social externalities (Pegasys 2014). It should also look at why investment is needed in the first place, because there is the possibility that a proposed investment will address the symptoms and not their cause. This is for instance because: "….despite massive investments in storage (estimated at USD $3 trillion in the last 30 years) there has been negligible increase in water stored because of siltation…" (Brabeck-Letmathe 2015) hence earlier investments in watershed conservation and better land management would have avoided the need for a new dam. But political economy would seem to favour concrete monuments rather than grass roots environmental measures. And political economy in emerging markets that are beginning to enjoy increasing availability of public finances may "…compromise transboundary accountability and cooperation…" (ICA Secretariat 2012).

But as the IUCN/IWA point out (2013), there is a considerable range of obstacles in the way of comprehensive, accountable and cooperative pre-investment appraisal. They include:

- Dis-connectivity in policy, infrastructure and institutions.
- Lack of functional regional agreements.
- Inadequate institutional capacities, knowledge, information and awareness.
- Out of date thinking and a lack of creativity, hence poor uptake of new approaches.
- Silo based mentalities with highly differentiated stakeholders different across the three securities (water, agricultural and energy) with no interest in mutually beneficial trade-offs and compromises.
- A need for new environmental safeguards as new impacts across the three security silos.
- Limited attractiveness for private sector to investment.

The last bullet point is particularly interesting because despite the perceived limited attractiveness, the private sector is looking for opportunities in all three nexus sectors and in many emerging markets. The Development Finance Institutions are also vigorously promoting Public Private Partnerships for the same purpose[23]. Because it is more likely to understand an integrated supply chain than public silos, the private sector could in fact be the more effective at analysing and subsequently resolving "…the current contradictions that are becoming evident as a consequence of the attempts to develop a grand nexus approach…." (Allan et-al 2015). After all, as pointed out by IUCN/IWA (2014) "…Business connection to the nexus – at its most basic - is through the delivery, production or supply of energy, food or water, and through the interconnection and reliance on any one of these in inputs to their own business model…." And as we have already noted "…as basins become crowded, as populations grow, and as climate change takes effect, more solution providers will be required, and increasingly this will involve many delivering broad public service agendas….".

The problem is that the same source suggests that nexus projects are "…struggling to attract private sector investments….'. Nexus advocates need therefore to establish a common vocabulary where vital public services in the delivery and conservation of nexus commodities can be articulated in terms that investors can understand and respond to (IUCN/IWA 2014). Instead of attracting investors to potentially interesting nexus opportunities (mobilising thereby commercial discipline and non-state finances) it is proving difficult to divert their attention from "…the risk to the profits of business as usual" because "…in the past decade there is much evidence of corporate awareness of their vulnerabilities to both local water and global energy scarcities…" (Allan et-al 2015). Also, profits into the long term require service delivery and value addition, not just primary resource exploitation, but as Pegasys point out (2014) "The focus for the nexus during the developing stage is on resource exploitation (energy extraction and food cultivation). This requires prioritisation of investment to overcome the infrastructural and other constraints on the use of these resources….". And in a similar vein the evidence shows that "….strategies and business models tailored to the regulations and laws of nature markets do not translate well into the markets of emerging countries, many of which are characterized by opaque regulatory climates, weak institutions, and invisible influence networks that may expose companies to unacceptable legal and reputational risks. Water, food and energy ecosystem actors have not yet agreed that cross-sector collaborations make sense and align to their needs….." (IUCN/IWA 2014). Even so, because of commercial discipline and their interest in sustainability: "…commercially viable Nexus projects will have a greater chance for long-term impact….." (IUCN/IWA 201).

But as Allan et-al point out (2015), the private sector's primary - and indeed statutory - responsibility is to its shareholders and not to the environment or state players in The Nexus. As yet there are very

[23] A word of caution is needed here because PPPs are not the silver bullet that many DFIs consider them to be; and outsourcing contracts which are often promoted as PPPs are not actual partnerships, and hence are not subject to the same commercial disciplines that genuine partnerships need to be.

few accounting rules to focus the investors' attention to these things. In addition, investors tend to avoid multi-purpose ventures because the transaction costs can be prohibitive, as in the case for instance of irrigation service delivery from a private hydro-power dam (Solanes 2015).

Another challenge regarding the mobilisation of commercial investors into nexus opportunities concerns the fact that "…where private investment is concerned, judicial processes tend always to favour the investor - but because this is so, countries are tending to be "reluctant to bring in international investors" (Solanes 2015). And the private sector can also be cynically exploitative in fulfilling its statutory responsibility to provide its shareholder with profits. In Chile for instance non-used power generation rights "…are kept on hold, utilized to block other generation rights and eventually played as bargaining chips to delay approval to bona fide generation projects, until a payment is made to the speculator…" (Solanes 2015).

Nonetheless the potential benefits of involving the private sector outweigh the risks so long as there are transparent and well enforced economic and regulatory frameworks to strengthen the investment incentive, reduce the risks and build the necessary resilience into the system (IUCN 2015 and Pegasys 2014).

### 3.2.5 Winners and Losers

This section considers the ways in which the various issues encountered in the literature impacts the four classes of stakeholder adopted in sub-section 2.1. Some of the issues are obviously relevant to more than one stakeholder, and as the Impact Typology in Table 2 showed, a win for one class of stakeholder could be a loss for another. In order therefore to avoid clumsy repetition, the issues are dealt with in a tabular fashion in sub-section 3.2.5.2. Before proceeding to it however, there are some stakeholder neutral issues to cover.

#### 3.2.5.1 Neutral Issues

The first, and very significant point to note in the context of winners and losers, is that nexus "alarmism" does not just emanate from the "usual suspects". Because in some ways it begins with the scarcity discourse, it has become an urgent matter both for the survival of all humanity, a matter which engages everyone in *"...the race for what's left: the global scramble for the world's last resources..."* (IUCN 2015); with specific concerns being raised by the global business community and political establishments (Allouche *et-al* 2015). Difficulties emerge however, because *"...different sectors have different objectives, frameworks, tactics and language..."* (IUCN 2015).

Economics also play an important role, because water, agricultural and energy security are subject to global prices shocks while technological advances that improve efficiencies in one sector may increase costs in another: the energy costs of irrigation water use efficiency being a prime example (Bellfield 2015).

Another key issue is that both winners and losers share important knowledge gaps. For instance:

- demand-led technological and market solutions are developed in ignorance of supply side limits and political realities (Allouche *et-al 2015*).
- Major asymmetries in the use of economic sectors in the water-food-trade and energy-climate change sub-nexi are largely unquantified (Allan *et-al 2015*).
- There is a risk that socio-economic and environmental impact assessment remain generic in the absence of the finely tuned data needed to evaluate each investment on its own account (Solanes 2015)
- Trade-offs need to be understood in quantitative terms and incorporated into pre-investment appraisal/due diligence processes (Solanes 2015)

The dynamics of political economy are once again important, not least because of possible inconsistencies between global priorities and local concerns - the scale issue once again (Allouche *et-al* 2015):

- as noted before, different stakeholders have different understanding of the nexus issues.
- Resource allocations are political decisions.
- The nexus as a systems approach fails to engage with the international political economy of food and energy (Allouche *et-al* 2015).
- Where countries or regional groupings depend, even in part, on international development financing there is a potential disconnect between donor and local interests. For instance SADC wanted hydropower, but what it actually got were river basin organisations and capacity building for IWRM (Muller 2015).
- There is a pernicious tendency to "cook the books" for reasons of political economy when estimating the benefits of public investments (Riddell 2014, Solanes 2015).

### 3.2.5.2 Winners and Losers in the Stakeholder Landscape

This sub-section ends the literature review with a simple table (Table 5), beginning with multiple wins and progressing down to multiple losses, that indicates whether or not a stakeholder class wins, loses or remains unchanged as a result of various issues raised by the literature review.

TABLE 5 WINNERS AND LOSERS IN THE INSTITUTIONAL LANDSCAPE

| ISSUE | | State entities | Pop-ulations | Private sector | Environ-ment |
|---|---|---|---|---|---|
| **Type** | **Description** | | | | |
| **ECONOMIC** | The world system needs more trade flows in agriculture across more countries and virtual water flows | winner | winner | winner | winner |
| **ECONOMIC** | Land uses for energy and food production are closely related, and can be made compatible. The production of bioenergy feedstock, in particular energy crops but this can be addressed by improving land-use efficiency and the use of agricultural waste. | winner | winner | winner | winner |
| **ECONOMIC** | Agricultural water users can be given economic incentives to save water. | winner | winner | winner | winner |
| **ECONOMICS** | a single unit of water can serve multiple uses which increases the economic efficiency of its utilisation | winner | winner | winner | winner |
| **PLANNING** | Water management can be carried out in practically integrated ways based on multiple-use planning from the start and recognition of the interrelationships between rainfalls, flows in streams and underground. | winner | winner | winner | winner |
| **ENVIRON-MENTAL** | Infrastructure helps to unlock the value water brings to societies, but can also contribute to the degradation of natural ecosystems - impacting thereby downstream production (productivity) and people. | winner | winner | winner | loser |
| **ENERGY** | Renewable energy is seen as a reliable alternative to meeting growing energy demand for water pumping and conveyance, desalination and heating, while ensuring the long-term reliability of water supply. | winner | | | winner |
| **ENVIRON-MENTAL EXTERNALITY** | Benefits from the hydropower dam is reduced deforestation and soil erosion because of reduced demand for firewood | winner | | | winner |
| **ECONOMIC** | Energy security is generally meant to mean energy to ensure economic growth (not the same as energy for all) | winner | loser | winner | |

| ISSUE | | State entities | Pop-ulations | Private sector | Environ-ment |
|---|---|---|---|---|---|
| **Type** | **Description** | | | | |
| **ENERGY** | Palm oil expansion is affecting smallholder food production. This expansion is expected to increase if/when demand for biodiesel picks up in Europe. This is not to say that palm oil is bad, rather it should be expected in a way that benefits small producers not large estates | | Loser, but potential winner | | winner |
| **ECONOMIC** | Links can be made between healthy eco-systems and cross-sectoral distribution of economic benefits | | winner | | winner |
| **ECONOMICS** | For many OECD countries water is an area of commercial opportunity | | | winner | |
| **ENERGY** | More use of rain fed agriculture uses less water and energy than irrigated systems but has trade-offs in terms of lower productivity and greater vulnerability to drought. | | loser | | winner |
| **ECONOMIC EXTERNALITY** | The scarcity values of water embedded in food and manufactured commodities are not reflected in the prices paid by consumers for the goods they purchase in private-sector markets. Because the exchange values along the supply chains have been very severely distorted by subsidies and taxes, the costs of degrading water and other ecosystem services have been invisible and until recently ignored | | winners | | loser |
| **ENVIRON-MENTAL EXTERNALITY** | The intensive use of pesticides and fertilisers to improve agricultural yields impacts water quality through run-off. | | winner | | loser |
| **ENERGY** | Relationship between free energy and groundwater depletion in India, solving one problem (energy) created another on (over exploitation) | | winner | | loser |
| **ECONOMIC EXTERNALITY** | In the food supply chain consumers, legislators and markets conspire to provide under-priced cheap food where the cost of water cannot be considered hence increasing competition for water leads to many hot spots worldwide, where the need to restore the ecosystem services of blue water has become vital | | winner | | loser |

| ISSUE | | State entities | Pop-ulations | Private sector | Environ-ment |
|---|---|---|---|---|---|
| **Type** | **Description** | | | | |
| **ECONOMICS** | Trade can be mutually beneficial in nexus terms, where a country with one kind of resource scarcity trades with another country with a different mix of resources. But trade can also result in externalities that exacerbate resilience challenges elsewhere: for example, the water-abundant UK imports soft fruits from more water-stressed countries such as South Africa. | winners and losers | | | |
| **ECONOMIC** | Commodification of resources can ignore environmental externalities. | | | | loser |
| **ENERGY** | Food and energy production interfere with each other when power plants replace food plantations and lead to increased food prices. | | loser | | |
| **ENERGY** | Drainage for large palm oil estates takes water out of circulation for local use. | | loser | | |
| **ENERGY** | Hydropower diverts attention from other renewables which may have more commercial potential. | | | loser | |
| **ENERGY** | The processing of fossil fuels, including newer sources such as shale gas, is water intensive, as is the electricity generation process itself. | | | | loser |
| **ENVIRON-MENTAL EXTERNALITY** | It is possible that nexus thinking under-plays environmental externalities. | | | | loser |
| **SECURITY** | Some nexus solutions may increase food insecurity risks for the poor | | loser | | |
| **SECURITY** | If resources that support production are not immediately rendered secure, then "the overall consequences of such unique changes will substantially reduce the standard of living. | | loser | | |
| **SOCIAL** | Consuetudinary uses and local rights are negatively affected by large infrastructure projects. They affect the nexus among water, energy and staples that sustain local populations. | | loser | | |
| **REGULATORY** | Problems are compounded in countries affected by land and water grabbing processes, where governments grant and charter large chunks of land and water without assessing water availability and water users. | | loser | | loser |

| ISSUE | | State entities | Pop-ulations | Private sector | Environ-ment |
|---|---|---|---|---|---|
| **Type** | **Description** | | | | |
| **ENVIRON-MENTAL** | Between 1997 and 2011, the estimated loss in annual services from ecosystems was $2.7 trill for swamps and floodplains and $7.5 trill for tidal marshes and mangroves. An ADB study estimates that poor river health in Asia could end up costing $1.75 trill annually. | loser | | | loser |
| **ECONOMIC EXTERNALITY** | Losses along the food supply chain represent waste of resources used in production, such as water and energy | loser | | | loser |
| **ENVIRON-MENTAL EXTERNALITY** | Water-efficient irrigation systems are more energy intensive and can negatively impact aquafer resources through increasing consumptive use and reducing return flows of water through evaporation. | loser | | | loser |
| **SUPPLY SIDE LIMITS** | Emergent framing of the nexus leads to demand-led technological and market solutions that ignore supply side limits and political dimensions. | loser | | | loser |
| **ENERGY** | Hydraulic fracturing requires huge amounts of water and threatens to pollute groundwater. | | loser | | loser |
| **PLANNING** | Large dams embody the nexus and challenge Dublin IWRM while offering multi-purpose resource management options, but with potential social and environmental downsides. | | loser | | loser |
| **SECURITY** | Water security elements – access, safety and affordability – are affected by the energy and food sectors. | | loser | | loser |
| **SECURITY** | In less developed countries the national planning focus often concerns improving access to the country's key resources, rather than managing the trade-offs between them, or ensuring the long-term supply of those resources. | loser | loser | loser | loser |

## 3.3 The Case Studies

In accordance with the Terms of Reference, this section provides an overview[24] of "….relevant case studies and projects discussed during the IWA/IUCN Africa Nexus workshop…" and '…other regionally relevant material…".

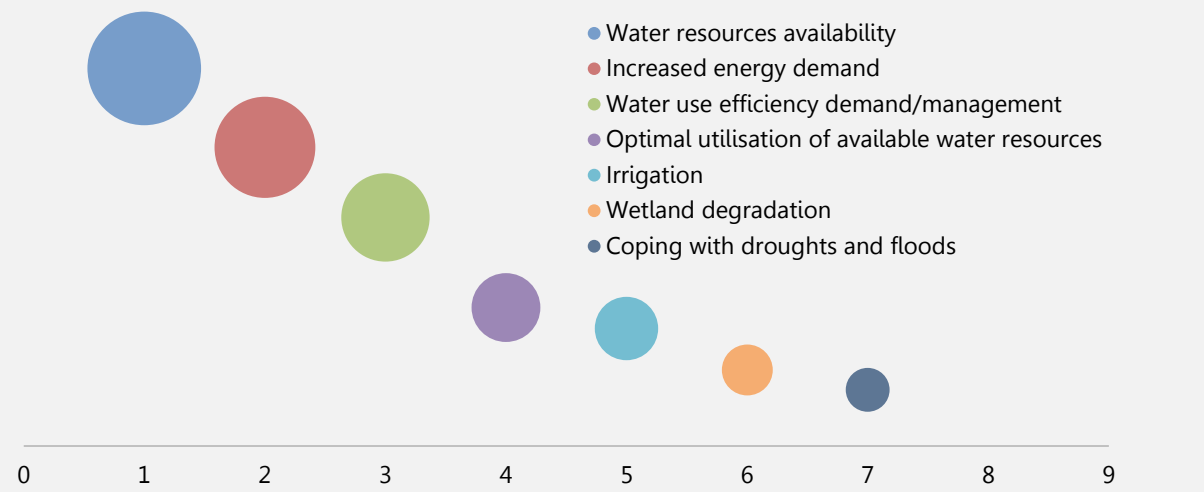
### 3.3.1 Case Studies from the Africa Nexus Workshop

Before looking at these case studies, it must be understood that each was predicated on a river basin. Although the 35 participants represented a variety of constituencies, 13 of them represented water resources. In addition, the workshop itself was planned by a team almost exclusively comprising water experts. The literature consistently made it clear that The Nexus is different from IWRM because it is neither hydro-centric, nor is it based on hydrological planning units. The nature of the participants' profile and the basin focus of the case studies is likely to explain why each of the case studies are either heavily or entirely focussed on water problems!

#### 3.3.1.1 Lake Victoria Basin

According to the consensus of the Africa Nexus workshop, water availability is the main problem in the Lake Victoria Basin. On first consideration, this appears somewhat inconsistent with the "nexus relevant" problems articulated by riparian stakeholders during the preliminary design phase of the Nile Basin Decision Support System (NB DSS - Table 3 referred). However, if the issues in Table 3 are ranked in terms of the number of countries with the problem and the national ranking of the problem, the primacy of the water availability challenge is confirmed – see Figure 6 where the horizontal axis shows the ranking and the size of the "bubble" captures the relative importance of the issue (developed from Riddell 2008).

FIGURE 6 RANKING OF THE PROBLEMS FACED IN THE LAKE VICTORIA BASIN




Although the workshop made no specific reference to a nexus style approach for solving these problems, some of the proposed solutions – if correctly applied – have considerable nexus potential. On the other hand, others have less so, as shown in Table 6.

[24] That is to say, rather than provide reworked or summarised versions of existing material, the approach has been to tease themes of specific relevance to this document out of the case studies.

TABLE 6 NEXUS SOLUTIONS IN THE LAKE VICTORIA BASIN

| Problem | Solution proposed at the workshop | | |
|---|---|---|---|
| | **Small dams (including for micro-hydro)** | **Soil and water conservation** | **Rain water harvesting** |
| ***Water resources availability*** | self-evident | water conservation is self-evident, but soil conservation will reduce sedimentation of storage facilities and may increase groundwater recharge | self-evident |
| ***Increased energy demand*** | Self-evident | | There is a possibility that too much localised water harvesting may reduce the amount of water available for power generation |
| ***Water use efficiency/demand management*** | depends on how efficiency is defined, but unless it refers to economic efficiency, these solutions have no obvious relevance to the problem. | | |
| ***Optimal utilisation of water resources*** | this is a largely institutional opportunity | | |
| ***irrigation*** | small dams can be used for irrigation and depending on the energy balance, these dams may provide enough energy for high precision irrigation | has the potential to increase the productivity of green water and hence reduces the need for irrigation | ideal for high value crop production or supplementary irrigation |
| ***Wetland degradation*** | could reduce stream flows into wetland | reduced (anthropogenic) soil erosion would reduce sedimentation in wetlands; water conserved in wetlands would also be beneficial | could reduce stream flows into wetlands |
| ***Droughts and floods*** | Self-evident | Increased flooding is often associated with degraded catchments so this will help | Would reduce runoff rates and save water |

Despite the convincing nature of most of the proposed solutions, participants also identified a range of significant obstacles to implementation.

- There is a reported lack of agreement across the basin in terms of both the problems and mutually beneficial approaches to their solution; a problem which was encountered repeatedly during the design stage of the NB DSS when promising positions reached between the basin hydrocrats were sacrificed on the altars of national political economy. At this point, it is noted that the participants recommended a decentralised approach for each of the solutions. This could be considered less threatening in a trans-boundary sense and therefore has potential for avoiding the problems of political economy.
- There is a reported lack of information and data needed to implement the solutions. Again, this was very much the case during preparation of the NB DSS and made clear by the quality of data and information contained in the different riparian's country baseline reports.
- Institutional capacities and available resource remain inadequate.

It is tempting to suggest that each of these problems could be addressed by the Nile Basin Initiative which even has its headquarters in the Basin. But this assumes that the NBI has the same level of support, commitment and expectation from its members – which has yet to be demonstrated. Nonetheless, despite possible "buy-in" problems[25], the NBI's Nile Equatorial Lakes Subsidiary Action Programme (NELSAP) investment agenda promotes power development; power transmission, interconnection and power trade; water resources management; management of lakes and fisheries; agricultural development and control of water hyacinth.

To what extent these initiatives are being planned is not clear from the website (http://nileis.nilebasin.org/content/nile-equatorial-lakes-subsidiary-action-program) but the huge effort that has gone into the DSS, including national capacity building, has equally huge potential for a desirable nexus result.

#### 3.3.1.2 The Niger River Basin

The workshop participants identified the main problem in the Niger Delta as "resource squeeze" characterised or caused by competing uses; increasing demand; conflicts; high variability; population growth and development pressure. Other sources include climate change as another problem (Golden and Few 2011).

In more detail, water availability and flood cycles in this highly seasonal river - on which seasonal wetlands of great economic, socio-economic and habitat significance depend – has been severely compromised by hydropower development and extensive irrigation schemes.

To fix this, workshop participants proposed strengthened cross sectoral integration at the regional level; combined with decentralised options assessment; better infrastructural designs. In the absence of capacity building however, these approaches would have limited utility. Hence, a range of institutional measures was suggested, including:

- The establishment of an enabling environment for a wider array of options, not least for the private sector (because of its implicit resource use efficiency). The facilitation and even catalysation of a wider array of investments options is consistent with a nexus approach because it provides an opportunity for the private sector to invest in alternatives to hydropower.
- Strengthening technological and scientific capacity so as better to inform and legitimise trade-offs and synergies.
- General capacity building for improved nexus oriented dialogue and "buy-in".

#### 3.3.1.3 The Orange-Senqu River Basin

According to the workshop participants, the main problem in the Orange-Senqu Basin are the increasing multiple demands on its finite water resources. However, as will be shown below the basin is also facing numerous governance and environmental threats including one which if not urgently dealt with, will condemn a significant part of the basin to an everlasting cycle of droughts and floods; compromise the basin's entire water economy; and create a socio-economic catastrophe among its poorest inhabitants.

[25] Note to reader: to 'buy into' the decision, that is, to agree to give it support, often by having been involved in its formulation.

In order to address the problem of competition for the basin's resources, the workshop recommended an institutional solution whereby the Orange-Senqu Commission (ORASECOM) would be transformed into a basin authority. ORASECOM (which was established in 2000) has been described as *"..the forum in which issues such as benefits sharing can be discussed, along with other technical issues.....but operational issues are implemented at country scale by the relevant national water ministries...Most of the activities of ORASECOM are of a technical nature, through the Technical Advisory Committee, but its overall goal of balance economic development is supported at both this technical level, and also at the political level through ministerial representation...If agreement cannot be reached on technical solutions to specific issues, discussion reverts to political negotiation...under the jurisdiction of international water law..."* (Sullivan 2014). As such, the workshop's recommendation concerning ORASECOM's elevation to a basin authority is compelling.

Obstacles identified by the participants include a silo mentality within and across sector, and aspirations for independent national water, agricultural and energy security. These are correct[26], but it is important to note South Africa's dominance of the basin's water economy. For instance, its agricultural export sector leaves little room for competition, with the result that for instance, Lesotho exports water to South Africa and imports it back with added value in fresh fruits and vegetables. There is potential to change this however.

South Africa's current water allocation is already some 98% accounted for, yet population is expected to rise by around 30% before the middle of this century. The current assumption is that more will be released from Lesotho, in part to allow growth of the South African agricultural sector. But as will be shown below, reinvigoration of Lesotho's agriculture sector will be essential if the imminent environmental apocalypse is to be averted – better then, for Lesotho to retain its water and export it with added value in fruits and vegetables to South Africa. Accordingly, it is noted that another of the workshop's recommendations is the development of a "nexus decision support system"; but there is already a basin DSS which is reportedly operated as a black box by water managers in South Africa, with riparian unaware of its inner workings. Establishment of a more transparent DSS with a nexus orientation would therefore be timely, so long as the measure was accompanied by the capacity building needed for all riparian to understand the new DSS and participate in its use.

A nexus oriented DSS is also needed to address the broader spectrum of problems that the basin is facing. These are:

- Pollution largely from mining, but also from large-scale agriculture, chicken farms and urban waste water treatment plants. Although pollution is widely acknowledged as a serious concern by the regulatory institutions, *"...the strength of these institutions is quite variable.."* (Sullivan 2014).
- Wetland degradation in Lesotho's highlands, which is largely due to unsustainable grazing practices but exacerbated by different governance systems (the civil administrative system is responsible for regulatory issues while chiefdoms are response for land allocation matters – these two systems are not well aligned in Lesotho). These wetlands, some of which are of a type not found anywhere else, are an essential component of the basin's water tower. What is particularly interesting about this from a nexus perspective is that most of the grazing animals are sheep and goats which are kept for their wool. This wool is of a very high quality and hence the sector, although artisanal, is not poor. The entire sector could be reformed in the direction of small ponds[27], controlled grazing and irrigated fodder lots. This would be one way that an agriculture sector initiative could contribute to a water sector win.
- Another way would be to stop soil erosion in the Lesotho's watersheds. It has been estimated that an average 1.3 tonnes of soil flow across the border into South Africa every second, of every day in every year[28]! This has inspired another commentator to suggest that all the soil will have gone by 2040[29]! If that happens all storage will have been compromised by sedimentation, and instead being attenuated by

[26] The material which follows is based on this writer's recent work in Lesotho where he was responsible for allocating the majority of the forthcoming $EDF_{11}$ grant support for IWRM measures.
[27] The value of the fleece is greater if the animals are soaked with freshwater once or twice.
[28] The "Lesotho IWRM Strategy" of 2009.
[29] http://www.barrymannphotography.com/GN-soil.html

> both natural and built infrastructure, all rainfall will run-off immediately and become raging floods leaving drought in its wake for the rest of the year. Yet there are many agricultural options by which to avoid this, most of which consist of industrial crops with recognised soil binding properties, significant carbon sequestration and high potential for value addition in country. Such crops, which include bamboo and industrial hemp for instance would protect the watersheds and created employment both on and off-farm while avoiding conflict with South Africa over where the region's vegetables are grown. But at present high level political economy which says that "Lesotho is a maize growing culture and should not be growing anything else" perpetuates an increasingly dire threat. A threat for which agriculture represents a nexus solution both for both water availability and hydropower (if the dams are to remain operational by the prevention of sedimentation).

As will be seen below (sections 3.4.4.4 and 4.2), with support from the European Union, authorities in Lesotho are actually in the process of planning a nexus style approach to address all these problems.

