ID Water Scarcity Synthesis Report

Participatory workshop for the interdisciplinary research on water scarcity and climate change in the Ewaso Ng'iro North River Basin

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Semi-circular bunds in Naibunga, Kenya. Photo by Peter Messerli, 2023

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Introduction

The workshop, held at the Kisimani Eco Resort, Isiolo, Kenya, was organised by the Wyss Academy for Nature at the University of Bern (WA). It was attended by 52 participants with diverse backgrounds (Fig. 1), including eight members from the WA headquarters in Bern and four members of the WA East African Hub. The Centre for Training and Integrated Research in ASAL Development (CETRAD) co-organized the workshop, with four key staff members attending, including Dr Boniface Kiteme, the Director of CETRAD.

Among the local stakeholders, seven Community Conservancy Managers were in attendance, alongside fellow Conservancies and the Northern Rangelands Trust representatives. Mr Ali Sarite, Isiolo County Executive Committee (CEC) Environment, opened proceedings. Mr. Jackson Muturo, Laikipia County Director of the National Environment Management Authority also attended the event. Seven representatives of the Financing Locally-Led Climate Action (FLLoCA) from the surrounding counties (Baringo, Isiolo, Laikipia, Marsabit, Samburu) attended, and four gave presentations on their work. Various researchers from Kenyan universities presented their work, as did representatives of various conservation NGOs.

Figure 1: Expertise of the participants in the Water Scarcity Workshop, Isiolo, June 2023.

Objectives of the Workshop

The objectives of the workshop were introduced by **Dr Benson Okita** (Director of the Wyss Academy East Africa Hub) in his opening presentation:

1. fostering discussions on the challenges that stakeholders face in the context of water scarcity, climate and biodiversity changes in the basin;
2. identifying existing and potential solutions to these challenges;
3. identifying ongoing monitoring activities related to water scarcity, climate and biodiversity changes in the basin;
4. identifying gaps in knowledge, data and communication; and
5. strengthening a collaborative network of partners (particularly regarding data access, data sharing, and contributing to field and research missions) to turn knowledge into actions.

Mr Ali Sarite (CEC of Water, Sanitation, Energy, Environment, Natural Resources and Climate Change of the Isiolo County Government) formally opened the workshop, mentioning that both from personal experience and his constituents, water was becoming scarcer due to recurrent drought events and over-abstraction of water, grazing was poorer and more animals were dying. He stressed the need for practical solutions to these problems and assured the will of county governments to support the development of collaborations and solution implementations to improve water scarcity in Ewaso Ng'iro.

Dr Kiteme (Director, CETRAD) started the scientific programme with an overview of water resources within the Ewaso Ng'iro North River Basin (hereafter referred to as the Ewaso Ng'iro basin), reviewing the status, challenges and research needs required to manage the surface and ground waters of the catchment sustainably. The Ewaso Ng'iro basin gets its source from Mount Kenya and Aberdare, and flows through Kenyan Highlands. The North River basin spreads across eight counties: Laikipia, Meru, Samburu, Garissa, Isiolo, Marsabit, Wajir and Mandera (https://www.kenya-atlas.org/). Dr Kiteme likened this upland-lowland system to a "water-being", the health of which was greatly declining. He dated this ill health back to at least the 1940s when over-abstraction and lack of appropriate management were already impacting downstream users and communities. He identified five key challenges relating to water scarcity in this catchment: 1) over-utilisation of ground & surface water; 2) limited knowledge of surface water hydrology & constraints; 3) the dynamics of water abstraction; 4) climate change; and 5) water quality. The relative importance of these challenges, the issues that arise from them, and the research gaps associated with each are listed in Table 1, alongside an indicator of how much is known about each challenge. In summary, Dr Kiteme stressed that the underlying "wicked problem" of water scarcity

and consequent over-use is due to inadequate long-term data to allow robust hydrological modelling of the Ewaso Ng'iro catchment in a manner that incorporates the impacts of both global warming and abstraction. He further stressed that, even if there were robust outputs available to inform sustainable use of the surface and ground waters, the political will is lacking to draft appropriate legislation and enforce its enactment.

It is urgent to develop a long-term monitoring system of water well-being (as done by CETRAD for surface water flows) to enable continuous interventions and ensure water health under stress.

Table 1: Challenges related to water scarcity in the Ewaso Ng'iro North River basin, as highlighted by Dr. Kiteme.

Challenge	Relevance	Issues	Current Knowledge	Gaps
1. Over-utilisation of groundwater (GW)	High importance for humans & their livelihoods (domestic, livestock, agricultural use), and critical for downstream ecosystem services & biodiversity.	• Abstraction greater than recharge • Upcoming transregional demand • Poor governance, weak legislation and little enforcement	1/5	• GW extent, volume and recharge; • Spatio-temporal contribution of SW to GW recharge (GW – SW interactions); • Spatio-temporal distribution of GW use & users.
2. Over-utilisation and conflicts over surface water (SW)	Very high importance for upstream & downstream human populations – domestic & economic activities; critical for biodiversity, livestock, wildlife & tourism.	• Over-abstraction • Conflicts • Complex & poorly performing water governance • Endangered downstream hydrological & ecological functions (Ecological Reserve unknown)	4/5 (CETRAD database)	• Contributions of non-perennial tributaries and GW to SW flow; • Effect of water governance on SW flow; • Functions of SW for biodiversity and wildlife.
3. Use and users dynamics	Human multiple use of Ewaso Ng'iro basin is the most important factor influencing SW & GW availability and long-term sustainability.	• Agro-industrialisation and economic modernisation are main drivers and increase pressure and conflicts • Spatio-temporal variation in use (quantity and pattern) by various activities • Poor monitoring of current abstraction & non-existent future planning, allied with weak regulations	3/5 (CETRAD database)	• Key question: How to improve governance, management & technology to strengthen knowledge and sustainability? • Spatio-temporal distribution of SW and GW use and users by actor categories; • Establishing effective evidence-based water governance and effective abstraction rates.

Challenge	Relevance	Issues	Current Knowledge	Gaps
4. Climate Change	Climate change will influence sustainability of catchment, will increase or decrease the impacts of use and users on water health, and will complicate ability to quantify the hydrological balance spatially and temporally.	• Increased unpredictability of the water-being and related risks (conflicts, management challenges) • Insufficient long-term monitoring at appropriate spatial scale allowing creation of suitable hydrological, ecological (ecosystem services, e.g. Ericksen et al. 2012, Kiteme et al. 2021) and socio-economic models to inform policies, management and actual abstraction of GW and SW across the Ewaso Ng'iro basin	2/5	• Impact of climate change on water-being, risks and opportunities; • Development and evaluation of hydrological models at suitable scales; • Political goodwill needed for policy development to ensure sustainability and equitable water governance.
5. Water quality	Increasing (agro-) industrialisation and urbanisation affect water quality; water quality of both GW and SW impacts water availability for use, alongside increasing abstraction and quality issues.	• Lack of suitable monitoring stations across the area: where they exist, they tend to use "old" technology • Ensuring delivery of appropriate water quality has implications for governance, management & technology, and cost	1/5	• Water quality not analysed systematically; • Hotspots of current