#### 3.3.1.4 The Pangani River Basin

Unsatisfied demand for water was cited at the workshop as being the main problem in the Pangani Basin. There are several reasons for this, largely to do with a combination of over-allocations and limited institutional capacity. Climate change is already making things worse and is expected to become even more problematic when Kilimanjaro's glaciers disappear (estimated 2020). Two other factors exacerbate water shortages even further: hydropower development and the fact that unlike typical basins around the world (but like other basins in Tanzania) the bulk of the agricultural development is upstream of the power stations and hence irrigates with water that was intended for hydropower generation.

Related problems concern wetlands that are threatened by disrupted annual hydrographs and pollution, largely accruing to agricultural/agribusiness effluence but in part due also to solid waste. Obviously the reduced flows seriously compromise the river's absorption capacity for pollution.

Acknowledging that water scarcity in the basin has been due largely to allocations in favour of hydropower, the workshop participants suggested that solutions will involve multi-purpose micro dams, green technology and alternative energy sources (specifically solar and wind). These self-evidently are building blocks of a nexus approach. But the participants went further by suggesting a shift to hydroponic crop production by 30% of farmers in the basin. This is not as outrageous as it may first appear because much of the upper reaches of the catchment is planted to high value export horticulture.

Unfortunately the participants identified a considerable list of potential obstacles to the win-win nexus solution they had proposed. These include:

- a lack of political will
- incompatibility of stakeholder interests
- a range of institutional shortcomings such as inadequate technical capacity; limited knowledge and awareness; limited monitoring capacity and an unwillingness to enforce regulations
- lacks of finance and access to new technologies, which themselves have limited availability
- land disputes.

### 3.3.2 Other Regionally Relevant Material

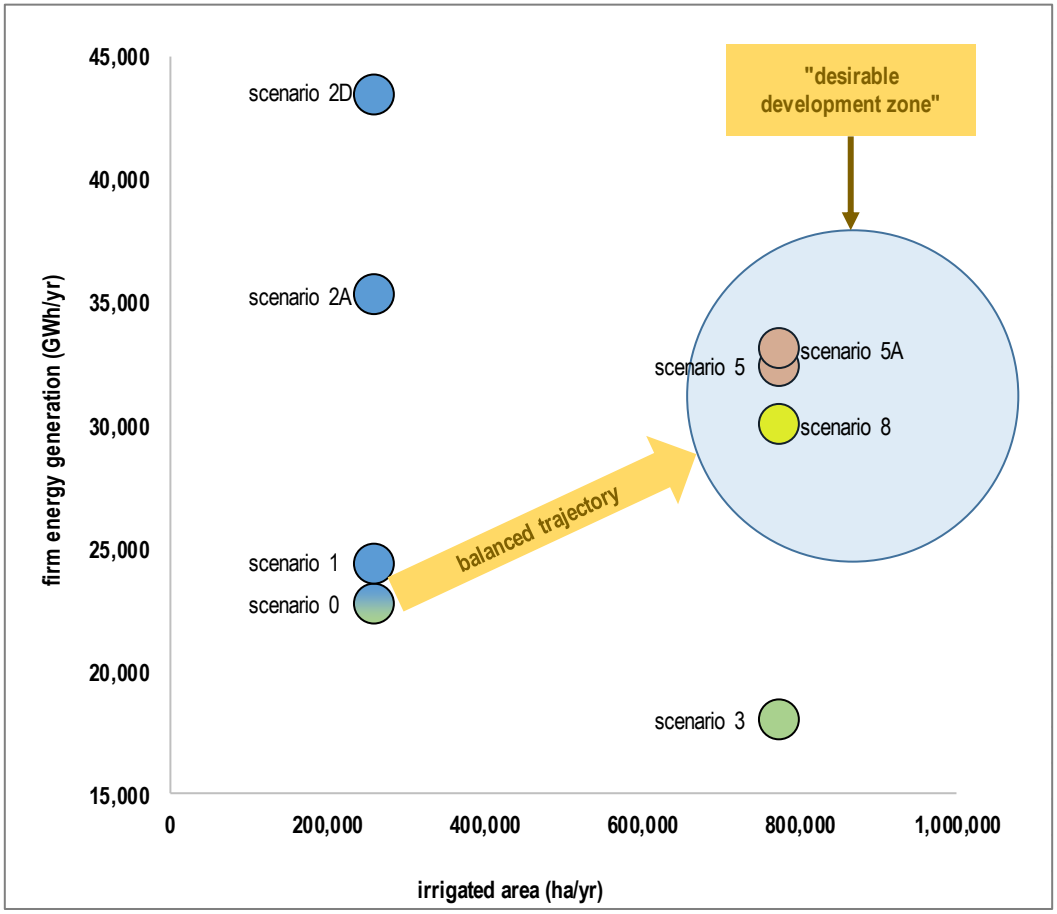
By way of complementing the essentially generic case studies presented above, this section looks a selection of more specific case studies from three other important Africa river basins, including that of the Volta River which is one of the target basis for this report.

### 3.3.2.1 The Zambezi

In 2010 the World Bank published the results of a multi-sector investment opportunity analysis for the Zambezi Basin (Alavian *et-al 2010*). Using a total of 29 different scenarios, the analysis assessed the relative strengths and weaknesses of different combinations of investment concepts for hydropower, irrigation and floodplain restoration in the basins – with domestic water supply and environmental stream flows as unaffected givens in almost every case. The material presented in this sub-section has been taken entirely from the World Bank study but comprises only that which is necessary to establish an appropriate case study for the purpose of the current study – it is not presented as a thorough review of what is a very interesting and very much more comprehensive exercise on part of the Bank.

Despite analysing 29 scenarios the Bank itself homes in on only eight when crafting a graphic reproduced here as Figure 7 which provides a very helpful illustration of how trade-offs work between the three nexus elements; water, agriculture and energy.

FIGURE 7 POTENTIAL FOR ENERGY GENERATION AND IRRIGATION BY DEVELOPMENT POTENTIAL IN THE ZAMBEZI BASIN




Simply stated, the figure illustrates changes in the production of one sector (energy) under a range of development scenarios which include either no change, or a single change in another sector (such as irrigation). It should be noted that irrigated area is not the same as equipped area because an equipped area can irrigate more than one crop per year which obviously increases the demand for water, especially where one season is much drier than the other -as is the case in the Zambezi Basin.

The scenarios examined by the figure are as follows:

- Scenario 0: is the baseline situation which has an installed hydropower generating capacity of 22,776 GWhr/year, and an irrigated area of 260,000 ha. All demand for domestic water supply is satisfied; but

although allowance is made for the restoration of natural flooding in the Lower Zambezi Delta, no other allowance is made for environmental stream flows.

- Scenario 1: shows what happens if power generation is better coordinated (an increase of 7.1% in capacity). As with the baseline case, all demand for domestic water supply and for flood restoration in the lower delta are satisfied; but no allowance is made for environmental stream flows.
- Scenario 2A: assumes that the existing development plans of the Southern African Power Pool are implemented, but with all demand for domestic water supply and flood restoration in the lower delta satisfied along with an allowance made for environmental stream flows.
- Scenario 2D: is the same as for 2A but with power generation fully coordinated throughout the basin.
- Scenario 3: assumes no investments in hydropower which is produced under non-coordinated conditions, but all currently identified irrigation potential is developed and used to irrigate an additional area of 774,000 ha with all demand for domestic water supply and flood restoration in the lower delta satisfied along with an allowance made for environmental stream flows. It indicates a significant trade-off against power generation and for growth of the agricultural sector. However, the expanded irrigation service would create an additional 250,000 jobs, which is another trade-off, especially as new value chains[30] and improved livelihoods would increase demand for energy.
- Scenario 5: is basically the same as scenario 2A, but with the additional 774,000 ha of irrigated area and shows that a portion of the investment in new power generation would be traded off against increased agricultural production and employment generation (but would probably contain the increased energy demands of the newly employed agricultural sector workers and the value chains they are employed in).
- Scenario 5A: is the same as 5A, except that power generation is coordinated.
- Scenario 8: is the same as 5, except that hydropower dams are used for flood protection, whereby they are operated at less than full supply level during flood seasons in order to provide unused storage for flood attenuation purposes. It can be assumed that the economic benefits of flood protection more than outweigh the economic costs accruing to sub-optimal power generation.

The point of this case study is to suggest that any solution falling into what the World Bank calls the "desirable development zone" will almost by definition, be a nexus oriented solution.

It was noted above, that coordinated operation of hydropower dams can increase their joint supply of power. The same approach can maintain existing levels of generation in a fashion which introduces synergies with other sectors. The case of the Kafue Flats which lie within the Zambezi Basin provide a good example of how this could work.

The Flats themselves are located in Zambia on the Kafue River between the Itexhi-Itexhi and Kafue Gorge dams and are of immense social, economic and environmental value. The Kafue Gorge dam is situated at the downstream end of the Flats and is Zambia's largest. The Dam provided 50% of the country's need when it became operational with a capacity of 900 MW in 1973, with a surplus of 431 MW being exported to neighbouring countries such as Zimbabwe and South Africa. Since then however, to keep pace with increasing demand it became necessary to increase the supply of water to the dam by the construction of a second dam the - Itexhi-Itexhi – at the upstream end of the Flats. Releases from Itexhi-Itexhi provided enough water to maintain maximum power generation at Kafue Gorge.

[30] Some of which will produce waste material which could be used for co-gen; rice husks or bagasse for instance. Other agricultural waste, if composted would reduce the need for energy intensive synthetic fertilisers, other waste still, could be used for biogas production etc.

The problem is that this arrangement severely disrupted the natural hydrology of the Flats on which social, economic and environmental interests depended. Under natural conditions, the Flats flooded annually and as such provided a bountiful fishery for the local population and nutritious recession pasture for their cattle. But the joint operation of the two dams meant that the Flats no longer flooded and the fishery sector was severely compromised. Other members of the local population are pastoralists, but with no floods, there was no recession moisture to regenerate the rich pastures which had sustained their cattle. In addition, the floods maintained a globally significant eco-system which included large numbers of grazing mammals – and their predators. Similarly, the Flats sustained more than 450 species of birds including the vulnerable wattle crane for which the Flats is one of Africa's most important sites. Loss of annual flooding took a terrible toll on the wildlife and hence on the tourist industry it supported.

A major reason for the disrupted annual floods was that – as is common with hydropower everywhere – operating rules at the Itexhi-Itexhi Dam demanded that it be kept as full as possible at all times. Accordingly, water that could have been passed downstream the Flats remained upstream of the dam.

However studies carried out, sponsored by the WWF in 2004 showed that, if armed with better hydro-meteorological data emanating from upstream in its catchment, operators at Itexhi-Itexhi Dam being assured concerning forthcoming inflows, would no longer have to keep their dam full in order to maintain supplies to Kafue Gorge. Models based on this idea then confirmed that enough water could be released to restore flooding in the flats without compromising power production at Kafue Gorge – a good example of nexus synergy based on the coordinated operation of hydropower dams. Clearly the objective in this case was to restore flooding. But the same approach could be used to prevent flooding (recall scenario 8 above), whereby dams are operated at less than full supply level, based on data concerning incoming flows, leaving room for flood attenuation when necessary.

#### 3.3.2.3 The Volta River

The potential nexus benefits of trading hydropower for flood protection has already been noted; but there is also nexus potential in a trade-off between agricultural production and flood protection; and the Volta River provides a good example of how this could work.

In September 2009, Burkina Faso experienced its most destructive rains in almost a decade. This forced operators of the Bagre Dam, a hydroelectric facility situated just upstream from the Ghana border, to open the dam's main gates. This was the sixth time that this had been necessary since the dam was completed in 1994[31]. And every time this resulted in flooding downstream, an indication of the costs of which is revealed by the 2009 case when flood damage was estimated to cost $152 mill, including $ 15 mill for immediate humanitarian assistance and infrastructure repair.

[31] http://www.irinnews.org/report/86015/burkina-faso-ghana-one-country-s-dam-another-s-flood

This is interesting because Burkina Faso is in the process of significantly expanding its rice production sector (Riddell 2014)[32]. At first impression, this may seem somewhat ill-advised given the thirsty nature of rice and the very high evapotranspiration rates that will apply; but according to some sources there is an intention to use the System of Rice Intensification which would reduce water requirements significantly. Either way, it is reasonable to expect that the rice would be produced in basins. But rice basins can be used to attenuate flooding an approach which is actively being researched in Malaysia[33]. Although like any other crop, rice is sensitive to inundation, it can withstand moderate flooding for around three days, and more if yield reduction can be accommodated. The nexus opportunity for Burkina Faso therefore, would be to have its new rice fields intercept and attenuate an incoming flood before it reaches the dam, and even downstream in the event that emergency releases are still necessary. As mentioned previously, excessive, prolonged inundation of the rice would cause a yield reduction, hence the trade-off between agriculture and flood protection. But if the economic costs of so doing are less than those accruable to flood damage, farmers could be compensated for this.

Moving further downstream we come to the Bui Hydroelectric project which Ghana commissioned in late 2013. In terms of energy security, the dam is of significant importance. This is in part because of Ghana's relatively high rate of electrification access, at 72% of the population (expected to rise to 100% by 2020) but it is also because energy exports to neighbouring countries are an important source of foreign exchange revenues for Ghana (Abavana date not known). The dam itself is described as multi-purpose because of a 30,000 ha irrigation scheme which will be supplied from the dam – which almost certainly introduces a trade-off with power. Enhanced fisheries and tourism are also claimed as potential multi-purpose benefits. However, there are also environmental trade-offs because of *"…flooding of a large area within the Bui National Park…"* and because of the need to resettle some 1200 people (Abavana date unknown).

Finally, with respect to the Volta River there is the Kpong Dam where a trade-off between power generation and irrigation will be necessary if the full potential of the proposed 4,100 ha Kpong Irrigation Scheme component of the Accra Plains Irrigation Project is to be realised (BRLi 2013). Normal operational fluctuations in the dam take its water level below that needed for gravity supply to the irrigation scheme which would otherwise require pumping. The trade-off concerns the *"…need to develop a specific management of water level in the dam…"* (BRLi 2013). While this could reduce the dam's power generation capacity, it would reduce the operational of costs of the irrigation scheme.

#### 3.3.2.4 The Blue Nile

A cascade of dams proposed for Ethiopia's portion of the Blue Nile during the mid '2000s could have provided a genuine nexus solution to at least three challenges faced by the three Eastern Nile riparian; Egypt, Ethiopia and the Sudan.

The first challenge concerned the need for more water. At the time however, evaporation losses from Lake Nasser on the Egypt/Sudan border were estimated to be some 10 $km^3$ per year. This was due to a combination of its low stage/storage ratio and the high temperatures which prevail at its location and altitude. If the same water was stored at a higher altitude in narrow valleys with high stage/storage ratios and lower temperatures, three benefits would accrue:

- Water availability would be increased downstream which could increase the irrigated area.

[32] And see also: http://agra-alliance.org/media-centre/news/a-ricepowered-green-revolution-in-burkina-faso/
[33] No reference, this comment is based on the direct experience of the consultant in Malaysia 2010.

- Water flowing through Sudan on its way to Egypt would increase navigation depths[34].
- A great deal of hydropower could be produced for the benefit of the entire Nile Basin

However, for reasons of political economy, Egypt bitterly opposed the measure because of perceived threats against its own water security[35], and continued in its attempts to be allocated more of the Nile's water. Ethiopia has therefore gone it alone by constructing the Grand Renaissance Dam on the Blue Nile shortly before it crosses the border with Sudan. Initially, this was bitterly resisted by the Egyptians, even though the dam had been approved by the Nile Basin Initiative and is expected to increase water availability upstream while generating 15,000 GWhr/yr.

More recently however, Egypt, Ethiopia and Sudan have signed a preliminary accord that when finalised will *"achieve benefits and development for Ethiopia without harming Egypt and Sudan's interests"*[36]. Notwithstanding the fact that the dam has been questioned on technical grounds by some experts, if their fears prove groundless, there is a real chance that the Grand Renaissance Dam will become a convincing, large scale demonstration of a successful nexus approach because of its multiple benefits as listed above.

## 3.4 The Stakeholder Consultations

### 3.4.1 Questionnaire Design

The questionnaire is divided into three parts. Part 1 simply provides basic information about the respondents and their affiliations. Part 2 is intended to capture general thinking about the nexus challenges and opportunities that each respondent and/or their organisation faces on a normative basis, it is not specific to a particular example of infrastructure. Part 3 - which itself has four sub-sections - concerns specific examples of water infrastructure – if any - with which a respondent is working or is directly familiar with. Its first sub-section (3a) provides a simple description of the infrastructure in question in terms of its status, its stakeholders and its expected impact on them. The second sub-section (3b) captures information about infrastructure which has already been commissioned or which is under implementation as a result of successful pre-investment appraisal. The third sub-section (3c) captures information about specific examples of infrastructure that has been selected but is either in the pre-appraisal stage or for which the appraisal process produced an unfavourable result; and the fourth sub-section (3d) captures information about specific infrastructural needs have been confirmed, but for which no infrastructure has yet been selected.

Sub-sections 3b, c and d are based on the cascade of questions presented in Figure 8. Although these three sub-sections have many questions in common, there are crucial differences so the figure presents separate cascades of questions for each. After a brief introductory section, the cascades themselves pass through four interrogative clusters dealing with: the selection process; the selection criteria (which could equally be articulated as the defining factors); how the infrastructure is being, or will be financed in both capital and recurring terms; and finally the functionality of the infrastructure in question. The three cascades converge in this last cluster where the colour coding shows that out of eight possible responses, six could apply to each cascade, a seventh applies only to the sub-section 3c and d infrastructure and the eighth applies only to the sub-section 3b infrastructure.

[34] Apparently this would have been quite a significant benefit according to Sudanese officials in discussion with the consultant in 2008.
[35] a weakness that had been spotted by Ethiopia's King Lalibela 1000 years before when he threatened to emasculate the Egyptian economy by damming the Blue Nile
[36] Egypt's President Sisi quoted by Al Jazeera on 24 March 2015

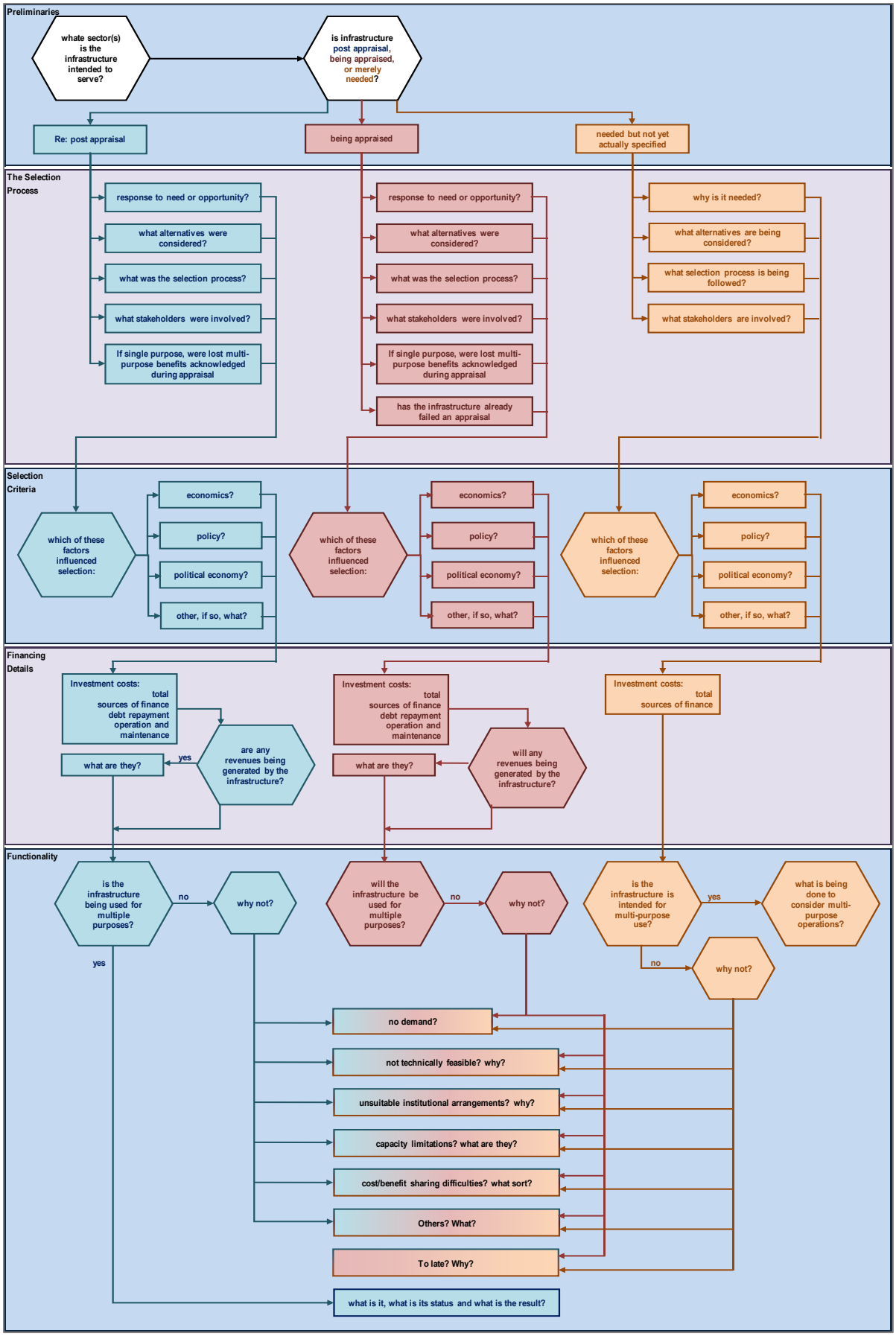
### 3.4.2 Institutional Stakeholders

In all, 29 institutional stakeholders were considered as potential invitees for the questionnaire survey. They fall into four categories and are listed with their mandates defined in a table presented as Part 1 of Annex A2, which also provides the rationale for their inclusion in or exclusion from the survey.

### 3.4.3 Individual Experts

Individual experts invited to participate in the stakeholder consultation are listed in Part 2 of Annex A2. In some cases they are members of relevant institutions that are not regional bodies, in other cases they have been selected because of their known expertise in nexus related issues. The table makes their affiliation clear and explains why they have been invited.

FIGURE 8 INTERROGATIVE FLOW OF QUESTIONNAIRE SUB-SECTIONS 3B, C AND D



### 3.4.4 Results

Unfortunately of the 29 institutional stakeholders invited to participate in the consultation only eight responded, while of the 41 individual experts, only one responded. This poor response had an obvious knock-on in terms of how many questions produced meaningful answers, as shown in Table 7 which indicates the percentage of questions for which meaningful responses were received. Based on this, it is reasonable to conclude that, had there been more respondents, then there would be an increased chance of more questions being relevant to them.

TABLE 7 PERCENTAGES OF QUESTIONS WITH MEANINGFUL RESPONSES

| Questionnaire section | Approx. % |
|---|---|
| Overall | **37%** |
| Section 2: Nexus Challenges and Opportunities Faced in the Respondent's Regions | **63%** |
| Section 3a: Stakeholders and Expected Impact, with respect to Existing Infrastructure | **100%** |
| Section 3b: Existing Infrastructure or Infrastructure that is Currently Under Implementation | **39%** |
| Section 3c: Infrastructure that has Yet to be Appraised or has Failed Appraisal | **10%** |
| Section 3d: Confirmed Need or Infrastructure, but Nothing Selected as Yet | **12%** |

What this means is that the stakeholder survey has produced meaningful results with respect to the relevance of a nexus approach in term of ongoing challenges and opportunities; stakeholder perceptions with respect to existing infrastructure and infrastructure that is already under implementation; but very little concerning new investments. The completed questionnaires themselves are included as Section A2.3 of Annex A2. The remainder of this section comprises a thematic summary of the results.

The reader will notice that section 3.4.4.1 has significantly more content than 3.4.42,3 and 4 which are little more than tables with some supporting commentary. This is because section 3.4.4.1 deals with the part of the questionnaire (Part 2) which provides analytical information justifying an analytical treatment here, whereas the others contain descriptive data which is more conveniently captured by means of tables.

Before proceeding, it is nonetheless worth stressing that the limited questionnaire response has not necessarily limited the usefulness of the results. This is because of the spread of stakeholder interests and responsibilities. Between them they represent or provide insight concerning:

- The Nile Basin
- The Volta Basin
- The Niger Basin
- The Senqu Basin
- ECOWAS
- Donor foci in East Africa
- The African Development Bank
- Lake Victoria Basin Commission
- State entities in East Africa

Together, their insight has allowed a range of substantive issues to be identified, and informed a broad and meaningful discussion about them.

### 3.4.4.1 Nexus Challenges and Opportunities Faced by the Respondents (Questionnaire Part 2)

Given that Section 3a of the questionnaire only has two questions, it will be clear from Table 7 that Section 2 generated the most interest among the respondents. Their thinking on the matter of competition is summarised in Table 8, which sets the scene for much which follows in this section. Although somewhat subjective (because of the need to smooth out regional inconsistencies where for instance one region shows the environment and another shows it as a loser for the same focus of competition) the table paints a fairly consistent picture in which i) the highest levels of competition across the regions concern bulk water and agriculture and ii) state entities and the private sector generally win the competition while populations and the environment are consistently the losers. This is not surprising given the high numbers of families that are engaged in agriculture.

TABLE 8 PERCEPTIONS OF CURRENT COMPETITION BETWEEN NEXUS ELEMENTS AND THE ASSOCIATED WINNERS AND LOSERS

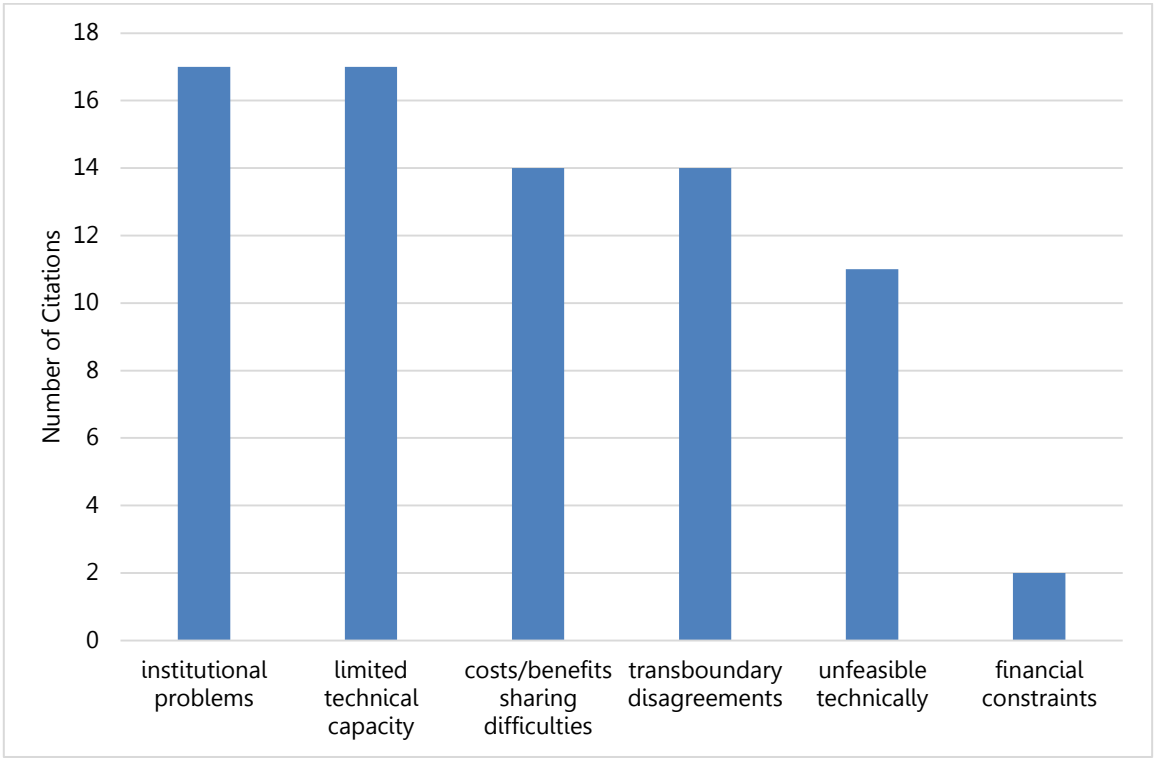
| Focus of completion | | Region | | |
|---|---|---|---|---|
| | | **All Africa** | **East Africa** | **West Africa** |
| ***bulk water vs agriculture*** | significance | 1st | 1st | =1st |
| | winners | state entities | state entities | none |
| | | private sector | private sector | |
| | losers | environment | environment | population and environment |
| | | population | population | |
| ***bulk water vs energy*** | significance | 2nd | 2nd | =1st |
| | winners | state entities & population | state entities | none |
| | | private sector | | |
| | losers | environment | environment | population |
| | | population | population | state entities and environment |
| ***agriculture vs energy*** | significance | 3rd | 3rd | 3rd |
| | winners | state entities & population | state entities | none |
| | | private sector | private sector | |
| | losers | population | population | |
| | | environment | state entities and environment | population |
| | | state entities | | state entities and environment |
| *Notes* | | | | |
| | *If a given stakeholder class has the same N° of mentions as a winner and a loser, it is not included* | | | |
| | *Where more than one stakeholder class appears in a cell, it means that they had the same N° of mentions, otherwise the stakeholder classes are ranked vertically* | | | |

The results of a similar exercise focussing on what is constraining resolution of the competition are captured in Figure 9. Although the nature of the stakeholder responses was not suitable for regional sub-divisions, the figure tells a very interesting and compelling story: capital costs are not cited as a problem for instance[37]. Neither for that matter are the technical challenges. Instead, of the 75 reasons cited by the respondents, 62 concern constraints that can be resolved at the institutional or political level. These comprise:

- Actual institutional shortcomings in terms of both architecture and technical capacity; and
- Cooperation shortcomings in terms of cost/benefit sharing and transboundary issues (both of which introduce issues of politics and political economy).

At a technical level, feasibility may be a significant constraint, but based on the research, it may be that limited technical capacity constrains the ability of planners to "think outside of the box", especially with respect to scale and the possibilities that natural infrastructure represents.

FIGURE 9 CURRENT CONSTRAINS ON THE RESOLUTION OF COMPETITION




This simple analysis introduces a substantive point. The low prevailing levels of investment in multi-purpose infrastructure may not mean that opportunities are limited. On the contrary the challenge would seem to be an inability to see and seize them. Drilling down into the various commentaries provided by the respondents sheds some light on why this might be.

- Priority based planning and the enforcement of regulations are compromised by reasons of political economy.
- Institutions are slow in evolving and the adoption of new or upgraded skills.
- Staff are often inadequately remunerated and incentivised, while lacking the abilities needed for i) budgeting and appraising multi-purpose investments; ii) holistic diagnoses; and iii) the development of plans that are based on long term visions and assessments.

[37] This statement which is supported by the questionnaires received has been disputed by peer reviewers. This may be explained by the possibility that respondents to the questionnaire are not directly concerned with financing matters and have merely assumed that there is no problem because they have not directly faced any.

And all of these challenges are intensified by the silo thinking and unbalanced policies which prevail at both the national and regional levels.

The next part of questionnaire section 2 required them to assess the prospects for resolving competition in the future. Their responses concerning the relative potential of trade-offs, compromise and synergy proved to be remarkably consistent with the institutional challenges. This is because they favoured trade-offs and synergies over compromise. Trade-offs are of course symptomatic of silo thinking – meaning in this case that a more powerful institution will be able to force its will on a weaker one. And by definition, synergies have no losers.

Compromise on the other hand requires a level of institutional cooperation which clearly is not there.

So far the analysis has concerned the current situation. When asked about the likelihood of future competition, the responses suggest that somewhere in Africa there will be conflict between bulk water and agriculture and between agriculture and energy within the short term and between bulk water and energy within the medium term. There are however, regional variations as shown in Table 9 where the short term means less than five years; medium term means five to fifteen years and long term means more than fifteen years in the future.

TABLE 9 EXPECTATION OF FUTURE CONFLICT

| Source of conflict | Regional variations | | |
|---|---|---|---|
| | **Overall** | **East Africa** | **West Africa** |
| ***bulk water vs agriculture*** | very likely in the short term | very likely in the short term | quite likely in the medium term |
| ***agriculture vs energy*** | very likely in the short term | very likely in the short term | not likely |
| ***bulk water vs energy*** | very likely in the medium term | quite likely in the medium term | quite likely in the long term |

Regardless of the regional variations, there is no escaping the fact that nexus style conflicts will need to be taken more seriously within the next 15 years. This is crucially important because nexus approaches to the specification, identification, preparation and implementation of water infrastructure could easily take up to 15 years in some cases and up to five years in almost all cases. The clock really is ticking and the stakes are high. The time to establish a nexus style paradigm is now.

According to the stakeholders, winners and losers going forward without such a paradigm are suggested by Table 10, where changes from Table 8 are highlighted by dark blue borders; new or improved winners are identified by blue text and new or worsened losers by purple.

It is important to understand that the differences between Tables 8 and 10 are more heuristic than empirical; but it is nonetheless interesting to note that they do suggest a more favourable future for state entities and the private sector and a less favourable future for populations and the environment. But no surprises there if current trends continue, not least concerning a political economy which favours business more than people and the environment.

Figure 10, which is a reworking of Figure 9 provides a similar comparison between the current and future situations by suggesting how constrains on conflict resolution might change[38]. The figure shows a decrease in terms of all constraints except those arising from transboundary disagreements. This is not a surprise because competition for water is likely to increase. In addition, problems of technical feasibility will decrease as institutions slowly reform and strengthen, which the figure also indicates.

TABLE 10 PERCEPTIONS OF FUTURE PERCEPTIONS BETWEEN NEXUS ELEMENTS AND THE ASSOCIATED WINNERS AND LOSERS

| Focus of completion | | Region | | |
|---|---|---|---|---|
| | | **All Africa** | **East Africa** | **West Africa** |
| ***bulk water vs agriculture*** | winners | state entities & **private sector** | state entities & **private sector** | **state entities & private sector** |
| | losers | environment | environment | population |
| | | population | | |
| ***bulk water vs energy*** | winners | state entities | state entities | **state entities & population** |
| | | private sector | private sector | |
| | losers | environment & population | environment & **population** | **private sector** |
| ***agriculture vs energy*** | winners | state entities | state entities | state entities & private sector |
| | | private sector | private sector | |
| | losers | **environment** & population | environment & **population** | **environment** & population |

*Notes*

*If a given stakeholder class has the same N° of mentions as a winner and a loser, it is not included*

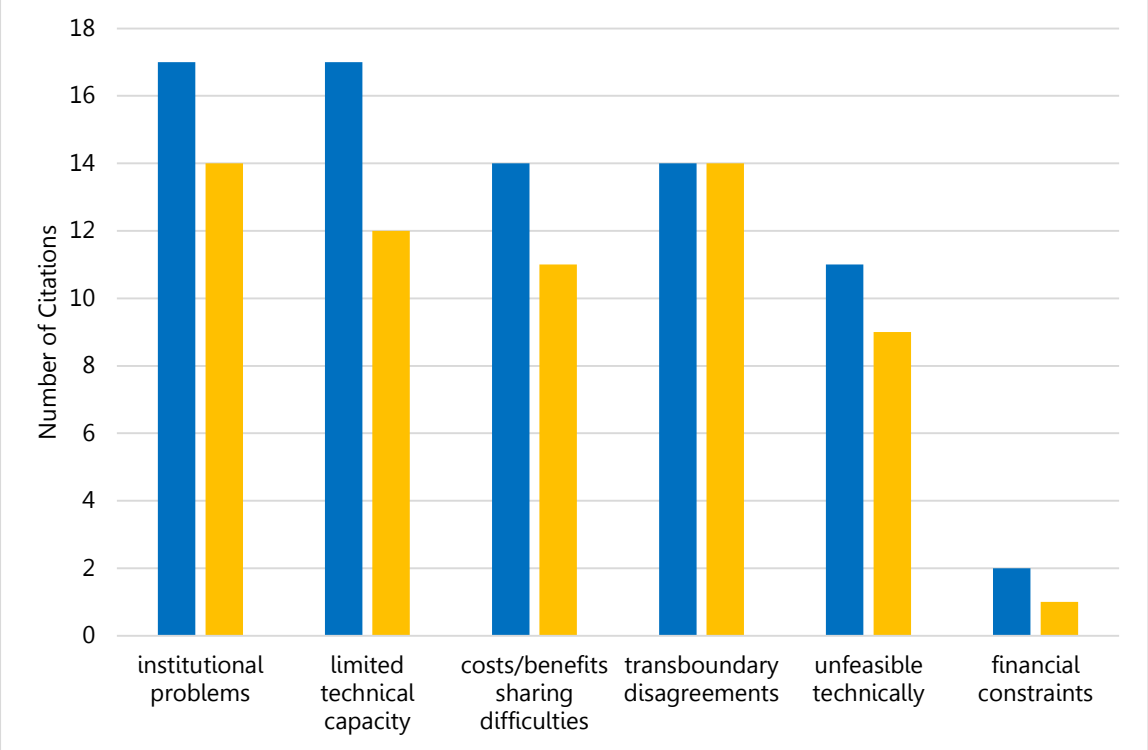
*Where more than one stakeholder class appears in a cell, it means that they had the same N° of mentions, otherwise the stakeholder classes are ranked vertically*

The stakeholders themselves throw some light on this with their insights which can be summarised as follows.

- Countries persist in prioritising their own needs at the expense of transboundary trade-offs and compromise, a problem which is exacerbated where there are differences in technical capacity and negotiating skills and/or power.
- Despite some improvement, institutions remain slow in evolving and still have a lot of catching up to do, especially with respect to the adoption of new or upgraded skills.
- Weak transboundary collaboration frameworks with agreements that have yet to be signed still being developed.
- Aging or inadequate infrastructure.
- Increasing pollution and climate change impact.

[38] There were less citations overall for the future case, the values for current citations in Figure have been adjusted accordingly.

FIGURE 10 FUTURE CONSTRAINTS ON THE RESOLUTION OF COMPETITION




In terms of trade-offs, compromise and synergy, stakeholders do not foresee an increased willingness to compromise, however a considerably greater emphasis on synergistic solutions is expected. Since this study is intended – in part – to guide the specification, planning and operating of future investments in water infrastructure, it is worth taking a closer look at the respondents' thinking. In terms of trade-offs therefore, they suggest that from a planning perspective that decisions should be guided by the relative contribution each sector makes to the broader economy (this of course would explain why state entities emerge as winners). They also noted that the most obvious example would be between irrigation and hydropower. But even with these classically competing sectors opportunities for synergy can be found. Both sectors introduce losses: hydropower because of evaporation (as per the losses from Lake Nasser mentioned above); and irrigation because of inefficient, imprecise irrigation. But precision in irrigation water management is directly proportional to the energy available. So the opportunities for a synergistic approach to the two sectors is obvious – and although at first sight this would seem to be a trade-off in terms of energy, at the economic level it may be advantageous as well as contributing to food security and employment creating objectives. Hence the suggestion of one respondent, that a successful synergy depends on a clear demonstration and understanding of all the benefits.

Other opportunities for synergies may lie between a combination of natural and built infrastructure. Lesotho for instance would be able to invigorate and transform its agricultural sector by investments in catchment management, but these would also increase the supply of bulk water (by better attenuation of rainfall events) and reduce sedimentation in the dams needed to store the "new" water.

Finally with respect to synergy, one respondent noted that a workable tariff structure in one sector, say energy, could be used to subsidise investments in another – water supply and sanitation for instance, which itself would benefit from increased energy for treating and conveying water.

Not surprisingly, opportunities for compromise were less obvious – except for one!

There are huge opportunities for policy level compromise between food self-sufficiency and income based food security. This opportunity would play out in terms of crop choice. A country whose political economy favours self-sufficiency in rice for instance, but with no productive comparative for the crop might do better growing a less thirsty, higher value crop to feed into value chains of one sort or another. This has profound implications for the planning and operation of irrigation schemes. Wetland rice schemes generally have infrastructural footprints (costs and scale) that are larger than those for less thirsty crops, while the standing water constrains crop diversification opportunities for the progressive farmer[39]. Add to this, the possibilities that increased energy introduces for irrigation-on-demand and crop diversification brings the story conveniently back to synergy.

In fact, it is fair to say that genuine opportunities for synergy explain why some respondents felt that competition is unlikely in some respects and locations (question 2.11 of the questionnaire). Their views on this acknowledged that in large West African river basins for instance, considerable amounts of water remain unallocated – hence opportunities do remain for synergistic, multi-sector investments.

But despite this cause for optimism, it is impossible to close this section without returning to the cross-cutting issue of an institutional approach! As stated by the respondent from the African Development Bank: "….although our response[40] was affirmative; it is worth noting that this competition is more likely to happen where institutional structures at both the national and development partners' levels do not allow for integrated strategy setting and planning…."

### 3.4.4.2 Stakeholder Perceptions of Existing Infrastructure and Infrastructure Under Implementation (Questionnaire Part 3a&b)

Six respondents provided their perceptions of how benefits accrue to specific examples of existing infrastructure. Their thoughts are set out in Table 11.

TABLE 11 PERCEIVED BENEFITS OF EXISTING INFRASTRUCTURE

| Type | Impact | | | Comments |
|---|---|---|---|---|
| | **Beneficiary** | **Level** | **Positive benefit as reported** | |
| **Multi-purpose dam in the Nile Basin** | state entities | high | economic and socio-economic | None provided |
| | | | peace and stability | |
| | private sector | high | secure factors of production | |
| | | | new markets | |
| | population | high | family and lifestyle | |
| **Multi-purpose dam in the Volta River Basin** | state entities | high | none reported | The dam is used for energy production, agriculture, industry and the maintenance of environmental stream flows |
| | private sector | high | none reported | |
| | population | high | none reported | |
| | environment | high | none reported | |
| **Various water treatment works** | state entities | high | economic and socio-economic | Most of the works have governments as key stakeholders |

[39] Even if an individual farmer is able to drain his field, standing water in his neighbour's will tend to saturate his own soil.
[40] The answer to the question of whether competition was very likely, quite likely or not likely, was "not likely".

| Type | Impact | | | Comments |
|---|---|---|---|---|
| | Beneficiary | Level | Positive benefit as reported | |
| **around lake Victoria** | | | peace and stability | |
| | private sector | high | secure factors of production | None provided |
| | | | new markets | |
| | population | high | family and lifestyle | Societal benefits are considerable |
| | | | income | |
| | environment | high | there are negative impacts on landscape productivity and biodiversity | Some benefits are nonetheless claimed in terms of the protection, management, quality and conservation of water sources |
| **Bulk water dam in the Senqu Basin** | state entities | high | economic and socio-economic | Transboundary water security benefits |
| | | | peace and stability | |
| | private sector | low | secure factors of production | Potentially high, but currently constrained because of limited use of water for production, especially in private sector agriculture |
| | | | new markets | |
| | population | high | family and lifestyle | Improved water security, especially in the water scarce lowlands of Lesotho |
| | | | income | |
| | environment | high | landscape productivity | The environmental benefits are potentially high, but need synergistic investments in natural infrastructure to be achieved |
| | | | biodiversity | |
| **Multi-purpose dam in Kenya (currently still under implementation)** | state entities | high | economic and socio-economic | The dam is part of a national development strategy |
| | private sector | high | secure factors of production | Largely concerning agriculture |
| | | | new markets | |
| | population | high | family and lifestyle | Improved water supply, new agricultural opportunities and improved energy security |
| | | | income | |
| | environment | medium | landscape productivity | Biodiversity impact is expected to be negative |
| **Multi-purpose dam in Tanzania** | state entities | high | economic and socio-economic | The dam contributes to government revenues |
| | | | peace and stability | |
| | private sector | high | secure factors of production | The dam was built to supply water for a diamond mine |
| | population | high | family and lifestyle | Household, irrigation water supply benefits and employment opportunities |
| | | | income | |
| | environment | low | landscape productivity | Biodiversity impact is negative |

The table largely speaks for itself and confirms that a promising range of multi-purpose benefits is already accruing to examples of existing infrastructure and is realistically expected to accrue to infrastructure under implementation.

Even so, the table also shows that the natural environment consistently comes last in the order of priorities. It is good therefore that the table includes the Lesotho/Senqu example which reminds us of the gains to be made if synergistic investments in natural infrastructure are included in an overall investment concept. Table 12 – which is self-explanatory - continues this theme by indicating the relevance to each of the nexus elements of the same infrastructure.

TABLE 12 RELEVANCE OF THE INFRASTRUCTURE TO THE NEXUS ELEMENTS

| Type | Nexus element | | | Comments |
|---|---|---|---|---|
| | Water | Agriculture | Energy | |
| **Multi-purpose dam in the Nile Basin** | Most important | Most important | Most important | The infrastructure is being built on a transboundary river and as a result of flow regulation will increase water reliability downstream. Although it is being built by an upstream country for hydropower, other uses within the country and downstream are being considered.<br><br>Although no details were provided, the respondent did confirm that the decision to proceed with this $4.8 billion dam was exclusively based on economics; and that the entire cost will be covered by the government. This was perhaps necessary to avoid censure from the Development Finance Institutions, as the dam itself has generated a fair amount of controversy. |
| **Multi-purpose dam in the Volta River Basin** | Most important | Partially important | Most important | This is the most downstream of all major structure on the Volta River, but 40% of its inflows are transboundary deriving from upstream countries. Although multi-purpose, when constructed, it responded only to economic imperatives, to the detriment of social and environmental considerations.<br><br>The VBA itself is responsible for the operation and maintenance of the dam which is 50 years old. |
| **Various water treatment works around lake Victoria** | Very important but inadequate | Potentially very important, but still in the nascent stages | | Comment provided, but not relevant to this table |
| **Unspecified in the Niger Basin** | Most important | Partially important | Partially important | No comment given |

| Type | Nexus element | | | Comments |
|---|---|---|---|---|
| | Water | Agriculture | Energy | |
| **Multi-purpose dam in Kenya (currently still under implementation)** | important | Most important | important | The decision to proceed with this dam was made against an exclusively economic suite of criteria:<br>• The net present value should (unsurprisingly) be positive – it was estimated at 24.8 billion Kenya shillings, or approximately $ 240 million.<br>• The benefits costs ratio (*ditto*) should be greater than unity – expected to be 1.46; and also unsurprisingly…<br>• The Internal Rate of Return should be greater than the cost of capital and was estimated to be 18% (the source did say what the cost of capital was, and neither was it clear whether this calculation concerned the Economic or the Financial rate of return.<br>Financing sources comprise a mixed bag of DFI grant (0.07%), DFI loan (34.4%) and government itself (64.9%) |
| **Multi-purpose dam in Tanzania** | Most important | Partially important | Not important | Cost benefits sharing difficulties are reported for this structure which is over 60 years old. This is apparently because The beneficiary population around the dam has no sense of ownership in its regard and hence consider all operating costs to be borne by the private company which is responsible. The dam is nonetheless stated to be in good condition. |

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### 3.4.4.3 Infrastructure that has yet to be appraised or has failed Appraisal (Questionnaire Parts 3c)

As was made clear in Table 7, response to this section of the questionnaire was particularly sparse. It related only to i) water treatment works around L Victoria (which is of limited relevance here, and ii) Lesotho where an infrastructural approach to integrated catchment management that falls into a fuzzy grey zone between infrastructure that has yet to be appraised and infrastructural needs awaiting a response. For convenience, it is discussed in the next section.

### 3.4.4.4 Infrastructural Needs Awaiting a Response (Questionnaire Part 3d)

The Lesotho example just referred to will be revisited momentarily below because it provides a highly relevant story with which to end what is essentially a forward looking section.

First however, three interesting points have been made by respondents.

- Infrastructural planning and development should at very least acknowledge the reality that the beneficiaries, among other things can be thought of as a market, and be based on a consideration of how infrastructure could be used to open up and take advantage of that market in a socio-economically transformative fashion (N.B. the role of the market is revisited below in section 4.1).
- New national legal frameworks are emerging that attempt to shift investment responsibility in favour of populations and the environment (in theory, these need not constrain private sector opportunities and benefits).
- Ongoing national development plans, or DFI programmes were often formulated before the emergence of these new policy foci and unfortunately remain set-in-stone[41].

With all this in mind and as will be seen below, the Lesotho example has great potential as an example of potential best practice. It all concerns the next phase of European development financing in the form of the 11th European Development Finance grant support allocation and EIB soft investments in a value chain approach to integrated catchment management (€78 mill and up to €300 mill respectively). Initial scoping has been done already, with appraisal about to start (which is why it straddles this and the preceding section).

The programme – which has yet to be named - basically compromises a nation-wide suite of initiatives comprising coordinated investments in both built and natural infrastructure that will have multi-purpose benefits in terms of improved utilisation and productivity of land and water resources. If successful, the programme - which is due to begin in late 2016/early 2017 - will contribute to catchment restoration and management; socio-economic transformation and increased water availability at both bulk and local scales. Its benefits moreover, by preserving the Southern Africa water tower represented by Lesotho's beautiful highlands – including not least, their globally unique high altitude wetlands –will include positive water quality and quantity benefits throughout the entire water economy of the Senqu basin. In other words the programme will prevent the catastrophic flood/drought cycles and the associated economic implosion that is currently inevitable without a programme such as this.

What makes it particularly interesting here is that the proposed approach avoids the persistent silo based thinking of the line ministries by:

- capacity building for multi-sector investment appraisal by the non-line Ministry of Development Planning.
- Bespoke planning at catchment level by local catchment management committees which will also receive capacity building for the purpose;
- Demand driven investment via autonomous district level development funds; and
- Levering commercial investment into value chains deriving from the investments in natural infrastructure.

[41] This introduces the major associated problem of potentially conflicting donor objectives, indicators and monitoring procedures.

# 4 Analysis and Use of the Research Results

## 4.1 Emerging Themes

If the nexus is an acknowledgement of the need for trade-offs, compromises and synergies between water, agriculture and energy at a time of climate change and increasing competition, then it will be clear that in most cases a three pronged approach will be necessary, namely: political, institutional and infrastructural. The focus of this study is of course infrastructure which is needed to store and/or manage water; to convey water to irrigate crops and to generate energy. But good politics are needed to make sure the right kind of infrastructure is selected; ensure the sustainable allocation of the natural resources required and to provide adequate finance for both capital and recurring costs. Similarly, appropriate institutions (both hard and soft[42]) are needed to operate and maintain the infrastructure; to enforce the regulatory framework needed to ensure the sustainable use of the natural resources and to make sure that physical efficiency gains are transformed into increased economic efficiency, social equity, socio-economic transformation and sustainable ecosystem services.

Given all this, and given also - as was argued in sub-section 3.2.2, that water is the "senior" nexus element - the theme emerging loudest from the foregoing analysis concerns the failure so far to translate the nexus dialogue, which seems so far to remain largely analytical, conceptual or philosophical – into actual multi-use infrastructure. As already noted, the most recent ICA annual report shows that only some 2.5 % of investments addressed this opportunity in the reporting period and this is reflected in the ongoing dialogue itself which seems rarely to consider infrastructure. It is suspected that this is because the dialogue seems dominated by the academy or special interest lobby groups and not by infrastructural practitioners.

This may be the most important suggestion to emerge from this study – and could be simply articulated thus: "It is time to redirect the dialogue toward the infrastructure itself"

As already noted, perceptions of insecurity lie behind most, if not all searches for nexus trade-offs, compromises and synergies. But in this context security is a multi-headed beast which is perceived differently by different classes of stakeholder - Section 2 referred. Even so and despite this, security of any kind is usually the responsibility of state entities to deliver. The nexus concept provides a means by which they can do this for bulk water[43], agriculture and energy in the most economically efficient, socially equitable and environmentally responsible fashion.

Nonetheless two caveats apply as follows. They are obviously related, and should be acknowledged as cross-cutting before discussing the key themes that have emerged.

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[42] In this context:

- ***hard"*** institutions are physical institutions which include public sector institutions in the form of relevant official stakeholders at every level of the civil administrative hierarchy, plus where water is managed on a basin basis, at every level of the hydrocracy. They will also include farmer organisations and private sector service providers and investors in service infrastructure.
- ***"Soft"*** institutions are the policies, laws, regulations, trading/market mechanisms and incentives that ensure the smooth and equitable running of the sector, attract new players into it and guarantee the sustainability of the natural resource base on which it depends.

[43] Which includes floods as well as droughts!

1. First, there is no single, "one-size-fits-all" nexus concept; and it will be self-evident that this is because natural resource threats differ from location to location as do the associated challenges and opportunities.

And,

2. scale is a crucial determinant of a nexus solution – the examples provided in Box 4 suggest why this might be.

Against this background, four key themes emerge.

### 4.1.1 Silos and Linear Thinking

Silo based thinking - which is encountered both behind and across national or regional boundaries and even within the walls of heavily departmentalised institutions - remains a significant obstacle against the kind of lateral thinking needed to identify and promote nexus style solutions. Agricultural policies for instance continue to be drafted in isolation of water policies and vice versa while institutions with higher level objectives in common (such as food security, economic growth or socio-economic transformation) fail to cooperate, and instead compete for resources, both financial and natural.

**Box 4 – Examples of Scale in Nexus Solutions**

The Ethiopian Grand Renaissance Dam, is a $4.8 billion example of basin level infrastructure that – potentially at least and all other things being equal – will have widespread benefits in terms of bulk water, agriculture and energy.

At the other end of the scale is Bangladesh's highly decentralised nexus solution to sustainable irrigation-on-demand service delivery and self-regulating energy service delivery whereby farmers pay in advance for the right to pump water using pre-paid charge cards which they get topped up against payment by local, self-employed agents. These they insert into their local, electrically power pumps. Farmers have noticed the relationship between energy costs and the productivity of water in their farming systems. As a result they are beginning to shift from wetland rice to high value, dry foot systems. In addition, as every transaction is monitored by radio at the centre in real-time, the country's water managers are able to track water allocation and consumption with a great deal of accuracy.

This has three implications, and they are related:

- The most obvious implication is that single solutions to multiple problems remain elusive. A hypothetical example[44] serves to illustrate this. It will be recalled that i) severe flooding is reported as being problematic in the Volta River Basin; and ii) that Burkina Faso has embarked on a "green revolution" intended to transform this desert country into a major rice producer. While the flooding is indubitably a real problem, the wisdom of allocating so much water to rice production might be of questionable wisdom. However, and this is just an idea to serve as an example, if the paddy fields were actually intended first as a flood attenuation measure, then the agriculture (which need not be limited to wetland rice – there are alternative ways to grow rice, and there are other crops that could be grown), would be a peripheral benefit. While this is merely a hypothetical example – a nexus approach suggests that a search for approaches like this should become the default.
- Efforts to solve watershed problems are usually limited to watershed solutions. But this may already be impossible in some cases and will almost certainly become impossible in many more. For instance, if too many people are abstracting water from a catchment it is likely that the only sustainable way to solve the problem would be to reduce or even negate their direct dependence on the resource. This requires a response from other sectors, notably the industrial or services sector, because the real problem may be a lack of employment opportunities not a lack of water. A similar argument applies also to pastoralists complaining that there is not enough water or pasture for their livestock, when the real problem is too many cattle. Limited employment opportunities and too many cattle, while causing problems in a watershed are actually part of the problemshed (as defined in the executive summary), and it is in the problemshed that solutions must be identified. So in term of nexus of thinking, the problem could be a lack of energy which constrains industrial development, not a lack of water!
- Continuing with this line of thinking would acknowledge that value chains for water and energy increase the unit productivity of both; while increasing employment opportunities in the problemshed. And, when

[44] Which subject to further study could in fact be real, but such study is beyond the scope of this document.

small producers have a stake in the value chains, it increases the virtual size of the land holdings which supply the value chains. This is crucially important where land fragmentation is a contributory factor re: watershed degradation - but it does require a degree of lateral thinking on the part of planners and investors.

It is almost certain that all this will already be clear to most readers. Strange therefore that it remains a black art in the eyes of typical policy makers and planners! Possible reasons for this are explored below in Section 4.1.4.

### 4.1.2 Political Economy

Simply stated, the underlying problem here is that a typical politician is unlikely to expend scarce and hard-won political capital that will make him or her unpopular in the short term in order to make someone else look good in the long term! As with silos and linear thinking, this also has implications.

- First, politicians and planners that could work together towards common solutions to their problems do not want to relinquish control over limited budgets and resources. Not only does this lead to inefficient allocation of those resources, it can also mean that weak but wise institutions lose out to less wise, but more powerful interests (including the vested interest of their senior officials) – behind and across national boundaries once again.
- Second, in addition to the well described concepts of economic and physical water scarcity, the rejection of productive comparative advantage in favour of political economy introduces a third manifestation of scarcity: namely political scarcity. Thus in Egypt for instance, a political economy that continues to allocate water to agriculture, which accounts for only 14% of GDP, yet provides a livelihood for 57% of the population leads to political scarcity of water, the ripples of which are felt throughout the Nile Basin. And in India, a political economy that provides free energy allowing poor farmers to pump as much water as they want, to whatever crop they want, whenever they want to, leads to massive over abstraction: and indeed to suicide when a lack of funds for operation and maintenance in the power sector leads to outages just when heavily indebted farmers need water the most to maintain profitable yield levels.

### 4.1.3 Which is Best – Trade-Off, Compromise or Synergy?

The stakeholder consultation suggested that in the absence of a paradigm shift in the way that politicians and planners think, compromise will remain a distant, unfulfilled dream – section 3.4.4.1 referred. Yet were it not for the need for political capital, compromise between politically cheap mantras about agricultural self-sufficiency and politically expensive but economically advantageous agricultural sector makeovers might actually represent the low hanging fruit. Correctly crafted and based on an acknowledgement of the role of a well regulated market, such a compromise could make investment in combined energy and agriculture infrastructure desirable rather than controversial.

And the Bangladesh example in Box 4 helps to explain why. Self-regulating irrigation on demand requires farmers to connect the dots between the costs of energy and the cost of water. When this insight is combined with vibrant markets for their crops, farmers can shift towards higher value, less thirsty crops. This leads in turn to higher agricultural productivity of water (which contributes to economic growth and socio-economic transformation) while the water savings increase the supply of water that could be used to increase the amount and reliability of the energy supplies - either by hydropower or the irrigation of bio-energy crops - which the farmers need to power the pumps in the first place. And promisingly, this calculus applies at any scale to any kind of irrigation method.

It will be obvious that any pressurised scheme – regardless of size – requiring energy for pumping will i) be more sustainable if the energy itself is sustainable, and ii) more likely to use less water if the recurring costs of pumping are recovered in irrigation service charges. But it may be less obvious to some readers that this also applies to gravity fed schemes. This is because the more energy that is available in terms of elevation head across flow control structures, the more precisely those structures

can be operated. Increased elevation head at control structures may itself require energy to increase the elevation head at the point of offtake.

And since cost recovery potential is obviously directly proportional to farmer profits, the increased precision and hence reliability of irrigation service delivery, together with well-regulated markets has the potential to make farmers shift to higher value farming systems, and to encourage investments into agricultural value chains where risks of failure are mitigated by reliable good quality inputs and cheap, plentiful energy.

Once again the benefits accrue in terms of economic growth and socio-economic transformation.

All that is needed is an expenditure of political capital on a measure of compromise.

### 4.1.4 Donor Drag

Another, and perhaps the least articulated, theme could be thought of as "donor drag", which is manifested in three ways.

- According to stakeholders, the policy cycles of various donors and development finance institutions i) lag behind the promulgation of promising new policy frameworks in client countries or ii) fail to adapt to them.
- Donors and/or development finance institutions operating in a particular country sometimes have incompatible and even opposing objectives[45]. This is self-evidently problematic for a country trying to "do the right thing"; and even more so if none of the competing objectives reflect new policy frameworks at the national level.
- Finally, and closely related to the combined problems of "the donor knows best" and "the next big thing" is the problem already anticipated by one of the two caveats posited above. It concerns the inability or unwillingness of donors and development finance institutions to adapt their philosophical products to the challenges and opportunities of real life, tending instead to stick with a "one size fits all" approach[46]". Various explanations can be suggested for this, but most range between an inability or unwillingness to think outside the box on the part of the officials involved and an assumption on the part of a typical bank that the MBAs, PhDs and theoretical opinions of its staff are more relevant than the hard won, practical experience of experts that have actually implemented and operated projects, especially national experts struggling on a day-to-day basis to make the most of whatever is available.

[45] For instance, in the late 1990's the Asian Development Bank wanted to lend $0.5 billion dollars to the Vietnamese water sector, but would only do so if a sector apex institution was in place first. At exactly the same time, the World Bank wanted to lend the same amount to the same sector for the same purpose, but would only do so if establishment of the apex body was delayed for some years until an institutional needs gap assessment have been completed!

[46] By way of example: a couple of years ago, this writer was advising a well-known development bank on the modernisation of country A's irrigation sector. However, the bank's desk office being familiar only with one other counter - country B - insisted that "we did it in country B like this, so we'll do it like this in country A": this despite massive differences between the two countries in terms of their respect sizes, economies, populations and structures of the sectors in question, and despite the fact that the government in country A wanted a bespoke solution that addressed its country's specific needs and opportunities rather than a tried, but untested example from elsewhere! This example is particularly apposite because it very much included the development of convincing principles concerning the development and use of large scale, potentially multi-purpose infrastructure.

## 4.2 The Rapid Assessment Framework

The Rapid Assessment Framework (RAF) is intended to assess the extent to which current and upcoming infrastructure projects address nexus challenges in the Lake Victoria and Volta River Basins. In particular, the RAF should i) provide general information about current and future investments in infrastructure; and ii) include a suite of criteria capturing financing, costs and benefits, policies, benefits and trade-offs. Clearly, in order to be "rapid" such a framework should be simple to use, but if it is to be of optimal utility, certain elements could also be used as the basis for multi-criteria analysis (MCA) or comparison with alternatives or other examples.

Accordingly, the proposed RAF has two parts and provides users with i) a simple fiche setting out summary details of the infrastructure and its geo-political context, and ii) a weighted scoring system capturing its expected performance, benefits and trade-offs.

A draft RAF is presented below as Table 13. As will be clear to the reader, it builds on the analytical framework used for the literature review. But it also incorporates two out of three of the assessment "lenses" proposed by Pegasys (2014)[47]. These are:

- Resource endowment: i.e. what is the natural resource endowment of the country or region in relation to water, agriculture and energy, and what are the human, financial and institutional resources available to mobilise them?
- Development status: what is the level of development and the nature of the economic development trajectory of the country or area under consideration?

The RAF has two parts; one, a project fiche providing a summary of the proposed investment and the politico-development context in which it will be made; and another providing the inputs, in terms of policies/institutions and benefits/trade-offs for the MCA. Although the Terms of Reference required the RAF to be applied to the Lake Victoria and Volta River Basins, neither the research not the stakeholder consultations provided enough meaningful information for this. The example used to populate Table 13 therefore concerns the Lesotho programme currently under detailed planning, as described above in section 3.4.4.4. Not only does this represent an excellent example of a nexus style approach to real challenges in a real river basin, it also confirms to the Terms of Reference requirement that the example is either starting, current or upcoming.

In this example, the project fiche tells the reader that the investment in question will take place in a developing market with a functional, but sub-optimal democracy, which is experiencing developmental constraints in terms of politics, political economy despite an abundance of unexploited natural resources. In addition, it describes the proposed investment not only in terms of its physical characteristics, but also in terms of the sectors it will serve; the drivers of investment (economic growth, socio-economic transformation and catchment restoration). Finally, financial and economic issues are captured in terms of costs (financial, social and economic), benefits (ditto) and sources of finance.

The second part of the RAF – i.e. the MCA – goes beyond the descriptive by requiring the user to assess, rather than describe a range of nexus issues, and to do so in three ways.

- Verbal assessments of:
  - Whether or not the conditions are likely to enable or constrain the proposed investment. In the Lesotho example and despite silos and political-economics challenges at the centre, the

[47] The third lens dealing with the extent to which ***resilience thinking*** informs nexus discussions and development planning is assumed covered by the RAF as a whole.

RAF confirms that a combination of decentralised administration; a demand driven, programme approach; capacity building and a scale oriented approach together suggest that conditions are indeed enabling.

- The extent to which key political and institutional factors will influence the implementation, operations and financing of the investment. Again, the situation is largely favourable. This time because the programme will have many, heterogeneous components planned and operated at the decentralised level, and because the politico-institutional context will allow the use of grant support to lever soft development bank loans.
- Expected financial and/or economic performance, which in the example given yet cannot yet be estimated beyond a nominal value of greater than unity. This assumption is justified because the programme's concept assumes that the financial and/or economic feasibility of each component will established as a precondition of its inclusion in the programme.
- The extent to which the four stakeholder classes will be winners or losers. Here, the example is potentially doubtful with respect to state entities, which might lack the needed political capital, and the private sector, because there is no guarantee that opportunities to participate will be taken up.

- In terms of a simple score given to each of the verbal responses. Consistent with the need for rapidity, hence simplicity and indeed objectivity, the idea is for each response to be scored either -1 if not ideal, 0 if neutral and 1 if ideal. This avoids a potentially messy and more subjective process requiring whoever is completing the framework to score between say 1 and 10 where 1 is bad and 10 is good for instance.
- By applying weighting factors to the scores. These indicate the relevance or otherwise of a particular issue to the investment's specific target location**.** This is because not all of the questions have equal significance at the global level. In other words, an issue which might be of pivotal significance in one location may be completely negligible in another. Weighting factors are avoiding this problem. By means of the MCA in other words, stakeholders of a nexus challenge or opportunity would develop a suite of weighting factors specific to that challenge or opportunity thereby allowing different solutions or approaches to be compared, using a simple score, within a common framework.

As already noted, the example given is currently at a detailed planning stage. The MCA gives it a score of 9.5. If it were decided however, to compare this with a less politically expensive but more standardised approach operated from the centre, then the scores might change as shown in Figure 11. Brown highlights identify the changes which contribute to the lower score which allows the two approaches to be compared.

TABLE 13 THE DRAFT RAPID ASSESSMENT FRAMEWORK

| Project Profile | | |
|---|---|---|
| **Topic Cluster (from the ToR)** | **Question** | **Response** |
| **geography and politics** | **Where is the infrastructure?** | Lesotho |
| | **What is the development status of the country in terms of:** | |
| | political system and stability? | Functional democracy, disrupted from time to time by political turf wars and protectionism |
| | level of development? | Low to moderate, but with certain advanced elements such as state of the art resettlement modalities (where needed) |
| | economic development trajectory? | Sub-optimal, not well defined and heavily constrained by silo thinking and political economy |
| | main economic sector? | Agriculture, livestock, manufacturing, mining and remittance incomes (largely from miners in South Africa) |
| | **What is the natural resource endowment of the country in relation to:** | |
| | water? | Large quantities of unallocated renewable water resources |
| | agricultural potential? | Vast and undeveloped, at least in terms of non-traditional crops and value chain inputs |
| | energy? | Considerable undeveloped potential in terms of both hydropower and bioenergy |
| **general information** | **What kind of infrastructure is it/will it be?** | A combination of natural and built infrastructure increasing bulk water supply and contributing to a value chain approach to catchment restoration, management and productivity |
| | **What sectors does/will the infrastructure serve and how:** | |
| | water? | Increased supply of water for households, industry, agriculture and transboundary trade |
| | agriculture? | The investment will increase the availability of water for small-scale, high value crop production, including irrigated fodder to take the strain of natural grazing areas |
| | energy? | By increasing the supply of water for hydropower, and by mobilising the considerable bioenergy potential in the country's agriculture and rangeland management sectors |
| | **What were/are the drivers of investment?** | Economic growth, socio-economic transformation driven by catchment restoration and management, and investments in non-traditional value chains |
| | **What were/will be the attributable Costs in terms of:** | |
| | finance and economics? | Currently unallocated budget of €78 mill in grant aid, and up to approximately € 300 mill in soft development bank loans |
| | social issues? | Small and highly localised if any |
| | the environment? | Small and highly localised if any |
| | **What are/will be the attributable Benefits in terms of:** | |
| | finance and economics? | Yet to be determined |
| | social issues? | Increased and diversified livelihoods, especially in the rural areas |
| | the environment? | Urgently needed, major benefits by securing the sustainability and productivity of the Southern Africa water tower |
| | **What were/will the sources of finance** | European Union grant aid and leveraged European Investment Bank soft loans |

FIGURE 11 AN ALTERNATIVE APPROACH FOR LESOTHO

| MULTI-CRITERIA ANALYSIS | | | | | |
|---|---|---|---|---|---|
| **TOPIC CLUSTER (from ToR)** | **QUESTION** | **RESPONSE** | **SCORE -1 0 +1** | **WEIGHT** | **RESULT** |
| **policies and institutions** | **Was or will the investment be enabled or constrained in terms of:** | | | | |
| | multi-use policies | Enabled as a result of the proposed demand driven, district level disbursements proposed will avoid the problems of silo thinking and limited multi-purpose investment appraisal capacity at the centre | 1 | 0.75 | **0.75** |
| | appropriate institutional capacity and arrangements? | Enabled because of the decentralised approach, which includes comprehensive capacity building | 1 | 1.20 | **1.20** |
| | scale? | The programme is multi-scale as opposed to scale defned | 1 | 1.50 | **1.50** |
| | **How did or will these factors influence:** | | | | |
| | specification and design? | Not signficantly because of the heterogeneity of the programme | 0 | 0.50 | **-** |
| | operations? | Potentially beneficially because of the decentralised approach | 1 | 1.00 | **1.00** |
| | capital financing? | Favourably because of the ability of the grant support to lever and indeed soften the loan financing | 1 | 1.50 | **1.50** |
| | operational financing? | To soon to tell | 0 | 1.50 | **-** |
| **benefits and trade offs** | **What is the actual or target cost/benefit ratio** | nominal > 1.0 | 1 | 0.50 | **0.50** |
| | **Who are or will be the winners and losers?** | | | | |
| | state entities? | Depends on the amounts of political capital that is willingly expended, there may be some losers | 0 | 1.50 | **-** |
| | populations? | Increased, diversified livelihood opportunities | 1 | 1.50 | **1.50** |
| | the private sector? | Potential winners, but this depends on response to new opportunities and the appetite of potential investors and any significant benefits are only assumptions at this stage | 0 | 1.00 | **-** |
| | the environment? | In macro terms, the environment is the principal beneficiary | 1 | 1.50 | **1.50** |
| | | | | **TOTAL SCORE** | **9.45** |

# 5 CONCLUSIONS AND RECOMMENDATIONS

## 5.1 Priorities, Options for facing them and the Challenges That Might be expected

The research presented above has shown that there are already some promising examples of multi-purpose infrastructure – both existing and under implementation - and examples of infrastructure that could be. In addition the Lesotho example confirms that a nexus approach need not be confined to single items of infrastructure, but instead that an entire programme approach can have nexus characteristics and deliver nexus results even if (some of) the components may be single purpose. Nonetheless a default nexus approach remains constrained by a range of obstacles and constraints. According to stakeholders that responded to the questionnaire, in the short term (within five years) competition will increasingly emerge between bulk water and agriculture, and between agriculture and energy. But within fifteen years, difficulties with water versus energy are also expected.

All is not yet lost however, so before proceeding to examine priorities, it is useful to be reminded of what is not a problem, at least in the target areas – Figure 10 referred.

- Technical Feasibility is not a worry – we know how to do it, and where difficult technical challenges are encountered, they are expected to reduce as skills and modelling options improve – albeit slightly - along the lines suggested by the Figure.
- Also, there is for the time being, enough water left in both target basins for a new approach to make a difference[48]. Even so, this bold statement does not reflect i) the real and increasing likelihood that despite surpluses at the basin level, competition for bulk water will increase as the observer moves closer to the point of abstraction; and ii) the likelihood that seasonal, and perhaps trans-annual flow variations call for storage.
- However, although Finance would appear to be the least of the problems, with only a small increase in its relevance in the longer term at least in the eyes of the questionnaire respondents. But According to the Africa Infrastructure Country Diagnostic (AICD), the infrastructure need of Sub-Saharan Africa exceeds US $93 billion annually over the next 10 years. To date, less than half that amount is being provided thus leaving a financing gap of more than US $50 billion to fill. With this in mind it will be obvious that a nexus approach has the potential to make finances go further by providing infrastructure that serves more than one need, while in some cases providing revenues that can be used for cross funding or cross subsidisation purposes.

In other words, although the clock is ticking as regards intensifying competition, it is not yet too late. Sufficient building blocks needed for trade-offs, compromises and synergies are available and hence win-win-win outcomes are also available. But if resources continue to be allocated into single sector solutions, nexus options will begin to disappear. With this in mind, it will be clear that short term investments in large scale, long term single purpose infrastructure would be of questionable wisdom given that typically, the utility of such infrastructure would become increasingly limited, while locking up financial and water in sub-optimal operations into the long term.

Another way of saying this is that it is best to mainstream nexus solutions while nexus opportunities are still available. But as argued above, there are various obstacles that must be overcome if the nexus is to be the default approach.

So what are they? Again, Figure 10 referred, they are:

- institutional problems, which will continue to dominate, despite some improvement;

[48] See for instance Figure 14 in FAO: Land and Water Bulletin N° 4 "*Irrigation Potential in Africa, a basin approach*".

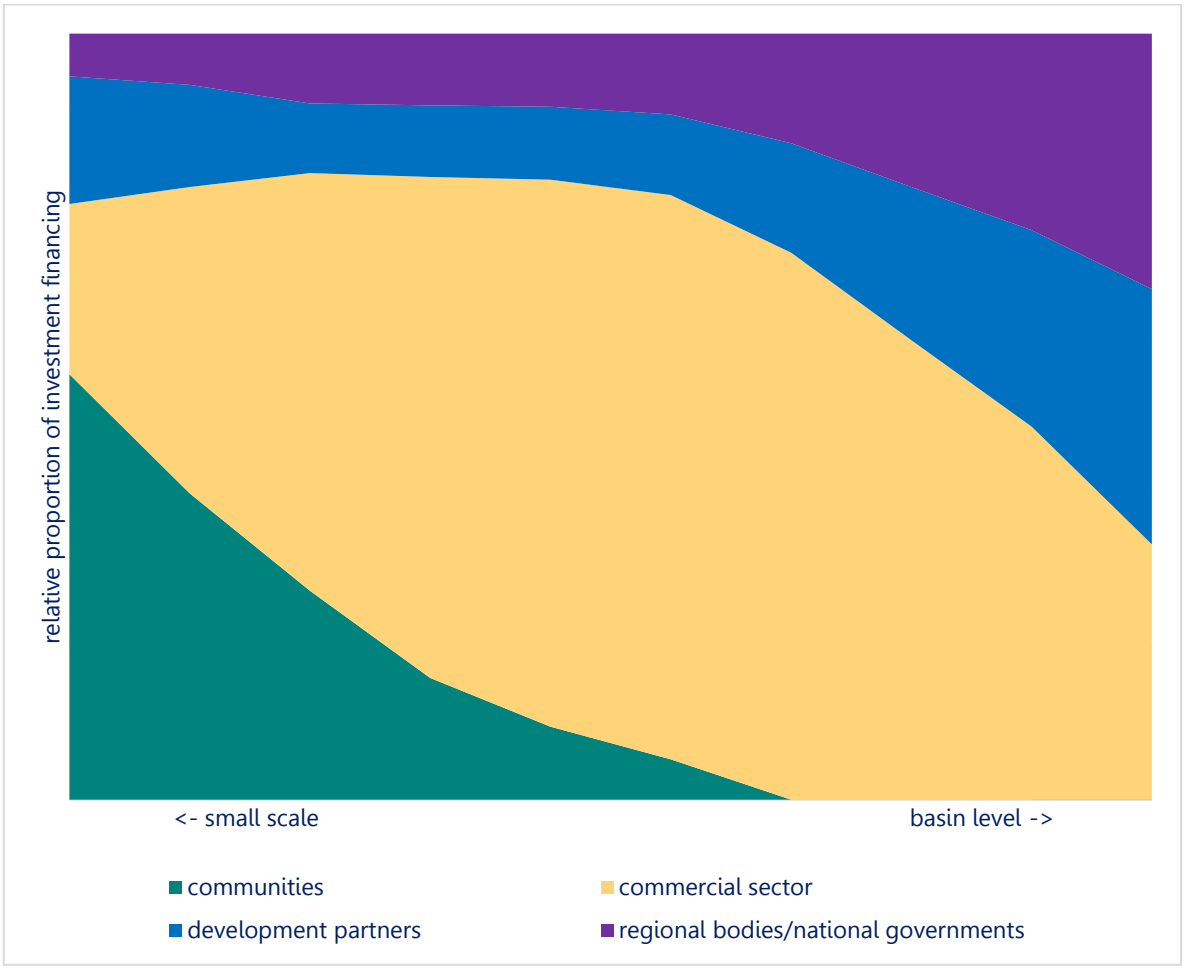
- ditto limited technical capacity;
- cost/benefit sharing challenges are expected to intensify; and
- transboundary disagreements again ditto.

Based on the research and analysis set out respectively in sections 3 and 4, Table 14 identifies options for addressing these priorities while noting any challenges that could be expected and relating them to the relevant emerging themes. Clearly, some of the priorities are interlinked and as such call for an integrated strategy. Section 5.3 which ends this Main Text proposes a road map for the implementation of such a strategy.

## 5.2 Possible Funding Modalities

The relevance of scale has already been noted as a key determinant of a nexus specification. This section suggests that scale is also a determinant of ideal nexus funding modalities - the following dimensionless model refers.

FIGURE 12 SCALE AND POSSIBLE FUNDING MODALITIES



Taking each funding source in turn:

- Development Partners: by which is meant development banks and bilateral donors which would remain active in small scale infrastructure development. But as scale increases, their efforts may be better expended on the policy and institutional measures needed to establish an enabling environment for multi-purpose infrastructure, especially for large scale and transboundary basin level investments. Finally, at the large scale side of the model, they should retain a major financing role.
- Regional Bodies and National Governments: are effectively the promoters/owners of publicly funded infrastructure. As such they should be involved in the counterpart funding of both capacity building for and investments in multi-purpose infrastructure. At the small scale side of the model, national governments (and their decentralised manifestations) should remain involved at the grass roots not just with respect to improved service delivery and beneficiary capacity building, but also with innovative financing models[49] that facilitate equity participation by small producers in value chains.
- The Commercial Sector*:* either independently or in partnerships with Governments can invest at any scale in both commercial agriculture and electricity supply. At the small scale side of the model, in addition to purely private schemes, there will be opportunities with respect to out grower programmes, and value chains which include small producers. As scale increases, there will be various opportunities for commercial investments including Public Private Partnerships (see Annex A3).
- Communities: which will be the grass roots beneficiaries of most publicly financed infrastructure. Nonetheless perceptions of ownership and the need for sustainability require that they participate financially in all publicly funded projects from which they benefit. Such participation can be in the form of labour or kind if cash is not available. However, the innovative financing mentioned above could be used to increase the accessibility and affordability of commercial loans that allow small producers to purchase high precision irrigation equipment; obtain equity in value chains and diversify their farming systems towards water smart agriculture. For convenience any NGO financing is assumed to be subsumed into community financing.

## 5.3 Basin Concept Notes

According to the Terms of Reference, this section is intended to "….provide recommendations to tackle the identified challenges through strategic infrastructure solutions for water, energy and food security…" for the Volta River and Lake Victoria basins. The recommendations themselves were meant to suggest bilateral solutions, investment opportunities and resource mobilisation options and be presented as Concept Notes identifying ways by which nexus principles can be integrated into a regional project. But as will already be clear from section 3 and 4 the body of nexus literature seemed to place greater emphasis on institutional and policy based issues, than on examples of actual infrastructure. This is important because the same issues were confirmed as significantly problematic from a stakeholder perspective as was clearly suggested by Table 7.

[49] Such as revolving funds; convertible loan notes and loan guarantees – which of course would be entirely appropriate for development partner support.

TABLE 14 PRIORITIES, OPTIONS AND CHALLENGES

| Priorities | Options | Relevant themes | Associated challenges |
|---|---|---|---|
| **Institutional problems** | | | |
| A range of institutional issues constrain the mainstreaming or achievement of trade-offs, compromises or synergies as a means by which to resolve competition between the three nexus elements.<br>• These issues include: institutional and policy silos;<br>• national and development partner institutional arrangements that do not favour integrated thinking;<br>• limited technical capacity, especially with respect to lateral thinking;<br>• slow institutional evolution;<br>• rigid development plans and associated milestones that are unable to adapt to new policy frameworks;<br>• the fact that even the best economic or technical approaches may be inadequate to fix problems of political economy;<br>• and power relationships (between national institutions and transboundary interests) that are unlikely to be softened in the short to medium term. | Institutions, including development partners need common objectives, and new metrics such as the economic efficiency of water or power use. | **silos and linear thinking** | Institutions might resist the introduction of common objectives and metrics as a result of perceived reputation risks, especially with respect to "non-traditional" business. An example would be an institution that is used to being monitored on the basis of say, how much irrigation infrastructure it has constructed being evaluated on the quality of the service it provides with that infrastructure. Thus instead of metrics such as irrigated commands areas, the agricultural productivity, or impact on rural livelihoods would be more relevant. |
| | Policy makers and planners need capacity building that goes beyond their day-to-day remits. This includes A new type pf capacity building, including curricula at single subject university need massive diversification | **silos and linear thinking** | Expert professionals in one particular field are likely to resist being seen perceived, or even failing as "amateurs" in another. |
| | Improve employment packages at public institutions | **political economy** | Improved employment packages will be perceived as being unaffordable, but if implement could mitigate the challenge immediately above. There is also a risk that political economy will constrain options for enforcing improved service cost recovery or tariff based cross-sectoral subsidies. |
| | Acknowledge importance of scale and go for decentralised planning and implementations | **political economy** | Smaller scales, decentralised approaches may reduce budgets and influence and hence may be resisted by large incumbencies. |

| Priorities | Options | Relevant themes | Associated challenges |
|---|---|---|---|
| | | **donor drag** | Although scale advantages might be consistent with donor policy, they might be questioned if they reduce disbursement flow rates. |
| | Enforce regulations and cost recovery mechanisms | **political economy** | Politicians are tempted to see political advantage if they reduce fiscal and/or increased operational demands on their electorate |
| | Look for compromise | **political economy** | Planners may not see any advantage in the yielding of influence implicit in a compromised based solution, even if they understand the rationale involved |
| | Establish well regulated market mechanisms that allocate costs and benefits while being independent of institutional palisades | **political economy** | Pricing mechanisms may (wrongly) be perceived as anti-poor, or where the private sector is powerful and influential, there may be reluctance to regulate markets. |
| **Cost/benefit sharing challenges** | | | |
| Difficulties with respect to cost and benefits sharing are in some respects self-explanatory except to suggest that they may accrue to both silos and technical difficulties in actually how costs and benefits should be shared between co-developers and co-users of infrastructure. Since these are essentially institutional capacity building issues, they are partially addressed by the measures proposed for solving the institutional problems.<br><br>In addition however:<br>• a lack of understanding and/or political capital limits opportunities for compromise or market based solutions that | Build equitable value chains based on compromise | **political economy**<br>**which is best – trade-off, compromise or synergy** | Politicians might want a piece of the action, or the enabling environment might be considered too costly from a political perspective, and hence that value chain investors cannot be attracted and or producer participation may prove difficult to finance, hence limiting the social benefits (but not catastrophically so) |
| | Market based approaches | **as above** | As above |
| | Regional solutions to local problems | **political economy** | Which is best – trade-off, compromise or synergy |

| Priorities | Options | Relevant themes | Associated challenges |
|---|---|---|---|
| would allocate costs and benefits differently and to mutual advantage; and<br>• it may well be that collateral but nonetheless significant societal and environmental benefits are not acknowledged. | Institutions, including development partners need common objectives, and new metrics such as the economic efficiency of water or power use | **political economy** | As above. |
| | Acknowledge importance of scale and go for decentralised planning and implementation | **political economy** | As above. |
| | Cross sector financing (tariffs from one sector support development in another) | **silos and linear thinking** | This might be perceived as an erosion of revenues |
| | Understand the benefits | **which is best – trade-off, compromise or synergy** | With adequate capacity building there should not be any major challenge. |
| | Look for the compromise | | |
| | Reduce competition for finances, increase service cost recovery | **political economy** | Although competition for financial resources would be reduced by increased revenues, there would be a political price to be paid (see above) and institutions/departments with increased revenues may want to keep them in their entirety. |
| | Natural infrastructure, not concrete monuments | **political economy** | Natural infrastructure does not produce concrete "monuments" and may require cooperation institutions or departments (in the case of development partners) that have hitherto not cooperated or that have sector specific budgets and objectives. |
| **Transboundary disagreements** | | | |
| This again and at first sight, is largely self-explanatory: there are geopolitical ramifications to transboundary infrastructure and powerful countries will tend to win out over weaker riparian: or, territorial turf wars at the national level may compromise transboundary agreements that favour | Natural vs built infrastructure | **silos and linear thinking**<br>**which is best – trade-off, compromise or synergy** | As above. |
| | Regional solutions to local problems. | **silos and linear thinking** | Regional solutions to local problems may require retreats from politically cheap mantras concerning self-sufficiency in terms of agriculture and |

| Priorities | Options | Relevant themes | Associated challenges |
|---|---|---|---|
| one institution over another. In addition however, such problems are exacerbated by:<br>• inabilities to craft regional solutions to local problems that, by mobilising comparative productive advantage invest water and/or energy into value chains that expand and diversify livelihoods; and<br>• ignore the transboundary benefits of simple inventions involving natural infrastructure.<br>Regional solutions to local problems and investments in natural infrastructure both have the potential to increase supplies of water and/or energy, while contributing to increases in the economic efficiency of both. | | **political economy** | energy. There may also be perceived and indeed genuine concerns about national security. |
| | Acknowledge importance of scale and go for decentralised planning and implementations | **political economy** | As above. |
| | Self-sufficiency vs comparative advantage | **political economy** | As above re: regional solutions to local problems. |
| | Understand the benefits | **silos and linear thinking** | Although in this context the options would address transboundary disagreements, the associated challenges would be as above. |
| | Look for the compromise | | |
| | Trade-offs should reflect economics not institutional territory. | **which is best – trade-off, compromise or synergy** | Broad based capacity building would provide the necessary skills; but data availability and consistency might present a problem as might data sharing protocols and objectives. |
| | Regional solutions to local problems | **political economy** | As above. |

Even so it has been possible to repackage a combination of the research and the consultant's own knowledge concerning the two basins into a tabular concept note presented below as Tables 15 and 16 (tabular because of the desirability of standardised concept notes). In addition, it should be understood that the identification of specific investment opportunities would normally be undertaken as a stand-alone exercise involving travel and site visits, and not as one of six components of what is effectively a policy and practice diagnosis - investment opportunities suggested herein are therefore necessarily generic. In any case, the conclusions and recommendations that have emerged loud and clear from this study suggest that to embark on major programmes of infrastructure development before the policy and institutional obstacles have been overturned could be dangerously counterproductive.

The Concept Note rationale is based on the assessment of the two target basins' irrigation and energy sectors presented as Annex A4[50] and is based on five key principles[51]:

- Undeveloped irrigation potential remains very significant in the Volta River and Lake Victoria basins which both include food insecure countries while having significant opportunities for energy and industrial cropping.
- Irrigation – ideally on demand - should maximise total factor productivity based on regional solutions to local problems and the mobilisation of local productive comparative advantage – hence the term "irrigation" is not limited to food cropping.
- Both target basins lack access to sufficient and/or renewable energy.
- There is no advantage to be gained, and a lot to be lost if decisions to invest in joint agriculture and energy sector infrastructure are not made soon;
- Dual use infrastructure has the potential to generate higher revenues which could be used not just for recurring cost recovery, but also for sinking funds for new investments and cross sector subsidies for both capital and recurring costs.

Although these principles are clearly not scale dependent; scale is nonetheless a key determinant of how they are addressed in the Concept Notes.

[50] Where although the data on access to energy and hydropower potential is limited, it is enough to justify the investment strategies set out in the concept notes. Also, waste water irrigation is included by way of acknowledgment of the water supply and sanitation schemes currently under implementation around Lake Victoria, and the multi-purpose potential they represent for high value peri-urban irrigation.

[51] Data used to generate the annex is extremely limited with respect to the extent to which areas equipped for irrigation are also provided with drainage. In fact, this information is recorded only for Mali, where less than 5% of the equipped area has drainage. Since drainage is an essential building block of economic water use efficiency and the maintenance of environmental stream flows, "irrigation" as used in the Concept Notes means "irrigation and drainage" where new schemes are concerned, or "improved drainage" at existing schemes.

TABLE 15 VOLTA RIVER BASIN CONCEPT NOTE

<table>
<tr><th colspan="6">PROFILE ELEMENTS – VOLTA BASIN</th></tr>
<tr><th>Physical Features, Politics, Demographics and Development</th><th>Water, Agriculture and Energy Security</th><th>Key Nexus Institutions</th><th>Current Initiatives</th><th>Investment Opportunities for Natural and Built Infrastructure</th><th>Resource Mobilisation Options[1]</th></tr>
<tr><td>Catchment area: 400,000 km$^2$<br><br>Six riparian states; Benin, Burkina Faso, Cote d'Ivoire, Ghana, Mali and Togo, but the river flows mainly through just two of them: Burkina Faso and Ghana.</td><td>Although it has been estimated by FAO that the basin's entire irrigable area could be developed with only 75% of the annually renewable water, irrigation development has been generally minimal. Without irrigation however, rising populations will begin to result in widespread food insecurity</td><td rowspan="2">• Volta Basin Authority; but regulation is reportedly difficult at the level of the riparian states, which have many uncoordinated/non-aligned government agencies.<br>• West African Power Pool<br><br>Communications between stakeholders is often limited and any resulting actions are uncoordinated.<br><br>Data and information scope, quality and</td><td>In terms of the enabling environment:<br>• Ghana has a new irrigation policy, and a senior PPP policy which awaits a sector specific “junior” policy for the agricultural water management sector</td><td>Localised investments in watershed rehabilitation based on a combination of community based investments in natural infrastructure and agricultural value chains which include small producers.</td><td>• Communities<br>• Commercial Sector<br>• National Governments<br>• Development Partners</td></tr>
<tr><td>Four of the six riparian are functioning democracies; Burkina Faso and Togo are regarded as emerging and transitional democracies respectively. But typically, VBA riparian are among the poorest, especially in the rural areas.</td><td>Demand for energy exceeds supply, especially in Ghana<br><br>Poor water quality is a problem and arises, not least, because of inadequate regulations and standards.</td><td>In terms of basin plans:<br>• VBA has developed a new Strategic Plan, 2015-2019 that would contribute to changes at the institutional and policy levels by</td><td>Localised investments in agricultural value chains which include small producers and increase the agricultural productivity of water</td><td>• Communities<br>• Commercial Sector</td></tr>
</table>

| PROFILE ELEMENTS – VOLTA BASIN | | | | | |
|---|---|---|---|---|---|
| **Physical Features, Politics, Demographics and Development** | **Water, Agriculture and Energy Security** | **Key Nexus Institutions** | **Current Initiatives** | **Investment Opportunities for Natural and Built Infrastructure** | **Resource Mobilisation Options[/1]** |
| The basin has a population of around 23 mill people with an average growth rate varying between 2.5 % and 3.0 % per year. More than 70% of the population reside and derive their livelihoods in the basin. | Incompatibilities between dam operating rules for hydropower and irrigation are already emerging and are expected to become more intense and widespread | availability is reportedly low in the basin. | developing a Water Charter and Master Plan incorporating nexus issues<br>• VBA "Observatory for Water Resources and Related eco-systems".<br>• Flood and Drought Management Tools Project<br>• Volta HYCOS Project<br>• Volta River Basin Strategic Action Programme Implementation Project | | |
| Rain fed, and to a lesser extent irrigated, agriculture provides the livelihood for most of the population while representing 40% of the basin's economic output. | A combination of extreme rainfall events and uncontrolled dam releases from the upper portions of the basin leads to significant flooding. | | In terms of national plans:<br>• VBA has local grass roots pilot initiatives in Burkina Faso and Ghana | Combined rice and flood management infrastructure | • National Governments<br>• Development Partners |

| PROFILE ELEMENTS – VOLTA BASIN | | | | | |
|---|---|---|---|---|---|
| **Physical Features, Politics, Demographics and Development** | **Water, Agriculture and Energy Security** | **Key Nexus Institutions** | **Current Initiatives** | **Investment Opportunities for Natural and Built Infrastructure** | **Resource Mobilisation Options[1]** |
| Annual precipitation varies from around 1,100 mm in the south of the basin to less than 500 mm in the north where rainfall is not only scarce, but is also erratic. Temperatures can reach as high as the mid '40°s, which contributes to potential evaporation rates ranging from 1,500 mm/yr in the south to more than 2,500. It has been estimated that less than 10% of the precipitation contribute to the river flow | Flood and drought cycles are regularly encountered, especially in Burkina Faso. | | | Large scale multi-purpose dams: for water storage, irrigation (ideally on-demand), power and possibly groundwater recharge[52]). | • National Governments<br>Development Partners |
| Development in the basin is limited in terms of urbanisation, industry and irrigation; but hydropower development is well underway and is regarded as being crucially important. | Dams and reservoirs have been constructed throughout the basin and provide water for agriculture, industry and energy generation. | | | | |
| *Notes:* | | | | | |
| *1* *From Figure 11* | | | | | |

[52] Possibly because sources differ on this. According to https://wikis.uit.tufts.edu/confluence/display/aquapedia/Transboundary+Water+Governance+in+the+Volta+River+Basin : "*for instance, Groundwater in the basin is overexploited with excessive pumping without due regard to the recharge characteristics of aquifers. Lowering of the water table has also been observed in large parts of the basin and can lead to saltwater intrusion in the southern parts of the basin*": whereas according to a senior official of the VBA "*The opposite is more the case in the Volta basin, e.g., Lemoalle and deCondapa (2009) Water Atlas of the Volta basin. Excessive pumping is highly localized, e.g., along the coast*". The possibility therefore remains in the Concept Note, but perhaps only has localised relevance.

TABLE 16 LAKE VICTORIA BASIN CONCEPT NOTE

| PROFILE ELEMENTS – LAKE VICTORIA BASIN | | | | | |
|---|---|---|---|---|---|
| **Physical Features, Politics, Demographics and Development** | **Water, Agriculture and Energy Security** | **Key Nexus Institutions** | **Current Initiatives** | **Investment Opportunities for Natural and Built Infrastructure** | **Resource Mobilisation Options** |
| Catchment area: 194,000 km2 (263,000 km2 if the lake itself is included)<br><br>Climatic conditions can be described as equatorial hot and humid, with rainfall varying from some 1,350, mm/yr in the North East of Kenya's portion of the basin to 2,400 mm/yr in Uganda | In overall terms, the basin is water secure, but local conditions along with flood and drought cycles mean that in reality much of the basin is actually water insecure. | • Lake Victoria Basin Commission, which – among other things – contributes to five policy areas: ecosystems, natural resources and environment; production and income generation; living conditions | In terms of the enabling environment:<br>• Kenya, Tanzania and Uganda each have new irrigation policies that address the need economically productive water use in agriculture (but not all of these are yet promulgated)<br>• The EAC Agriculture and Rural Development Strategy | Localised investments in watershed rehabilitation based on a combination of community based investments in natural infrastructure and agricultural value chains which include small producers. .; | • Communities<br>• Commercial Sector<br>• National Governments<br>• Development Partners |

| PROFILE ELEMENTS – LAKE VICTORIA BASIN | | | | | |
|---|---|---|---|---|---|
| **Physical Features, Politics, Demographics and Development** | **Water, Agriculture and Energy Security** | **Key Nexus Institutions** | **Current Initiatives** | **Investment Opportunities for Natural and Built Infrastructure** | **Resource Mobilisation Options** |
| Five riparian partners: Burundi (7% of the basin) Kenya (22%), Rwanda (11%), Tanzania (44%) and Uganda (16%). | Food insecurity is encountered throughout the basin, but varies from structural insecurity in Rwanda through local insecurities in otherwise food secure Tanzania and Uganda, to seasonal shortages due to climatic anomalies in Burundi, Kenya | and quality of life; population and demography; and governance, institutions and policies<br>• Nile Basin Initiative<br>• East African Power Pool<br>• Lake Victoria Fisheries Organisation<br>In addition, a number of institutions have also been established to spearhead development in the basin through better water resource management; general supervision and coordination of environmental matters. These include:<br>• The Lake Basin Development | (2005-2030), the Food Security Action Plan (2011-2015), the EAC Sanitary and Phyto-sanitary Protocol and the EAC Water Vision provide a clear framework for sustainable management through integrated water resources management (IWRM). Other cross-cutting regional instruments including the EAC Climate Change Policy (2011), the Climate Change Strategy and Master Plan, as well as EAC Disaster Risk Reduction and Management Strategy call for promotion of Integrated Water Resource Management (IWRM) as a tool for climate change adaptation in the water sector. | | |

| PROFILE ELEMENTS – LAKE VICTORIA BASIN | | | | | |
|---|---|---|---|---|---|
| **Physical Features, Politics, Demographics and Development** | **Water, Agriculture and Energy Security** | **Key Nexus Institutions** | **Current Initiatives** | **Investment Opportunities for Natural and Built Infrastructure** | **Resource Mobilisation Options** |
| All riparians have functional democracies, although constitutional issues concerning presidential terms can be encountered in Burundi, Rwanda and Uganda. | | Authority<br>• National Environment Management Authorities (Kenya and Uganda)<br>• National Environmental Management Council (Tanzania) | In terms of basin plans:<br>• The Nile Equatorial Lakes Subsidiary Action Program (NELSAP) is an investment program under the Nile Basin Initiative (NBI) that promotes investments in power development, power transmission interconnection and power trade, water resources | Localised investments in agricultural value chains which include small producers and increase the agricultural productivity of water | • Communities<br>• Commercial Sector |
| The population within the LVB region is estimated at 40 million people (UNDP 2007) with an average population density of around 204cap/km/km2, | Flood and Drought events are a serious problem in the basin and result from a combination of irregular seasonal and trans-annual climatic variability and poor land management. | | | Peri-urban irrigation using urban waste water. | • Communities<br>• Commercial Sector<br>• National Governments |

| PROFILE ELEMENTS – LAKE VICTORIA BASIN | | | | | |
|---|---|---|---|---|---|
| **Physical Features, Politics, Demographics and Development** | **Water, Agriculture and Energy Security** | **Key Nexus Institutions** | **Current Initiatives** | **Investment Opportunities for Natural and Built Infrastructure** | **Resource Mobilisation Options** |
| but this increases to 1,200 pp/km$^2$ in Kenya. Average population growth rate for the basin is around 2.8 % per year. | Water levels in Lake Victoria, and hence multiple downstream interests face the effects face significant fluctuations. These derive from highly variable rainfall patterns | | management, management of lakes and fisheries, agricultural development etc. Lake Victoria Environmental Management Programme<br>• Lake Victoria Water Supply and Sanitation Programme<br>• Sustainable Water and Sanitation in Africa (USAID)<br>• Nile Basin DSS<br>• Flood and Drought Management Tools Project (http://fdmt.iwlearn.org/en) | | • Development Partners (depending on scale or whether or not a programme approach is involved) |

| PROFILE ELEMENTS – LAKE VICTORIA BASIN | | | | | |
|---|---|---|---|---|---|
| **Physical Features, Politics, Demographics and Development** | **Water, Agriculture and Energy Security** | **Key Nexus Institutions** | **Current Initiatives** | **Investment Opportunities for Natural and Built Infrastructure** | **Resource Mobilisation Options** |
| Over 70% of the population (of which 65% are under 25 years of age) is engaged in agricultural production, mostly small-scale – but with significant participation in the horticultural sector. Bee keeping and lake fisheries are also important[53] | | | In terms of national plans:<br>• Kenya: National Agriculture and Rural Inclusive Growth Project which is targeted – a/o –at a value chain approaches to sustainable watersheds and socio-economic | Large scale multi-purpose dams (water storage, irrigation and power).<br>Irrigation on demand | • National Governments and regional bodies<br>• Development Partners<br>• |

[53] According to http://www.ais.unwater.org/ais/aiscm/getprojectdoc.php?docid=3400, Lake Victoria is the world's most productive freshwater fishery.

| PROFILE ELEMENTS – LAKE VICTORIA BASIN | | | | | |
|---|---|---|---|---|---|
| **Physical Features, Politics, Demographics and Development** | **Water, Agriculture and Energy Security** | **Key Nexus Institutions** | **Current Initiatives** | **Investment Opportunities for Natural and Built Infrastructure** | **Resource Mobilisation Options** |
| In spite of the vast natural resources, the region is among the poorest in the world with two of the countries being among the five poorest countries in the World. The region is characterized by economies dependent on rain fed agriculture, subsistence farming; low industrialization; poor infrastructure, low levels of education attainment and skilled human resources, gender exclusion, an average life expectancy of 50 and high population growth of 3% per annum None of the countries in the region has a GDP per capita of more than US$ 600. In terms of human development (HDI), the EAC countries rank amongst the lowest | | | transformation (includes Districts within the LVB)<br>• At the national level, the importance of sustainable management of Lake Victoria is also highlighted in the national development strategies of the EAC countries. They include the: Vision 2030 and the Economic Recovery Strategy for Wealth and Employment Creation (ERS) for Kenya; Tanzania Development Vision 2025 and the National Strategy for Growth and Reduction of Poverty II (NSGRP II) for Tanzania; and Vision 2040 and the National Development Plan for Uganda, Vision 2020 and the Second Economic Development and Poverty Reduction Strategy (EDPRSII, 2012 -17) for Rwanda, and Vision 2025 and the Poverty Reduction Strategy Paper II (PRSP II) for Burundi | | • |

## 5.4 Next Steps: A Possible Road Map

The two Basin Concept Notes confirm that neither the Volta River, nor Lake Victoria are water insecure overall. Both however, are experiencing agricultural and energy insecurity: a situation which is expected to get worse. Yet there are huge undeveloped water resources that could be exploited – at various scales and in various ways - to fix both of these. Some also represent private sector opportunities in both the agriculture and energy sectors. But it may prove difficult, or even impossible to formulate, develop and operate the infrastructure in an optimally multi-purpose fashion without robust changes at the institutional and policy levels.

Although not actually specified in the Terms of Reference, this section suggests a road map towards nexus solutions in a typical African transboundary river basin – see Figure 13. It is understood that two target basins have been prioritised; but there is no reason why the road map would not be relevant in other transboundary basins. As a road map, the Figure is not especially detailed. Accordingly, it should be studied in conjunction with Table 14, which fleshes out the thinking behind the Figure and the concepts on which it is based.

In summary, the Road Map call for a three pronged, nine stage approaches involving:

- Investment oriented activities (three stages)
- Joint investment and institutionally orient activities (two stages)
- Institutionally oriented activities (four stages).

It begins with the following initiatives which should be implemented simultaneously:

- a hands-on identification and ranking study on the potential with respect to regional solutions to local problems, especially any that are trade based with value added possibilities;
- an institutional Knowledge, Attitude and Perception (KAP) Survey;

and

- an institutional needs gap assessment.

This will eventually provide a ranked list of investment nexus opportunities and an institutional prescription with respect to how best these opportunities could be seized.

One of the investment activities will concern:

- the establishment of agreed cost/benefits sharing protocols, which itself provides an opportunity for
- hands-on training and sensitisation of key stakeholders with respect to these protocols which ideally will respond to the early results emerging from the institutional needs assessment.

Also by this time, the institutional needs assessment and lessons learned while developing the cost/benefit sharing protocols will provide a diagnosis of any constrains on the enabling environment, not least at the policy level and as regards compromise and commercial investments

All the information needed to prepare and begin the implementation of an institutional capacity programme intended to break down silos; operationalise the cost/benefit sharing protocols and elevate the technical level of officials and their establishments, of which:

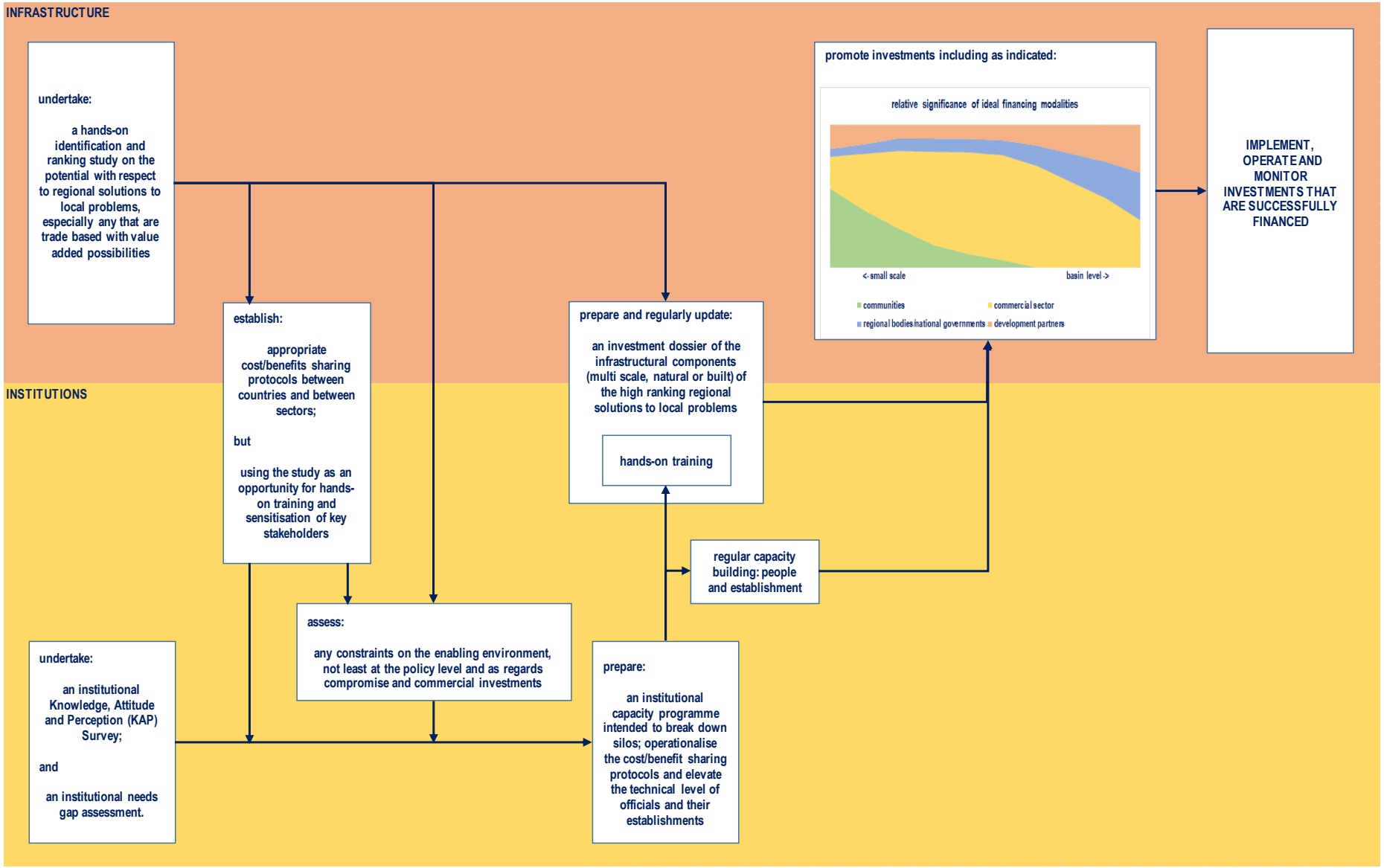
- part will involve regular capacity building: people and establishment

- while another part will involve the provision of hands-on training during the preparation of an investment dossier with respect to the infrastructural components (multi scale, natural or built) of the high ranking regional solutions to local problems

By now, the recommended approach will have produced an investment dossier and officials able to:

- identify and mobilise resources for the nexus infrastructure investments;
- plan, design, commission, operate and monitor the infrastructure;
- and ensure equitable and transparent cost/benefit sharing as appropriate between stakeholders.

FIGURE 13 ROAD MAP TOWARDS SCALE APPROPRIATE, MULTI-PURPOSE WATER INFRASTRUCTURE FOR A TYPICAL RIVER BASIN IN AFRICA.



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# ANNEXES

# A1 TERMS OF REFERENCE

## A1.1 Background

Regionalising the nexus dialogue provides an opportunity for discussing geo-targeted, realistic and relevant project proposals with a wide range of representatives. It facilitates future collaboration and can lead to better political uptake of the nexus concept in the region. It helps create momentum among decision-makers in the region to tackle nexus specific issues of special relevance for the region. These could include for example, how the planning, development and implementation of infrastructure is used to provide water, food and energy security in a transboundary basin which has several countries sharing water resources.

The Nexus Dialogue on Water Infrastructure Solutions was initiated by IUCN and IWA as an Outcome Initiative of the Bonn 2011 Conference. This dialogue process focuses development and optimisation of man-made and nature-based water infrastructure solutions from a nexus perspective. It comprises a series of regional workshops in Africa, Asia and Latin America that bring together problem owners and solution providers from the water, energy and food sectors in each region.

The Infrastructure Consortium for Africa (ICA) is committed to helping improve the lives and economic well-being of Africa's people by promoting increased investment and development of infrastructure in Africa. It is uniquely placed, with water and energy being two of its four main sectors, to be an influential partner in furthering nexus solutions at scale in the region.

Regional climatic, political, economic and social circumstances shape how the water-energy-food nexus is addressed and how infrastructure can be developed to supply water for different uses across the nexus. An analysis of the nexus space for infrastructure futures in Africa is needed to understand the regional challenges, solutions and opportunities for the water, energy and food sectors to increase their linkages and become more resilient in a changing world.

## A1.2 Objectives of the Work

To identify and to define an action-oriented outlook for: optimising multi-purpose water infrastructure and the enabling environment to develop and implement such infrastructure. The objective of the action-oriented outlook is to address nexus challenges, trade-offs, possible synergies and project opportunities relevant for Africa (and its regions) in general and of two selected river basins in particular.

## A1.3 The expected tasks to be undertaken by the Consultant are as follows:

For:

Output 1 - Draft Study Outline: the Consultant will develop - in consultation with IWA/IUCN with respect to contents – a study outline including references and suggestions for interviews, consultation and discussions with regional stakeholders.

Output 2.1 - Study Research: and based on a combination of literature reviews and on-line research the Consultant will produce an overview of selected Africa regional challenges and opportunities that incorporates relevant case studies and projects discussed during the IWA/IUCN Africa Nexus workshop[54] as well as other regionally relevant material.

Output 2.2 – Interviews, Consultations and Discussions with regional stakeholders: the Consultant will discuss with regional stakeholders (Regional Economic Commissions, basin organizations, experts, etc.) to ascertain on how they are planning and investing in multipurpose infrastructure.

Output 3.1 – Overview of Selected African Regional Challenges and Opportunities: the Consultant will

3.1.1: based on the study research, develop an overview of selected regional challenges and opportunities for multipurpose infrastructure in Africa;

3.1.2: using the overview of regional challenges and opportunities, develop a rapid assessment framework with input from ICA, IWA and IUCN. The framework must include a set of criteria with a geographical relevant methodology (for example, climate related risks) and aim to identify current and future nexus based interventions and the indicative costs and benefits; general information; financing; policies; benefits & trade-offs.

Output 3.2 – Detailed Basin Assessments: the Consultant will

3.2.1: identify water and multiple use infrastructure regional projects currently starting or upcoming. The research is to focus on the Volta basin and Lake Victoria basin, without disregarding projects from other areas in the region;

3.2.2: apply the rapid assessment framework to assess how current and upcoming infrastructure projects adequately deal with nexus challenges in the 2 selected basins. The assessment should be applied with a focus on 1-2 regional projects within the Volta and Lake Victoria basins and how interlinking water-energy-food priorities can be integrated (if it is not already), including, and should

a. identify which are nexus based interventions and what are the indicative costs and benefits. This means water, energy and food multi-purpose infrastructure;

b. identify priority areas and options for multi-purpose (nexus) infrastructure investment opportunities relevant to ICA members, based on existing policies and strategies in the selected basins (2); this will include:

- the collation of information on demand for water infrastructure to provide water supply, energy provision and food production; considering policies and strategies –where are the demands, type of infrastructure.

Identification of the challenges to developing WEF multi-purpose infrastructure. What are the obstacles? What are the causes of these obstacles?

[54] www.waternexussolutions.org/236/events/africa-regional-workshop.html#.UwXQTfldXVo

3.2.3: provide recommendations to tackle the identified challenges through strategic investment infrastructure solutions for water, energy and food security. This includes development of 2 project concept notes, for each basin, which identify how the nexus perspective can be integrated in a regional project in that basin, with:

a. practical bilateral solutions: water-food/water-energy/food-energy;
b. investment opportunities identified in natural and built infrastructure which can effectively and efficiently supply water for multiple uses to secure water, energy and food for ICA members;
c. recommendations outlined on how these investments can be mobilized. Who is involved? What incentives are needed? What policies are required?

Output 4 - Final Study: the Consultant will

4.1: submit Draft Study for review by IWA/IUCN and ICA, containing: (1) an overview of selected Africa regional challenges and opportunities and (2) detailed basin assessments;

4.2: incorporate feedback into a final version of the Study Report.

The specific outputs of the consultancy will be:

1. A Draft Study Outline
2. A Rapid Assessment Framework
3. A Draft Study Report
4. A Final Study Report

# A2 THE STAKEHOLDER CONSULTATION QUESTIONNAIRE

The results of the stakeholder consultation are presented below in section A2.3, after two sections listing the stakeholders that were contacted. Unfortunately, only eight of them actually responded. Nonetheless, their responses were enough to identify some important stories of relevance to the study. These stories were presented in Section 3.2.4 of the Main Text.

## A2.1 Institutional Stakeholders

| Institution | | Mandate or function | Relevance to the study |
|---|---|---|---|
| **Regional Organisations and Technical Bodies** | | | |
| **AMCOW** | African Ministers' Council on Water | To provide political leadership, policy direction and advocacy in the provision, use and management of water resources for sustainable social and economic development and maintenance of African ecosystems. | AMCOW has an active interest in water infrastructure and also initiated the AWF (see next row), it is likely to have an interest in the nexus. |
| **Contact(s):** | Fred Mwango: fredmwango@yahoo.com | | |
| **CAADP** | Comprehensive Action Plan for African Agricultural Development | Established as part of NEPAD in July 2003 and focuses on improving and promoting agriculture across Africa – see below. | CAADP is concerned with environmentally sound agriculture and the wise use of natural resources, including. As such it can reasonably be assumed to have views on and experience of nexus style challenges. |
| **Contact(s):** | Elijah Phiri: ephiri62@yahoo.com | | |
| **EAPP** | East African Power Pool | To pool the region's electrical energy resources in a coordinated and optimized manner to provide an affordable, sustainable and reliable electricity in the region | As what might be called an intergovernmental power wholesaler, the EAPP could reasonably be expected to have an interest in expanding and sustainable energy production. |
| **Contact(s):** | Joseph Magochi: jmagochi@eappool.org | | |
| **ECOWAS** | Economic Community of West African States | The promotion of economic integration across the region in order to achieve "collective self-sufficiency" for its member states by creating a single large trading bloc through an economic and trading union. | The economic integration sought by ECOWAS concerns all three nexus sectors. |
| **Contact(s):** | Ibrahim Babatunde Wilson: ibrwilson@yahoo.com | | |
| | Innocent Ouedraogo: ino@ecowas.int | | |
| | Anna Tengnas: annatengnas@gmail.com | | |

| Institution | | Mandate or function | Relevance to the study |
|---|---|---|---|
| **GWP** | Global Water Partnership | To facilitate a water secure world by supporting the sustainable development and management of water resources at all levels. | Convenor of the Water, Climate and Development initiative, and an important player in water and related issues over most of the continent. |
| **Contact(s):** | | | |
| **NEPAD** | New Economic Plan for Africa Development | To facilitate and coordinate the implementation of regional and continental priority programmes and projects and to push for partnerships, resource mobilisation and research and knowledge management. | All three nexus sectors appear in one or more of NEPAD's six thematic programmes. |
| **Contact(s):** | Nick Tandi: nick.tandi@thenbf.co.za | | |
| **SADC** | Southern Africa Development Community | To promote sustainable and equitable economic growth and socio-economic development through efficient, productive systems, deeper co-operation and integration, good governance, and durable peace and security; so that the region emerges as a competitive and effective player in international relations and the world economy. | Although SADC does not have its own agenda for water infrastructure, it is difficult to see how such a potentially influential body might have nothing to say about the nexus challenges and opportunities. |
| **Contact(s):** | Phera Ramoeli: pramoeli@sadc.int | | |
| **SAGCOT** | Southern Agricultural Growth Corridor for Tanzania | To mobilize private sector agribusiness investments, and, linked closely with public sector commitments, to achieve rapid and sustainable agriculture growth in southern corridor of Tanzania | The SAGCOT initiative is intended to catalyse ad facilitate commercial investment in an area with environmentally significant water resources; existing hydropower and undeveloped hydropower potential and vast undeveloped agricultural potential. |
| **Contact(s):** | Geoffrey Kirenga: Geoffrey.kirenga@sagcot.com<br>Jennifer Baarn: Jennifer.baarn@sagcot.com | | |
| **WAPP** | West African Power Pool | To ensure Regional Power System integration and realization of a Regional Electricity Market. | As for EAPP and SAPP |
| **Contact(s):** | Honoré Sanou: info@ecowapp.org | | |
| **WBCSD** | World Business Council for Sustainable Development | To galvanise the global business community for the creation of a sustainable future for business, society and the environment. | WBCSD "must haves" include objectives dealing with increased agricultural productivity and energy efficiency. Although do not necessarily involve major new infrastructure they are very much likely to involve compromise and trade-offs. |

| Institution | | Mandate or function | Relevance to the study |
|---|---|---|---|
| **Contact(s):** | Joppe Cramwinckel: cramwinckel@wbbbcsd.org<br>Julie Oesterlé: oesterle@wbcsd.org | | |
| **Development Finance Institutions and other Financial Initiatives** | | | |
| **ADB** | African Development Bank | To contribute to the sustainable economic development and social progress of its regional members individually and jointly. | The ADB has active portfolios in all three nexus sectors; including to one extent or another in each of the two target regions. |
| **Contact(s):** | John Sifuma: j.sifuma@afdb.0rg | | |
| **AWF** | African Water Facility | To mobilise and apply financial and human resources to ensure water security in Africa, thereby contributing to meeting the targets and goals established by the Africa Water Vision 2025 and the Millennium Development Goals. | The AWF is active in 50 countries where its portfolios include nexus sector initiatives. |
| **Contact(s):** | Sering Jallow: s.jallow@afdb.org<br>Mohamed El Azizi: M.elazizi@afdb.org | | |
| **IFC** | International Finance Corporation | to further sustainable economic development through the private sector. | The private sector is investing in all three nexus sectors, the IFC can therefore be assumed have a nexus position of some sort. |
| **Contact(s):** | Richard Colback: rcolback@ifc.org<br>Anders Ingvald Berntell: berntell@ifc.org | | |
| **WB** | World Bank | To promote long-term economic development and poverty reduction by providing technical and financial support to help countries reform particular sectors or implement specific projects—such as, building schools and health centres, providing water and electricity, fighting disease, and protecting the environment. | The WB finances projects in all three nexus sectors**.** |
| **Contacts:** | Diego Rodriguez: rodriguez1@worldbank.org | | |
| **Transboundary/River Basin Authorities** | | | |
| **BC** | Lake Victoria Basin Commission | to promote equitable economic growth; promote measures aimed at eradicating poverty; promote sustainable utilization and management of natural resources; promote the protection of environment within the Lake Victoria basin and promote compliance on safety of navigation | The LVBC has an interest in natural infrastructure (in the form of watershed management), bulk water, and agricultural expansion and intensification. These are nexus issues. |

| Institution | | Mandate or function | Relevance to the study |
|---|---|---|---|
| | | | |
| **Contacts:** | James Sano: jsano@ewsa.rw | | |
| | Ally-Said Matano: matano@lvbcom.org | | |
| | Canisius Kanangire: kanangire@lvbcom.org | | |
| | Omari R. Mwinjaka: mwinjaka@lvbcom.org | | |
| | Raymond Mngodo: mngodo@lvbcom.org | | |
| **NBA** | Niger Basin Authority | The promotion of cooperation among member countries to ensure integrated development of resources. | The NBA seeks to facilitate cooperation across and between all three nexus sector. |
| **Contacts:** | Henri-Claude Enoumba: hcenoumba@gmail.com | | |
| **NBI** | Nile Basin Initiative | To achieve sustainable socio-economic development through equitable utilization of, and benefit from, the common Nile Basin water resources. | The NBI's Nile Equatorial Lakes Subsidiary Action Programme (NELSAP) has both hydropower and agricultural components. Similarly its Eastern Nile Subsidiary Action Programme (ENSAP) include hydropower and bulk water components – hence **RELEVANT**. |
| **Contacts:** | Abdulkarim H Seid: aseid@nilebasin.org | | |
| **ORASECOM** | Orange-Senqu River Commission | To promote the equitable and sustainable development of the resources of the Orange-Senqu River and provide a forum for consultation and coordination between the riparian states to promote integrated water resources management and development within the basin. | Although the ORASECOM emphasis is largely oriented towards hydrology with no obvious sectoral or infrastructural perspective, it has just produced an IWRM plan (with possible AWF financing). |
| **Contacts:** | Lanka Thamae: lenka.thanae@orasecom.org<br>Rapule Pule: rapule.pule@orasecom.org | | |
| **SRBDA** | Senegal River Basin Development Authority | To promote self-sufficiency in food security, to improve the income of the local populations, and to preserve the natural ecosystems in the Senegal River basin. | The SRBDA claims both the energy and agricultural sectors as being of direct interest**.** |
| **Contacts:** | Tamsir Ndiaye: tamsir.ndiaye@omvs.org | | |
| **TARDA** | Tana and Athi River Development Authority | To undertake integrated planning, development coordination and management of the resources within the Tana and Athi River basins. | TARDA's current projects include irrigation schemes and hydropower**.** |
| **Contacts:** | Abdul Agona: aagona@tarde.co.ke | | |
| **VBA** | Volta Basin Authority | To: i) promote permanent | Nexus challenges and |

| Institution | | Mandate or function | Relevance to the study |
|---|---|---|---|
| | | consultation tools among the parties for the development of the basin; ii) promote the implementation of IWRM and the equitable distribution of the benefits resulting from their various uses; iii) authorize the development of infrastructure and projects planned by the stakeholders and which could have substantial impact on the water resources of the basin; iv) develop joint projects and works; v) contribute to poverty alleviation; the sustainable development of the Parties in the Volta basin; and, better socioeconomic integration in the sub-region. | opportunities are already encountered in the Volta River Basin – of particular concern is the region's high and increasing dependence on hydropower, and its vast undeveloped irrigation potential. |
| **Contacts:** | Charles Biney: cbiney@gmail.com | | |
| | Jacob W Tumbulto: jwtumbulto@gmail.com | | |
| **ZAMCOM** | Zambezi Water Course Commission | To promote the equitable and reasonable utilization of the water resources of the Zambezi Watercourse as well as the efficient management and sustainable development thereof. | Since all three nexus sectors are important and partially undeveloped in the Zambezi Basin (yet with competition already experience) ZAMCOM can reasonably be expected to have view on the nexus approach**.** |
| **Contact(s)** | John Metzger: metzger@zambezicommission.org | | |

## A2.4 Individual Experts

| Name | Position/ Organisation | Reason For Inclusion | Email |
|---|---|---|---|
| **Adwoa Painstil** | Water Quality Specialist/Water Resource Commission - Ghana | | himapainstil@yahoo.com |
| **Agnes Yobterick** | National Focal Point Officer/Ministry of Environment and Mineral Resources - Kenya | | nfpolvemp2kenya@gmail.com |
| **Anne Marie Ran** | GIZ | Was part of Nairobi workshop and GIZ has strong interest in the nexus concept | annemarie.ran@giz.de |
| **Audax Rukonge** | Agricultural Non State Actors Forum | | director@ansaf.or.tz |
| **Ben Ampomah** | Executive Secretary/Water Resource Commission - | | byampomah@yahoo.com |

| Name | Position/ Organisation | Reason For Inclusion | Email |
|---|---|---|---|
| | Ghana | | |
| **Ben Nyamadi** | CEO/Ghana Irrigation Development Authority | A senior official directly concerned with at least one nexus issue in Ghana, namely the Kpong Dam/Accra Plains Irrigation Project incompatibility | benvay@yahoo.com |
| **Boubacar Barry** | Coordinator in Burkina Faso/West African Science Service Centre on Climate Change and Adapted Land Use) | | barry.b@wascal.org |
| **Callist Tindimugaya** | Commissioner/Directorate of Resources Management, Ministry of Water and Environment, Uganda | Very knowledgeable about local and regional water sector issues | callist.tindimugaya@mwe.go.ug |
| **Elizabet Nselema Nkini** | Principal Environmental Engineer/Ministry of Water - Tanzania | Worth including if she has anything to do with the nexus style environmental threats to the LV fisheries | elizasally@yahoo.com |
| **Emily Ojoo-Massawa** | USAID - PREPARED Project | | emassawa@hotmail.com |
| **Eric Odada** | University of Nairobi/UNSGAB | | eodada@uonbi.ac.ke |
| **Geoff Wright** | Team Leader/Shire River Basin Management Project | Highly experienced water manager, currently working day to day with nexus issues in Malawi's portion of the Shire River and with recent IWRM experience in NW Tanzania | geoffreywright@gmail.com |
| **Jane Mumbi** | Nairobi Water | | jmumbi@nairobiwater.co.ke |
| **Jane Simiyu** | KfW- Nairobi | | jane.simiyu@kfw.de |
| **Japeth Onyando** | GIZ | | jonyando@gmail.com |
| **Japhet Frednand** | MVIWATA | | frednandjaphet@yahoo.com |
| **Jean Marc Garreau** | IUCN | | jean-marc.garreau@iucn.org |
| **Jens Vad** | International consultant in water infrastructure | Highly regarded water engineer with many years Sub-saharan experience of nexus sectors | |
| **Jerry Goh** | KILI FLORA | | jerryecgoh@gmail.com |
| **Jumanne Sudi Mpemba** | Basin Water Officer/Lake Victoria Basin Water Board, Tanzania | | Smpemba2001@yahoo.co.uk |
| **Kizzy Stanislaus** | TANESCO | | stanislaus.kizzy@tanesco.co.tz |
| **Léonce NIHANGAZA** | Ministry of Water and Environment - Burundi | | nihangazaleo@yahoo.fr |

| Name | Position/ Organisation | Reason For Inclusion | Email |
|---|---|---|---|
| **James Gotlewski** | Civil Military Operations Liaison, US Army, Kenya | | jgotlewski@usaid.gov |
| **Louis Mugisha** | Team Leader - Kyoga Water Management Zone Directorate of Resources Management, Ministry of Water and Environment, Uganda | | Louismugisha62@gmail.com; mugishalouis@yahoo.com |
| **Margaret Abira** | Regional Manager WRMA/LVSCA, Kenya | | info@lvnwsb.go.ke; mabira59@yahoo.com |
| **Mary Mwanzau** | Ministry of Agriculture - Kenya | | nmkyalo@gmail.com |
| **Matthew McCartney** | IWMI | | m.mccartney@cgiar.org |
| **Matthew Murgor** | KenGen | | mmurgor@kengen.co.ke |
| **Medhat El-Helepi** | UN Economic Commission for Africa | | MEl-Helepi@uneca.org |
| **Michael Ramaano** | Global Water Partnership Southern Africa | | M.Ramaano@cgiar.org |
| **Patrick Khisa** | Lake Victoria South Catchment Kisumu, Kenya | Water Resources Management Authority | patkhisa@yahoo.com |
| **Peter Bjornsen** | UNEP-DHI | | pkb@dhigroup.com |
| **Peter Kabok Aguko** | Lake Basin Development Authority (LVBDA), Kenya | Managing Director | kabpaguko@yahoo.com |
| **Richard Twum Barimah** | Dialogue on Dams - Civil Society representative | | rtwumus@yahoo.com |
| **Sabine Sibler** | Strengthening Water Associations Partnership (SWAP) | | sabine.sibler@swap-bfz.org |
| **Salimu Issa Lyimo** | Pangani Basin Water Office | The Pangani is an economically crucial river, but is facing a range of nexus style conflicts | salimlyimo27@yahoo.com |
| **Sowed Sewagudde** | Directorate of Water Resources Management and Flood and Drought project - Uganda | | sowed.sewagudde@mwe.go.ug |
| **Stephen Maclean** | Deputy Director/Ghana Irrigation Development Authority | As for Ben Nyamadi | Stevemacgh24@yahoo.com |
| **Tom Okurut** | Executive Director/NEMA Uganda | | tokurut@nemaug.org |
| **William Chipeta** | Head/Shire River Basin Management Programme, Malawi | Senior Government expert working directly on nexus issues on a day to day basis | wpcchipeta@yahoo.com |

## A2.3 Results

| QUESTION | | RESPONDENT | ANSWER | | | | | |
|---|---|---|---|---|---|---|---|---|
| 2.1 | Is there any existing competition between the bulk water, agriculture and energy sectors in the region for which you have either responsibility or a professional interest? | Jens Vad | Focussing on the situation in Lesotho, there is no existing competition due to the low level of development of agricultural water use in the country, however in the future there could be competition between the export of water to South Africa on the one side and domestic water use for bulk water supply to the lowlands of Lesotho and agricultural water use. The use of water for energy generation in Lesotho is presently non-consumptive hydropower generation and there is no competition. | | | | | |
| 2.2 | Please rate the intensity of competition between the sectors, using zero, low, moderate or | | bulk water vs agriculture | | agriculture vs energy | | bulk water vs energy | |
| | | Charles Biney | moderate | | moderate | | moderate | |
| | | Emily Ojoo-Massawa | low | | moderate | | low | |
| | | Henri-Claude Enoumba | intense | | moderate | | intense | |
| | | Mohamed el Azizi | moderate | | | | low | |
| | | Omari R. Mwinjaka | low | | moderate | | moderate | |
| | | Salimu Lyimo | intense | | moderate | | moderate | |
| 2.3 | Who are the winners and losers over competition for resources | | bulk water vs agriculture | | agriculture vs energy | | bulk water vs energy | |
| | | Abdulkarim H Seid | winners | private sector | winners | | winners | |
| | | Charles Biney | winners | none | winners | none | winners | none |
| | | | losers | population | losers | population | losers | population |
| | | | | environment | | environment | | environment |
| | | Emily Ojoo-Massawa | winners | state entities | winners | state entities | winners | |
| | | | | | | private sector | | |
| | | | losers | population | losers | population | losers | population |
| | | | | environment | | environment | | environment |
| | | Henri-Claude Enoumba | losers | population | losers | state entities | losers | state entities |
| | | | | environment | | population | | population |
| | | Omari R. Mwinjaka | winners | state entities | winners | state entities | winners | state entities |
| | | | | private sector | | private sector | | private sector |
| | | | | Population | | Population | | Population |
| | | | losers | environment | losers | environment | losers | environment |

| QUESTION | | RESPONDENT | ANSWER | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | Mohamed el Azizi | winners | state entities | winners | | winners | state entities |
| | | | losers | population | losers | | losers | population |
| | | | | environment | | | | environment |
| | | Salimu Lyimo | winners | state entities | winners | state entities | winners | state entities |
| | | | losers | environment | losers | state entities | losers | environment |
| | | | | | | population | | |
| **2.4** | What is constraining resolution of the competition over resources between the water, energy and | | bulk water vs agriculture | | agriculture vs energy | | bulk water vs energy | |
| | | Charles Biney | institutional problems | | | | | |
| | | | limited technical capacity | | | | | |
| | | | Unrealistic costing of activities with no consideration for natural resources and processes | | | | | |
| | | | Reason: Apart from inability to implement or enforce existing regulations on socio-economic development and use/conservation of resources, current costing | | | | | |
| | | Emily Ojoo-Massawa | transboundary disagreements | | | | institutional problems | |
| | | | institutional problems | | | | limited technical capacity | |
| | | | limited technical capacity | | | | costs/benefits sharing difficulties | |
| | | | costs/benefits sharing difficulties | | | | transboundary disagreements | |
| | | | Reason: Conflicts is usually due to no/or limited coordination amongst the insitutions that have lead roles in the management of these sectors. | | | | | |
| | | Henri-Claude Enoumba | transboundary disagreements | | | | transboundary disagreements | |
| | | | unfeasible technically | | | | unfeasible technically | |
| | | | costs/benefits sharing difficulties | | | | institutional problems | |
| | | | institutional problems | | | | costs/benefits sharing difficulties | |
| | | | limited technical capacity | | | | limited technical capacity | |
| | | | Reason: Growing water demand, and uncoordinated sectoral policies and measures, aggravated by the pressures of global change (including climate change), | | | | | |

| QUESTION | | RESPONDENT | ANSWER | | |
|---|---|---|---|---|---|
| | | Omari R. Mwinjaka | institutional problems | institutional problems | institutional problems |
| | | | limited technical capacity | limited technical capacity | limited technical capacity |
| | | | costs/benefits sharing difficulties | costs/benefits sharing difficulties | costs/benefits sharing difficulties |
| | | | unfeasible technically | unfeasible technically | transboundary disagreements |
| | | | transboundary disagreements | transboundary disagreements | unfeasible technically |
| | | | In the Lake Victoria Basin, we did conduct a study on the Water Release and Abstraction Policy for the LVB. The study indicated there are competitions between hydropower generation Vs water for agriculture and water supply for the people. On the other hand transport and fisheries sectors are also affected. There is of course lack of technical capacity and lack of benefit sharing. Each stakeholder is defending its sector in-terms of water use. The downstream countries are also impacted. The Institutions issue is another challenge as different Ministries have different policies on water resources and development. The Political issue is another cross cutting issues that affects the water use. | | |
| | | Mohamed el Azizi | unfeasible technically | | unfeasible technically |
| | | | transboundary disagreements | | limited technical capacity |
| | | | limited technical capacity | | costs/benefits sharing difficulties |
| | | | costs/benefits sharing difficulties | | transboundary disagreements |
| | | | financial constraints | | institutional problems |
| | | | institutional problems | | financial constraints |
| | | | Reasons: unfeasible technically – least relevant: the technical options (the constraint is not the water resource) exist although some R&D may be needed for<br>institutional problems – big constraint: inadequate structures and incentives in the midst of competition for limited financial resources<br>limited technical capacity – limited personnel with broad expertise, compounded by weak collaboration frameworks; could be outsourced, if resources permit<br>cost/benefits sharing difficulties - political priorities vis-à-vis economic constraints; limited stakeholder engagement<br>other: financial constraints – multi-purpose and greener investments usually call for bigger investments and time requirements and this may be constrained by financial resources | | |
| | | Salimu Lyimo | transboundary disagreements | | |
| | | | costs/benefits sharing difficulties | | |
| | | | institutional problems | | |
| | | | unfeasible technically | | |
| | | | limited technical capacity | | |
| | | | Reason: Technical capacity limits tanzania to harvest abundant water is blessed with. There are no infrastructures to store water. Soon after heavy flooding there follows drought. Transboundary disagreement is not an issue in tanzania. Only manifesting transboundary case is over lake victoria basin. Other major water catchments have no or have few cases of transboundary disagreements | | |

| QUESTION | | RESPONDENT | ANSWER | | |
|---|---|---|---|---|---|
| 2.5 | Please describe what - if any - are the opportunities for resolving the competition (yes or no) between the water, energy and agriculture sectors? | | bulk water vs agriculture | agriculture vs energy | bulk water vs energy |
| | | Charles Biney | trade-off | | |
| | | | compromise | | |
| | | | synergy | | |
| | | Emily Ojoo-Massawa | trade-off | trade-off | trade-off |
| | | | compromise | compromise | compromise |
| | | | synergy | synergy | synergy |
| | | Henri-Claude Enoumba | trade-off | trade-off | trade-off |
| | | Mohamed el Azizi | trade-off | | trade-off |
| | | | compromise | | compromise |
| | | | synergy | | synergy |
| | | Omari R. Mwinjaka | Currently this concept is not well understood. It may be implemented in some areas but it is not yet appreciated and known by most water users. | | |
| | | | Although each stakeholder defends his/ her own water use. At the LVBC, there are some compromises among the sectors. e.g the new water release and abstraction policy for the LVB. Countries have agreed to work together taking into considerations various sectors ( fisheries, water supply, agriculture, transport , hydropower, environment and downstream countries). | | |
| | | | Currently within the LVB there are no major abstractions for irrigation as well as bulk water issues. For now the concept of win – win under this theme is not very much visible. | Synergy is very important since there are number of downstream countries depending on the same water resources and hence a lot of awareness is needed. Under this, although there are some synergies on hydropower Vs agriculture it's not well understood by most stakeholders (farmers, electricity companies). Farmers are interested in produce and electricity companies are focusing in making profits. There are some few areas e.g. sugar can factories produce electricity and sell in to the companies. Synergy is very important since there are number of downstream countries depending on the same water resources and hence a lot of awareness is needed. | Under this, there are some synergies but very low. Again, this concept is not well understood by mist stakeholders and a lot of efforts needs to be done to educate various stakeholders on the importance of synergies. This is very important since there are number of downstream countries depending on the same water resources. |
| | | Salimu Lyimo | synergy | | synergy |

| QUESTION | | RESPONDENT | ANSWER | | | | | |
|---|---|---|---|---|---|---|---|---|
| 2.6 | How likely is it that competition between the bulk water, agriculture and energy sectors will emerge in the region for which you have either responsibility or professional | | bulk water vs agriculture | | agriculture vs energy | | bulk water vs energy | |
| | | Abdulkarim H Seid | Likely (mainly between Agriculture and Energy) | | | | | |
| | | | not likely | | very likely | | not likely | |
| | | | | | 5-15 | | | |
| | | Emily Ojoo-Massawa | quite likely | | very likely | | not likely | |
| 2.7 | Please rate the likelihood using: not likely, quite likely or very likely | | May-15 | | <5 | | >15 | |
| | | Henri-Claude Enoumba | quite likely | | quite likely | | quite likely | |
| | | | May-15 | | >15 | | >15 | |
| | | Ibrahim Wilson | quite likely | | not likely | | very likely | |
| | | | <5 | | 5-15 | | 5-15 | |
| | | Jens Vad | Quite likely – export to RSA restricting agricultural | | Not likely – rather opportunities for multi-purpose | | Quite likely – export to RSA might be prioritised | |
| | | | >15 | | | | >15 | |
| | | Mohamed el Azizi | quite likely | | | | not likely | |
| | | Omari R. Mwinjaka | >15 | | >15 | | >15 | |
| | | Salimu Lyimo | very likely | | quite likely | | quite likely | |
| | | | <5 | | <5 | | 5-15 | |
| 2.8 | Who are likely to be the winners and losers over competition for resources out of: | | bulk water vs agriculture | | agriculture vs energy | | bulk water vs energy | |
| | | Abdulkarim H Seid | winners | | winners | state entities | winners | |
| | | | | | | private sector | | |
| | | | | | | (large scale) | | |
| | | | losers | | losers | environment | losers | |
| | | Emily Ojoo-Massawa | winners | state entities | winners | state entities | winners | state entities |
| | | | | private sector | | private sector | | private sector |
| | | | losers | population | losers | population | losers | population |
| | | | | environment | | environment | | environment |

| QUESTION | | RESPONDENT | ANSWER | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | Henri-Claude Enoumba | winners | state entities | winners | state entities | winners | state entities |
| | | | | population | | population | | population |
| | | | | environment | | environment | | environment |
| | | Ibrahim Wilson | winners | population | winners | private sector | winners | population |
| | | | losers | environment | losers | environment | losers | environment |
| | | Jens Vad | winners | RSA due to dominance in the region | winners | | winners | RSA due to dominance in the region |
| | | | losers | population | losers | | losers | state entities |
| | | | | due to reduced possibilities for water use | | | | private sector |
| | | | | | | | | population |
| | | Mohamed el Azizi | winners | private sector | winners | | winners | |
| | | | losers | population | losers | | losers | |
| | | | | environment | | | | |
| | | Omari R. Mwinjaka | winners | state entities | winners | state entities | winners | state entities |
| | | | | private sector | | private sector | | private sector |
| | | | | population | | population | | population |
| | | | losers | environment | losers | environment | losers | environment |
| | | | | state entities (water service delivery) | | state entities (energy service delivery) | | state entities (energy service delivery) |
| | | Salimu Lyimo | winners | population | winners | state entities | winners | state entities |
| | | | losers | environment | losers | population | losers | environment |
| **2.9** | What might constrain resolution of the competition? | | bulk water vs agriculture | | agriculture vs energy | | bulk water vs energy | |
| | | Abdulkarim H Seid | | | unfeasible technically | | | |
| | | | | | limited technical capacity | | | |
| | | | | | costs/benefits sharing difficulties | | | |
| | | | | | institutional problems | | | |
| | | | | | transboundary disagreements | | | |
| | | | Reason: The Nile riparians have to yet ratify their Cooperative Framework Agreement (CFA). That means, there are no agreed upon binding standards (for | | | | | |

| QUESTION | | RESPONDENT | ANSWER | | |
|---|---|---|---|---|---|
| | | Emily Ojoo-Massawa | transboundary disagreements | | |
| | | | institutional problems | | |
| | | | limited technical capacity | | |
| | | | costs/benefits sharing difficulties | | |
| | | Henri-Claude Enoumba | The water risk drivers that affect the water security of the food | | |
| | | Ibrahim Wilson | unfeasible technically | | |
| | | | costs/benefits sharing difficulties | | |
| | | | limited technical capacity | | |
| | | | transboundary disagreements | | |
| | | | institutional problems | | |
| | | | Reason: very big differences in country agreements. Sometimes difficult to harmonize the different country policies into a regional policy | | |
| | | Jens Vad | institutional problems | | institutional problems |
| | | | costs/benefits sharing difficulties | | costs/benefits sharing difficulties |
| | | | transboundary disagreements | | transboundary disagreements |
| | | | Lesotho stands generally weak in negotiations with a more capacitated and powerful RSA. Limited capacity in Lesotho for assessment and planning of water | | |
| | | Mohamed el Azizi | transboundary disagreements | | |
| | | | limited technical capacity | | |
| | | | unfeasible technically | | |
| | | | costs/benefits sharing difficulties | | |
| | | | financial constraints | | |
| | | | institutional problems | | |
| | | | unfeasible technically – competition over limited water resources[2] | | |
| | | | institutional problems – big constraint: inadequate structures and incentives in the midst of competition for limited financial and water resources | | |
| | | | limited technical capacity – limited personnel with broad expertise, compounded by weak collaboration frameworks | | |
| | | | other: financial constraints – multi-purpose and greener investments usually call for bigger investments and time requirements and this may be constrained by | | |

| QUESTION | | RESPONDENT | ANSWER | | |
|---|---|---|---|---|---|
| | | Omari R. Mwinjaka | cost benefits sharing difficulties | | |
| | | | transboundary disagreements | | |
| | | | unfeasible technically | | |
| | | | institutional problems | | |
| | | | limited technical capacity | | |
| | | | Most of the sectors (water supply and sanitation, agriculture, energy etc) lack most of the issues mentioned above (technology, technical capacity, weak institutions etc). Although there are some efforts being made but a lot still needs to be done to address these challenges before it's too late. Competitions among sectors keep on increasing from day to day and this may results into conflict. e.g the Maasai Mara Serengeti, the destruction of the Mau Forest and abstraction on the up-stream sometimes results into very low flows for the Serengeti and hence the wildlife and environment in general becomes very much affected. | | |
| | | Salimu Lyimo | unfeasible technically | | |
| | | | costs/benefits sharing difficulties | | |
| | | | transboundary disagreements | | |
| | | | institutional problems | | |
| | | | limited technical capacity | | |
| | | | Multipurpose infrastructures (synergy) are most viable solution to our water-food-energy problems in tanzania. Technical capacity to take-on these multipurpose infrastructures such as dams is the main blockade. To some extent also, institutional set-up may hinder implementation of such solution if adapted. | | |
| 2.10 | Please describe what - if any - are the likely opportunities for resolving the competition | | bulk water vs agriculture | agriculture vs energy | bulk water vs energy |
| | | Abdulkarim H Seid | | Trade-off is a likely approach for resolving the competition. | |
| | | | | Compromise is a likely approach for resolving the competition. | |
| | | | | Synergy opportunities In the Eastern Nile. For | |
| | | Emily Ojoo-Massawa | trade-off | | |
| | | | synergy | | |
| | | | compromise | | |

| QUESTION | | RESPONDENT | ANSWER | | |
|---|---|---|---|---|---|
| | | Henri-Claude Enoumba | Trade-off: Requirement for rapid increase in water storage capacity, driven by food security risks, combined with future vulnerabilities to climate change and water insecurity<br>Massive water inefficiencies in irrigation; only 10% of irrigation is developed, but most of this is and will be inefficient, especially in dry areas<br>Huge untapped potential in rainfed and recession agriculture<br>Water insecurity for pastoralism<br>Fishing in Inner Niger Delta; dams upstream disrupt the timing of flows, causing reduced fishery | Trade offC: ompetition for water between electricity generation and livestock; because of change in timing of availability of water and flood, eg in the Inner Niger Delta<br>Competition for water between irrigation and hydropower; water storage currently under development will make this worse, because of evaporation losses, + competition for water with ecosystems<br>Example – planned Taoussa Dam in Northern Mali, where the priority is irrigation, but evaporation losses are extreme; therefore irrigation very inefficient, and loss of water projected to cause a net loss of hydropower downstream<br>Example – Kandaji dam, Niger (under construction), where the story is similar, but will be made worse by Taoussa dam | Trade off: Water –Energy :very poorly distributed potential for hydropower, because of inequitable distribution of water, combined with energy demand in dry regions of the basin.<br>Siltation of hydropower dams, reducing viability of hydropower<br>Dams need very large reservoirs because of lack of physical relief – therefore high evaporation loss and low efficiency, with implications for water availability for irrigation |
| | | | Compromise: Crop choices: alternatives to rice; technologies; integrated decision making<br>Devise benefit sharing mechanisms; eg siting irrigation in optimal locations but compensating elsewhere (eg PES for ecosystem management elsewhere)<br>Regional policy harmonisation to overcome contradictions between regional and national levels; eg to facilitate cross-border implementation<br>Apply decision tools for agricultural water management in planning and strategies<br>Re-optimisation and re-operation of dams; incorporating fishing, livestock and recession agriculture into dam operation<br>Introduce environmental flows in the decision making process | Compromise: Decentralised governance of water resources. Manage the Niger basin as 3 sub-basins: Guinea-Mali zone; Mali-Niger zone; Niger-Nigeria.<br>Set up sub-basin agencies, which then work on basin-wide integration through the NBA. Achieve better management at sub-basin level, connected to local realities, but coordinated with whole basin<br>Build institutional platform for cross-sectoral coordination; is this best placed in the RBO or not?<br>Integrated financing across sectors through such an institutional platform<br>Managed aquifer recharge as an alternative to dams | |
| | | | Synergy: Local communities; ie. water users and farmers | Synergy: NBA with partners; eg the Great Rivers Partnership | |

| QUESTION | | RESPONDENT | ANSWER | | |
|---|---|---|---|---|---|
| | | Ibrahim Wilson | trade-off | | |
| | | | compromise | | |
| | | | synergy, but only if the benefits can be clearly demonstrated | | |
| | | Jens Vad | Synergy: Catchment management and utilisation of rainwater will enable Lesotho to benefit from water | Synergy: Possible combined investments in agriculture and hydropower generation | Syngery: The topography of Lesotho provides possibilities for well planned investments in bulk |
| | | Mohamed el Azizi | Trade-offs: The number of people benefitting from the services;<br>The relative contribution of the sector to the economy<br>Governance issues and adherence to laws and declarations (eg the human rights to water and<br>The relative contribution of the sector to the economy<br>Governance issues and adherence to laws and declarations (eg the human rights to water and sanitation)<br>Compromises: water resource management and capacity development to fit quality of water to purpose (e.g., potential reuse of treated domestic wastewater for agricultural purposes)<br>Synergy water pricing and setting adequate tariffs may open opportunities for greater investments in the sectors e.g by the private sector building reservoirs/dams for multi-use | | Trade-offs: The number of people benefitting from the services;<br>The relative contribution of the sector to the economy<br>Governance issues and adherence to laws and declarations (eg the human rights to water and<br>The relative contribution of the sector to the economy<br>Governance issues and adherence to laws and declarations (eg the human rights to water and sanitation)<br>Synergy: same as for bulk water and agriculture, Generated energy can make The treatment and distribution of water more feasible |

| QUESTION | | RESPONDENT | ANSWER | | |
|---|---|---|---|---|---|
| | | Omari R. Mwinjaka | Trade off: This is yes, but it will take many years before communities and various stakeholders understood the concept. For now everyone fights for his/ her sector. A lot of awareness needs to be done. | | |
| | | | Compromise - *ditto* | | |
| | | | This is much more acceptable compared to other two above. If there will be e.g Multi-purpose storage reservoirs where farmers, water utilities and hydropower companies would work together then this may be acceptable. | This is much more acceptable compared to other two above. If there will be e.g Multi-purpose storage reservoirs where farmers, water utilities and hydropower companies would work together then this may be acceptable. e.g the Rusumo Falls constructed and will benefits Tanzania, Rwanda and Burundi. | |
| | | Salimu Lyimo | synergy | synergy | synergy |
| **2.11** | If you answered "not likely" to question 2.6, why do you not expect any competition between the bulk water, agriculture and energy sectors? | Henri-Claude Enoumba | In the Niger River Basin, the question is about the optimal mix of energy and food production (and climate change risk reduction), while ensuring the greatest possible environmental sustainability and reducing transboundary tensions. | | |
| | | Ibrahim Wilson | Because hydro power for example produces the cheapest source of energy for the sub region and governments are very much interested in developing them, there is enough water in the sub region but agriculture is mainly rain fed but it can also be mechanised for better yields by irrigation. Drinking/potable water is a problem in most parts of the region but bigger dams can be developed to alliviate this problem as there is plentiful amount of water in the sub region | | |
| | | Mohamed el Azizi | Although our response was affirmative, it is worth noting that this competition is more likely to happen where institutional structures at both the national and | | |
| **3a.1** | Please indicate the relative importance of the infrastructure in question to each of the stakeholders using high, medium or low, with a brief justifying comment. | Abdulkarim H Seid | state entities | high | |
| | | | the private sector | high | |
| | | | population | high | |
| | | | the environment | high | |
| | | Charles Biney | state entities | high | for energy production, agricultural, industrial and environmental requirements |
| | | | the private sector | high | |
| | | | population | high | |
| | | | the environment | high | |
| | | Emily Ojoo-Massawa | state entities | high | Most of the infrastructure have governments as key players |
| | | | the private sector | high | Most of the infrastructure have governments as key players |
| | | | population | high | All population want access to safe and clean water |
| | | | the environment | high | Protection, management and conservation of water sources |

| QUESTION | | RESPONDENT | ANSWER | | |
|---|---|---|---|---|---|
| | | Henri-Claude Enoumba | state entities | | Current initiatives in the basin that can contribute to improve food security include : the project for the building of the multipurpose dans of Fomi (in guinea) Taoussa (in Mali ) and Kandadji (in Niger) ; other dan projects on the Upper and the Middle Niger ; dans on the downstream part of the basin (Mambila, Zungueru, Katsina Ala, Onitsa, Lokoja and Makurdi dams (all in Nigeria ). Future infrastructures od Rehabilitation Fund for public irrigation schemes in Niger |
| | | | population | | Locally, however, dams historically have had far less to offer. Their physical footprint affects surrounding communities and impacts on land use — for instance, to prevent sedimentation of the reservoir, new limits may be placed on the use of watersheds — and on downstream |
| | | | the environment | | The actions of the Silting Control Programme |
| | | Jens Vad | state entities | high | important for water security for RSA as well as for Lesotho |
| | | | the private sector | presently low | due to low level of utilisation of water resources for agriculture – potentially of high importance for private sector agricultural production |
| | | | population | high | water security and water services problems in the lowlands of Lesotho |
| | | | the environment | high | not the infrastructure as such but investments in catchment management. The catchments in |
| | | Mohamed el Azizi | state entities | high | part of national development plans |
| | | | the private sector | high | for construction and agricultural purposes |
| | | | population | high | water supply, water for agriculture and availability of electricity |
| | | | the environment | medium | ESMP and Resettlement Action Plan in place and if implemented well, impact should be |
| | | Omari R. Mwinjaka | state entities | high | Most of the water utilities companies, hydropower plants are state owned. Most of the |
| | | | the private sector | medium | Most private companies owned big industries such as sugarcane, fishing industries etc. The investment into new technologies on irrigation, and machinery is one of the priorities of most private sectors. Its rated medium as there is no major water use by private sectors |
| | | | population | low | Most of the population in LVB are depends on subsistence agriculture. Therefore the water infrastructure is not an issue. Other services are provided by state entities and private sector. |
| | | | environment | low | The environment conservation does not require infrastructure. Environment and biodiversity conservation will always depend much on other sectors. What's the key here is not infrastructure but Government Policies and laws that will make sure other sectors take into account the environments aspects. e.g the environmental flows for Mara River basin. Where Countries are obliged to maintain the min. Flows for the river to cater for the environment. |
| | | | the private sector | | Large dams can themselves be highly profitable, enticing private developers with returns on capital of 15–20 per cent. |

| QUESTION | | RESPONDENT | ANSWER | | | | |
|---|---|---|---|---|---|---|---|
| | | Salimu Lyimo | state entities | high | source of revenue for government and domestic water supply source | | |
| | | | the private sector | high | the dam is used to supply water for mining activities and domestic use | | |
| | | | population | high | supply irrigation demand and domestic supply | | |
| | | | the environment | low | the dam changed ecosystem of the area. a river would be enough for the environment | | |
| **3a.2** | For the infrastructure in question, which - if any - of the impact types apply to the stakeholder? | Abdulkarim H Seid | state entities | | population | | |
| | | | economic growth and/or soc.econ trans | positive | family and lifestyle | positive | |
| | | | peace and stability | positive | income | | |
| | | | private sector | | environment | | |
| | | | secure factors of production | positive | landscape productivity | neither | |
| | | | new markets | positive | biodiversity | neither | |
| | | Charles Biney | state entities | | population | | |
| | | | economic growth and/or soc.econ trans | | family and lifestyle | | |
| | | | peace and stability | | income | | |
| | | | private sector | | environment | | |
| | | | secure factors of production | | landscape productivity | | |
| | | | new markets | | biodiversity | | |
| | | Emily Ojoo-Massawa | state entities | | population | | |
| | | | economic growth and/or soc.econ trans | positive | family and lifestyle | positive | |
| | | | peace and stability | positive | income | positive | |
| | | | private sector | | environment | | |
| | | | secure factors of production | positive | landscape productivity | negative | |
| | | | new markets | positive | biodiversity | negative | |

| QUESTION | | RESPONDENT | ANSWER | | | | |
|---|---|---|---|---|---|---|---|
| | | Henri-Claude Enoumba | state entities | | population | | |
| | | | economic growth and/or soc.econ trans | positive | family and lifestyle | positive | |
| | | | peace and stability | positive | income | positive | |
| | | | private sector | | environment | | |
| | | | secure factors of production | positive | landscape productivity | positive | |
| | | | new markets | positive | biodiversity | neither | |
| | | | In Mali, the 1981 Sélingué dam relocated over 12,000 people and affected roughly 30 villages. Since 1996, decentralisation policies have transferred 80 per cent of the dam's infrastructure taxes to three municipal, county and regional authorities in Baya, Yanfolila and Sikasso. The largest share, US$170,000 per year, accrues to the Baya municipality. Such indirect and incomplete schemes leave inequities unresolved. Dams and their impacts will become more acceptable where there is a direct link between affected people and the investment of hydropower benefits in their communities . | | | | |
| | | Ibrahim Wilson | state entities | | population | | |
| | | | economic growth and/or soc.econ trans | positive | family and lifestyle | negative | |
| | | | peace and stability | negative | income | positive | |
| | | | private sector | | environment | | |
| | | | secure factors of production | positive | landscape productivity | negative | |
| | | | new markets | positive | biodiversity | negative | |
| | | Jens Vad | state entities | | population | | Lesotho is blessed with relatively good water resources but apart from investment in major infrastructure for export of bulk water to RSA, the water resources are underutilised. There is a high potential for natural resources based economic development in the country provided a good policy, strategy and legal framework for improved catchment management is implemented that provides the incentives for private investments in small/ medium scale agriculture |
| | | | economic growth and/or soc.econ trans | positive | family and lifestyle | positive | |
| | | | peace and stability | positive | income | positive | |
| | | | private sector | | environment | | |
| | | | secure factors of production | positive | landscape productivity | positive | |
| | | | new markets | positive | biodiversity | positive | |

| QUESTION | | RESPONDENT | ANSWER | | | | |
|---|---|---|---|---|---|---|---|
| | | Mohamed el Azizi | state entities | | population | | |
| | | | economic growth and/or soc.econ trans | positive | family and lifestyle | positive | There are needs to implement the ESMP and the Resettlement Action Plan; and to continuously monitor the progress of the project and ensure stakeholder participation in the process |
| | | | peace and stability | | income | positive | |
| | | | private sector | | environment | | |
| | | | secure factors of production | positive | landscape productivity | positive | |
| | | | new markets | positive | biodiversity | negative | |
| | | Omari R. Mwinjaka | state entities | | population | | |
| | | | economic growth and/or soc.econ trans | positive | family and lifestyle | positive | |
| | | | peace and stability | positive | income | positive | |
| | | | private sector | | environment | | |
| | | | secure factors of production | positive | landscape productivity | neutral | |
| | | | new markets | positive | biodiversity | negative | |
| | | Salimu Lyimo | state entities | | population | | |
| | | | economic growth and/or soc.econ trans | positive | family and lifestyle | positive | |
| | | | peace and stability | positive | income | positive | |
| | | | private sector | | environment | | |
| | | | secure factors of production | positive | landscape productivity | positive | |
| | | | new markets | neither | biodiversity | negative | |

| | | | | | |
|---|---|---|---|---|---|
| **3b.1** | Please indicate the relative importance of the infrastructure in question to each of the three nexus sectors; ie most important, | | water | agricuture | energy |
| | | Abdulkarim H Seid | most important | most important | most important |
| | | Charles Biney | most important | partially important | most important |
| | | Emily Ojoo-Massawa | Very Important but inadequate | Very important but is still in the nascent stages | Very important but most of the communities still do |
| | | Henri-Claude Enoumba | most important | partially important | partially important |
| | | Mohamed el Azizi | important | most important | important |
| | | Omari R. Mwinjaka | most important | most important | partially important |
| | | Salimu Lyimo | most important | partially important | not important |

| QUESTION | | RESPONDENT | ANSWER | | |
|---|---|---|---|---|---|
| **3b.2** | please provide a brief description of the infrastructure in question using these themes | Abdulkarim H Seid | type | A large water storage dam together with a hydropower plant | |
| | | | capacity and size | Dam storage capacity: 74 BCM; 6000 MW | |
| | | | type and number of beneficiaries | private sector (industries) | |
| | | | | state power utilities | |
| | | | | fishing communities | |
| | | | | farmers (increased dry weather flow) | |
| | | | | communities in the floodplain (reduced flood risk) | |
| | | | any transboundary characteristics | The infrastructure is being built on a transboundary river; it will have considerable flow regulation effect | |
| | | | other relevant information | | |
| **3b.3** | Is the infrastructure a response to need or opportunity? | | yes, it is a response for meeting growing energy demand | | |
| **3b.2** | please provide a brief description of the infrastructure in question using these themes | Charles Biney | type | hydropower dam | |
| | | | capacity and size | 1,020 MW: Surface area of lake - 8,500 sq. km | |
| | | | type of beneficiaries | people within and outside the basin | 30 million |
| | | | any transboundary characteristics | The most downstream major infrastructure, which relies on water inflows (about 40% ) from upstream countries | |
| | | | other relevant information | At the time of construction of the Akosombo Dam in the early 1960s, economic considerations were the | |
| **3b.3** | Is the infrastructure a response to need or opportunity? | | both | | |
| **3b.4** | what alternatives were considered? | | geographic and economic | | |
| **3b.6** | what stakeholders were involved? | | Economic and political stakeholders, mainly | | |
| **3b.2** | please provide a brief description of the infrastructure in question using these themes | Emily Ojoo-Massawa | type | Water treatment and distribution in municipalities in the Lake Victoria Basin | |
| | | | type of beneficiaries | households | |
| | | | | industries | |
| | | | | commercial buildings | |
| | | | | gardens | |
| | | | any transboundary characteristics | Lake Vic is a transboundary water body | |
| | | | other relevant information | We are carrying out a basin wide vulnerability and impacts assessment and are looking at the | |

| QUESTION | | RESPONDENT | ANSWER | | |
|---|---|---|---|---|---|
| **3b.3** | Is the infrastructure a response to need or opportunity? | | both | | |
| **3b.4** | what alternatives were | | Use of traditional systems including pans. | | |
| **3b.2** | please provide a brief description of the infrastructure in question using these themes | Mohamed el Azizi | type | concrete faced rock fill dam for multi-purpose water use. | |
| | | | capacity and size | 77m high Storage capacity of the Dam is 681 million cubic meters (MCM). | |
| | | | type of beneficiaries | water supply Communities in semi-arid counties of Makueni and Kitui | 1.3 million people 500,000 people for domestic water in rural areas and another estimated 800,000 in the |
| | | | | Irrigation water for smallholder farmers | 40,000 Ha (phase 1 – 3,000 Ha and Phase II – 37,000 Ha) |
| | | | | Power supply for Konza City | 20MW of which 14MW will feed to the national grid |
| | | | any transboundary characteristics | none | |
| | | | other relevant information | The MPI is located in a semi-arid area with perennial food shortages. Inhabitants depend on food handouts. | |
| **3b.3** | Is the infrastructure a response to need or opportunity? | | The Athi River basin where the program is located has the lowest per capita water storage in Kenya, with the semi-arid counties of Kitui and Makueni being classified as food deficit and having poverty rates of 62.5% and 63.8% , respectively. Agriculture is mostly rain fed and there is no existing hydropower | | |
| **3b.4** | what alternatives were considered? | | A number of Dam sites along the Athi River Basin were reappraised and prioritised for implementation. Thwake multi-purpose water development project was ranked highest. | | |
| **3b.5** | what was the selection process? | | Several criteria were used in the process of ranking the dams. This included (i) the use of the dam, (ii) stage of development/study of the dam site, (iii) socio-economic status of the area to benefit from the construction of the dam and (iv) the possibility of the dam being in an area with water deficit. Dams with potential | | |
| **3b.6** | what stakeholders were involved? | | Government officials, Communities and their local representatives, civil society and consultant. Local NGO's involved in catchment management in the areas | | |
| **3b.2** | please provide a brief description of the infrastructure in question using these themes | Omari R. Mwinjaka | type | Water Supply and Sanitation under the Lake Victoria Water and Sanitation Project ( LVWATSAN II) and waste water facilities under the Lake Victoria Environmental Management Project (LVEMP II) | |
| | | | capacity and size | Medium for small towns (LVWATSAN II) | |
| | | | | Medium size (LVEMP II) | |
| | | | type of beneficiaries | Water utilities, Population/ water use for domestic | 10,000 – 20,000 for each of the 15 towns |
| | | | | Populations and water utilities companies | Bukoba, Mwanza, Kampala, Homabay, Bomet and |
| | | | any transboundary characteristics | There are some infrastructures that are focusing on rehabilitation and construction of waste water facilities under LVEMP II. These aimed at reducing pollution of the Lake and hence a Transboundary. The interventions for water supply and sanitation are not Transboundary. | |
| | | | other relevant information | | |

| QUESTION | | RESPONDENT | ANSWER | | |
|---|---|---|---|---|---|
| **3b.3** | Is the infrastructure a response to need or opportunity? | | These infrastructures are responses to the need. This was after intensive consultation with various stakeholders. | | |
| **3b.4** | what alternatives were considered? | | There were no alternatives as the focus was on the provisional of water supply and addressing pollution issues for the Lake Victoria Basin. But of course there are other components within the projects such as improving livelihood for the communities by providing and alternatives of their current activities in order to address environmental challenges. | | |
| **3b.5** | what was the selection process? | | 1. The LVBC prepared a concept note that was shared with the Partner States and presented to the Lake Victoria Basin Sectoral Council of Ministers who approved the concept;<br>2. The concepts were shared with the development Partners and approved;<br>3. A Consultant was selected and prepared a project document which was deliberated at different states; and later appraised by the Development Partners;<br>4. The Consultant prepared a long list of projects and interventions areas and selection criteria and was subjected to discussion with the Development Partners and Partner States;<br>5. Partner States selected the final interventions areas and activities that were approved by the Sectoral Council of Ministers for the LVB; | | |
| **3b.6** | what stakeholders were involved? | | A broader range of stakeholders were engaged in project activities (non governmental organisation, public benefit organisation, civil society, research institutions etc) as appropriate and in accordance with an agreed Stakeholder Consultation and Communication plan drawn from the EAC/ LVBC public consultation framework. The plan followed a stakeholder analysis which has been done by the Commission. Stakeholders such as EAC Secretariat, lake Victoria Fisheries Organisation, Lake Victoria Regional Local Authority Cooperation, Ministries responsible for Water and Natural resources in the Partner States, women etc were involved in the formulation of the programme. | | |
| **3b.2** | please provide a brief description of the infrastructure in question using these themes | Salimu Lyimo | type | Dam storage capacity: 74 BCM; 6000 MW | |
| | | | capacity and size | not known | |
| | | | type of beneficiaries | industry | one diamond mine |
| | | | | government | |
| | | | | population | |
| | | | any transboundary characteristics | no | |
| | | | other relevant information | The dam was built back in early 1950's to supply water to a mine after discovery of diamonds in | |
| **3b.3** | Is the infrastructure a response to need or opportunity? | | Was response to need (industrial need after discovery of huge deposit of diamonds) | | |

| QUESTION | | RESPONDENT | ANSWER | | | |
|---|---|---|---|---|---|---|
| 3b.7 | If the infrastructure is single purpose, were lost multi-purpose | Abdulkarim H Seid | yes/no | yes but no details | If no, what was the rationale | The infrastructure is being built by an upstream |
| | | Charles Biney | yes/no | it is multi-purpose | If no, what was the rationale | |
| 3b.8 | Was the final selection based on any of these issues? | Abdulkarim H Seid | Economics, if so | | | |
| | | | whose criteria were used? | | | |
| | | | What criteria were used? | | | |
| | | | What was the target value | | | |
| | | | what was the estimated value | | | |
| | | | what has been the actual value | | | |
| | | | Policy, if so | | | |
| | | | what policy | | date | |
| | | | Limited political capital or other political considerations, if so what? | | | |
| | | | | | | |
| | | | Other? If so what? | | | |
| | | Mohamed el Azizi | Economics, if so | | | |
| | | | whose criteria were used? | Agreed on between Government and consultant | | |
| | | | What criteria were used? | Net Present Value (NPV), Internal rate of return (IRR) and benefit Cost Ratio (B/C) | | |
| | | | What was the target value | NPV should be positive and IRR greater than the estimated cost of capital | | |
| | | | what was the estimated value | NPV = Kes 24.2billion, IRR = 18% and BC = 1.46 | | |
| | | | what has been the actual value | still under construction | | |
| | | | Policy, if so | | | |
| | | | what policy | | date | |
| | | | Limited political capital or other political considerations, if so what? | | | |
| | | | | | | |
| | | | Other? If so what? | | | |

| QUESTION | | RESPONDENT | ANSWER | | | |
|---|---|---|---|---|---|---|
| | | Omari R. Mwinjaka | Economics, if so | | | |
| | | | whose criteria were used? | Developed criteria developed by the Consultant but finally agreed by all the Partner States (Burundi, Kenya, Tanzania, Uganda and Rwanda) stakeholders during a Regional workshop. | | |
| | | | What criteria were used? | | | |
| | | | What was the target value | | | |
| | | | what was the estimated value | | | |
| | | | what has been the actual value | | | |
| | | | Policy, if so | | | |
| | | | what policy | | date | |
| | | | Limited political capital or other political considerations, if so what? | | | |
| | | | There have been no political considerations. But to buy in support for the project equal number of towns were selected. | | | |
| | | | Other? If so what? | | | |
| 3b.9 | Please provide your best estimate with respect to the costs, sources of finance, and their percentage contributions as appropriate | Abdulkarim H Seid | Total 4.8 billion | | | |
| | | | Breakdown | | | |
| | | | % covered by donor grant | | which donor? | |
| | | | % covered by development bank | | Which development ban? | |
| | | | % covered by regional body | 100 | which regional body? | |
| | | Mohamed el Azizi | Total 268.935 million | | | |
| | | | Breakdown | | | |
| | | | % covered by donor grant | 0.07 | which donor? | AfDB |
| | | | % covered by development bank | 34.4 | Which development ban? | AfDB |
| | | | % covered by regional body | | which regional body? | |
| | | | % covered by national government | 64.9 | | |
| | | | % covered by local government | | | |
| | | | % covered by private sector | | | |
| | | | % covered by beneficiaries | | | |
| | | | % covered by utility 1 | | | |
| | | | % covered by utility 2 | | | |
| | | | % covered by utility 3 | | | |
| | | | % covered by utility 4 | | | |

| QUESTION | | RESPONDENT | ANSWER | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | Omari R. Mwinjaka | Total | 120,000,000 LVWATSAN-AfDB)<br>40,000,000 ( LVEMP II- WB) | | | | |
| | | | Breakdown | | | | | |
| | | | % covered by donor grant | | 100 | which donor? | | |
| | | | % covered by development bank | | 100 | Which development ban? | World Bank and the AfDB | |
| | | | % covered by regional body | | | which regional body? | | |
| 3b.13 | Operation and maintenance | Charles Biney | how old is it? | | 50 | year, and what condition is it in? | | |
| | | | who is responsible for O&M? | | VBA | | | |
| | | | is it functioning as planned? | | | If nto why not? | | |
| | | Omari R. Mwinjaka | how old is it? | | 6 | year, and what condition is it in? | mostly sound | |
| | | | who is responsible for O&M? | | Water Utilities for the towns | | | |
| | | | is it functioning as planned? | | | yes | | |
| | Overall if there is demand for a multi-purpose solution, but the infrastructure is nonetheless single purpose what is the reason? | | limited capacity? | | yes | if yes, why? | Due to the lack of funds the interventions could not cover all the required interventions. | |
| | | Salimu Lyimo | technically non-feasible? | | | if yes, why? | | |
| | | | unsuitable institutional arrangements? | | | if yes, why? | | |
| | | | limited capacity? | | | if yes, why? | | |
| | | | cost/benefit sharing difficulties? | | yes | if yes, why? | de of ownership of the dam so have a thinking that all | |
| | | | others? | | | if yes, what? | | |
| 3c.1 | Please indicate the relative importance of the infrastructure in question to each of the three nexus sectors; ie most important, partially important or not important | Omari R. Mwinjaka | water | | agricuture | | energy | |
| | | | most important | | most important | | partially important | |

| QUESTION | | RESPONDENT | ANSWER | | | | | |
|---|---|---|---|---|---|---|---|---|
| 3c.2 | please provide a brief description of the infrastructure in question using these themes | Jens Vad | type | Investments in catchment management | | | | |
| | | | capacity and size | Nationwide programme to improve utilisation of water and natural resources | | | | |
| | | | type and number of beneficiaries | households and farmers in rural areas | potentially the entire country | | | |
| | | | | associated processing industries in urban areas | potentially the entire country | | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | any transboundary characteristics | Improved catchment management will have positive water quality impacts on the whole Orange Senqu | | | | |
| | | | other relevant information | | | | | |
| 3c.3 | Is the infrastructure a response to need or opportunity? | | The need for catchment management is a key focus area in the Government's long term strategy for the water sector | | | | | |
| 3c.4 | what alternatives were considered? | | There is no alternative if Lesotho is to survive and be economical viable | | | | | |
| 3c.5 | what was the selection process? | | | | | | | |
| 3c.6 | what stakeholders were involved? | | Stakeholders at all levels were involved in the formulation of the strategy | | | | | |
| 3c.2 | please provide a brief description of the infrastructure in question using these themes | Omari R. Mwinjaka | type | Waste water facilities | | | | |
| | | | capacity and size | | | | | |
| | | | type and number of beneficiaries | Populations, water utilities, farmers | | | | |
| | | | any transboundary characteristics | Yes, the project aimed at addressing pollution in the Lake Victoria. | | | | |
| 3c.3 | Is the infrastructure a response to need or opportunity? | | Yes | | | | | |
| 3c.4 | what alternatives were considered? | | | | | | | |
| 3c.5 | what was the selection process? | | | | | | | |
| 3c.6 | what stakeholders were involved? | | | | | | | |
| 3c.7 | If the infrastructure is single purpose, will any lost multi-purpose benefits acknowledged in any economic analysis? | Omari R. Mwinjaka | yes | | | | | |

| QUESTION | | RESPONDENT | ANSWER | | | |
|---|---|---|---|---|---|---|
| 3c.8 | Has the infrastructure already reached the appraisal stage and failed? If no, please proceed to question 3c.9. If yes, please complete the questionnaire by providing an explanation here | Abdulkarim H Seid | | | | |
| | | Charles Biney | | | | |
| | | Emily Ojoo-Massawa | | | | |
| | | Henri-Claude Enoumba | | | | |
| | | Ibrahim Wilson | | | | |
| | | Jens Vad | A substantial support programme from the EU is expected to focus on catchment management investments over the next 5 years – scoping study completed | | | |
| | | Mohamed el Azizi | | | | |
| | | Salimu Lyimo | | | | |
| 3c.10 | Please provide your best estimate with respect to theexpected costs, sources of finance, and their percentage contributions as appropriate | Omari R. Mwinjaka | Total | 30,000,000, | | |
| | | | Breakdown | | | |
| | | | % covered by donor grant | 66 | which donor? | KfW |
| | | | % covered by development bank | | Which development bank? | World Bank and the AfDB |
| | | | % covered by regional body | 34 | which regional body? | |
| 3c.14 | Functionality | Omari R. Mwinjaka | how old is it? | | year, and what condition is it in? | |
| | | | who is responsible for O&M? | Water Utilities for the towns | | |
| 3d.1 | Please indicate the relative importance of the infrastructure in question to each of the three nexus sectors; ie most important, partially important or not important | | water | agricuture | energy | |
| | | Abdulkarim H Seid | | | | |
| | | Charles Biney | | | | |
| | | Emily Ojoo-Massawa | most important | most important | most important | |
| | | Henri-Claude Enoumba | | | | |
| | | Ibrahim Wilson | partially important | partially important | partially important | |
| | | Jens Vad | | | | |
| | | Mohamed el Azizi | | | | |
| | | Omari R. Mwinjaka | most important | most important | partially important | |
| | | Salimu Lyimo | | | | |

| QUESTION | | RESPONDENT | ANSWER |
|---|---|---|---|
| **3d.2** | please provide a brief description of why the infrastructure is needed | Emily Ojoo-Massawa | The large population of the LVB (80% ), is engaged in agricultural production, mostly as small-scale farmers, for crops such as sugar, tea, coffee, maize, cotton, |
| | | Henri-Claude Enoumba | |
| | | Ibrahim Wilson | based on programs and projects funded by funding agencies like world bank, african development bank etc etc |
| | | Omari R. Mwinjaka | Transboundary waters link populations of different countries and support the livelihoods of a significant part of their populations. Wetlands, such as lakes and floodplains, are often shared between countries and provide invaluable ecosystem services to humans, such as food provision and reduction of flood impacts and pollution. Aquifers contain quality water, represent a substantial hidden global capital and support land and water ecosystems.<br>However, depleted and degraded freshwater supplies, caused by population growth, poorly managed development and weak governance, hamper sustainable development and underscore the need for cooperation between major water-use sectors – agriculture, fisheries, aquaculture, industry, energy, navigation and water supply and sanitation. Individual countries implement integrated water resources management to protect water and related ecosystems and to use them sustainably, and to reconcile the demands of different sectors for socio-economic development. The urgency to facilitate cooperation around shared waters increases as competition for the resource grows and climate change seems to increase hydrological variability and unpredictability.<br>Differences between riparian countries – in terms of socio-economic development, water resources management capacity, infrastructure, political orientation and institutional as well as legal contexts – represent challenges to the joint management and protection of transboundary waters and to effective and coordinated development. At the same time, such differences present opportunities for capacity development and cooperation. Effective transboundary water management starts at the national level, where coordination and cooperation between different ministries and institutions is needed, as are sufficient financing and political commitment. Some common obstacles are conflicting mandates, fragmented authority and limited capacity of national institutions.<br>These challenges calls for :-<br>i) Capacity building support to the Lake Victoria Basin Commission to formulate and implement regional policies on water supply, sanitation and environmental management; and<br>ii) Support the implementation of multi-purpose storage facilities, water supply and sanitation infrastructures with particular emphasis on conservation agriculture, integrated water resources management, agro forestry and mixed farming systems |
| **3d.3** | what alternatives are being considered if any? | Emily Ojoo-Massawa | The area needs development so what is being done is as per the local and regional development plans. Plans spanning a long period have not been implemented due to scarcity of resources |
| **3d.5** | What stakeholders are involved? | Emily Ojoo-Massawa | Most of these plans were developed at a time where local stakeholder views were never sought. Now they can use the Environment Act to force a hearing and incorporation of their views. |

# A3 PUBLIC PRIVATE PARTNERSHIPS IN IRRIGATION[55]

Increasing success in various countries56 with PPPs in water supply and sanitation has generated widespread discussion with respect to the possibilities of establishing PPPs for irrigation. Across the developing world, the private sector has been active in investing and managing on-farm agriculture and water management through large scale commercial enterprises, traditional small-scale irrigation systems and the rapid expansion of privately owned and operated boreholes. However, the mix of public and private investment in irrigation and drainage is less clear: most of the public private partnership experience in water service provision has been focused on the water supply and sanitation sector. And even though experience in WS&S has been mixed, there is a temptation to assume that such success as might be achieved in WS&S suggests that similar successes might be achieved in irrigation and drainage – especially by cash strapped governments looking to expand equipped areas or to reduce recurring costs. However, it should be firmly noted that successes in water supply and sanitation are not necessarily replicable in irrigation and drainage, because in addition to a revenue risk, investors in agricultural production and service delivery also face production risks (climate, pests and diseases) and market shock. In other words, even if users of irrigation services are eager to pay their service charges, they may not actually be able to do so.

There is quite a range of possible financial or transaction models for financing PPPs in irrigation and or energy provision, they fall into three broad categories: Public Contracts, Public Service Delegation and Co-Investment in Production.

Public contracts comprise:

- Service Contracts: which are usually short term arrangements under which the public sector engages the services of a private entity to undertake tasks such as system maintenance, fee collecting etc., that are difficult to undertake with the administrative means available to the relevant public sector institutions.
- Management Contracts: are similar to service contracts but transfer responsibility to the service provider for a fixed term. Such arrangements vary in complexity and sometimes involve the secondment to, or management by, the private entity of public employees.

Public Service Delegation (PSD) comprises:

- Leasing*:* which is an arrangement whereby the service provider is responsible for operating and maintaining a scheme, but is not responsible for its capital financing (although this is a somewhat blurred distinction in the case of rehabilitation and upgrading). Under lease arrangements, the contracting authority is paid a fixed rent by the service provider meaning that the service provider therefore carries all the commercial risk.
- Affermage*:* which is an arrangement similar to a lease, but the rent payable depends on the revenues collected by the service provider, meaning that the commercial risk is shared in some way between the service provider and contracting authority.
- Concession*:* which gives the service provider full responsibility not only for O&M of the scheme, but also its financing. Under a concession, ultimate ownership of the assets is vested in the Government and full use of the assets reverts to Government when the contract ends. As such concession arrangements represent considerable risk to the private interest.

55 Material in this annex has been adapted from a more detailed annex dealing with the same issues in Riddell et-al "An Irrigation Policy and Strategy for Belize", FAO December 2011.

56 Both developed and emerging.

- BOT*:* although apparently similar to concession, is actually quite different because the service provider receives a fixed amount from the contracting authority regardless of what actually happens in terms of water availability and use. In this respect a BOT is similar to a service contract than a PSD: but there are several variations on the BOT theme:
  - BOO (Build-Operate-Own), under which the assets remain indefinitely with the private interest
  - DBO (Design-Build-Operate), under which public and private sectors share responsibility for capital investments
  - ROT (Rehabilitate-Operate-Transfer), which is sometimes favoured where infrastructure needs major work.
  - Divestiture*:* is basically the sale of a public asset to a private entity and can hence be thought of as privatisation.

Co-Investment in Agricultural Production:

which - although in some ways can be thought of as a subset of DBO whereby the public and private sectors co-invest not only in infrastructure and service delivery, but also production - is listed separately here however, because the revenue risks are shared between the two players according to equity, rather than the terms of a service contract.

With specific reference to irrigation, it is also necessary to understand that a typical scheme has three components:

- Water Management: which concerns the interception and management/timely release of the water in a regulated fashion. Sometimes this component involves storage.
- Water Conveyance: which concerns the movement of water from its source to the border of the scheme along with the infrastructure and applicable operating rules. Sometimes this will involve a main/feeder canal or pipeline, other times it may involve the natural river itself if a dam is involved and dam releases are conveyed by means of the river.
- Water Distribution: which concerns the delivery of water to the fields and includes the secondary, tertiary and sub-tertiary systems. This may involve rotating the supplies and should be carried out in accordance with any rights system that may apply.

Similarly, it is possible to identify four categories of function that engage stakeholders:

- Investment*:* included within this category are scheme identification, planning, appraisal, financing, design and implementation.
- Regulation and Control*:* water allocation, bailiff functions, maintenance audit and price setting/regulation.
- Operation, Management and Maintenance (OMM): water allocations, water delivery (system operation) and system management (accounts, customer liaison etc.) and system maintenance.
- Agricultural Production, which is self-explanatory.

It is also crucial to note that:

- the potential private investor is not looking for the same benefit as the public sector. The latter is usually looking for some sort of socio-economic transformation[57] and cost reduction in service delivery (both capex and recurring) ***whereas the private investor will be looking primarily to maximise revenue or production based profits while minimising risks.***
- Despite the grand declarations from the Development Banks that the private sector is queuing up to help, it is not. While there is very significant interest in both the agriculture and energy sector, there is simply not enough cash to go round.

57 In that "beneficiaries" become "clients".

- Accordingly, it will be invested in schemes that optimize the risk/profit calculus according to whatever criteria investors use (some will accept high risk for high profits for instance). But this does not just require good schemes, it also requires enabling environments. IN other words, PPPs in irrigated agriculture and energy are not silver bullets and are so far very much unproven.
- Finally, and most important to remember, is that regardless of how enthusiastically government might embrace the concept, the decision to invest will be entirely that of the private player – hence even the best legal and policy framework may not result in any PPPs if the private sector is not convinced as to profitability and risk, and it would be naive to think otherwise.

# A4 THE STATUS OF IRRIGATION AND ENERGY SUPPLY IN THE VOLTA RIVER AND LAKE VICTORIA BASINS

## A4.1 Irrigation

**Irrigation potential, development and utilisation in the Volta River and Lake Victoria Basin**

| | Irrigation potential (ha) | Area equipped as % of potential | Area actually used as a % of potential | Area actually used as a % of equipped | Use of wastewater |
|---|---|---|---|---|---|
| | | | | | |
| Benin | 322,000 | 7.16% | 5.34% | 74.66% | |
| Burkina Faso | 165,000 | 32.89% | 27.96% | 85.00% | |
| Côte d'Ivoire | 475,000 | 15.32% | 14.09% | 91.97% | |
| Ghana | 1,900,000 | 1.63% | 1.59% | 97.98% | |
| Mali | 566,000 | 65.57% | 31.06% | 47.37% | |
| Togo | 180,000 | 4.06% | 3.47% | 85.57% | |
| **weighted means** | | **15.50%** | **9.49%** | **61.24%** | |
| Burundi | 215,000 | 9.97% | 0.00% | 0.00% | |
| Kenya | 353,000 | 42.66% | 27.54% | 64.55% | 0.00% |
| Rwanda | 165,000 | 5.83% | 4.81% | 82.50% | |
| Uganda | 90,000 | 12.38% | 11.76% | 94.96% | 0.00% |
| United Republic of Tanzania | 2,132,000 | 8.64% | 7.74% | 89.53% | 0.00% |
| **weighted means** | | **12.76%** | **9.50%** | **74.45%** | **0.00%** |
| *Sources* | *http://www.fao.org/nr/water/aquastat/data/query/index.html?lang=en* | | | | |
| | *first-hand knowledge on the part of the consultant* | | | | |

## A4.2 Energy

| Access To Energy And Hydropower Potential In The Volta River Basin | | | | | | |
|---|---|---|---|---|---|---|
| **Issue** | **Benin** | **Burkina Faso** | **Côte d'Ivoire** | **Ghana** | **Mali** | **Togo** |
| **principle source of energy** | biomass | 80% of supply derives from biomass | no information available | electricity is "...key determinant of the country's continued economic growth..." | biomass | no information available |
| **access to electricity** | energy consumption per capita is around 50% of the average for Sub-Saharan Africa, and 25% of the global average | some 20% of urban population and effectively 0% rural population | no information available | demand is fast outstripping supply | some 59% of urban population and effectively 14% rural population | no information available |
| **undeveloped hydropower potential** | "large" | no information available | no information available | no information available | approximately 22%, but most of this potential lies in the Niger and Senegal Rivers | no information available |
| **small scale possibilities** | 80 potential sites already identified | no information available | no information available | no information available | biogas and local grids have been identified as a significant possibility for the rural areas | no information available |

| Access to energy and hydropower potential in the Lake Victoria Basin | | | | | |
|---|---|---|---|---|---|
| **Issue** | **Burundi** | **Kenya** | **Rwanda** | **Tanzania** | **Uganda** |
| **principle source of energy** | biomass | petro-chemicals and (especially in the rural areas) biomass | biomass provides 85% of the country's energy overall and 99% in the rural areas | Biomass (electricity represents only 0.6% of total energy consumption in the country) | 90% from biomass |
| **access to electricity** | 5% of the population have access to the grid | 15% of the population | 14% of the population | some 12% of urban population and effectively 2% rural population | 15% overall, and 7% in the rural areas. But so far users with access to the grid enjoy a level of reliability which is compromised only by "…occasional load shedding" |
| **undeveloped hydropower potential** | not known, but the country remains a net importer of energy | approximately 55% of potential (1500 MW) of which 434 MW lies within the Lake Victoria Basin | Currently installed capacity is around 57 MW out of a currently identified potential of 232 MW | not known, but at the national level there is intense competition between agriculture and hydropower because most of the installed generating capacity is downstream of the irrigation (both actual and potential) | Around 60% of a total potential of some 2000 MW |
| **small scale possibilities** | there are some 8 examples of mini-hydro schemes in the country but half of them are reportedly out of service | considerable | at the time of writing, 23 state sponsored schemes supply some 14.13 MW between them - overall potential is nonetheless not known | many and diverse and not limited to mini-hydro | many and diverse and not limited to mini-hydro |
| *Source* | *https://energypedia.info/wiki/Portal:Hydro* | | | | |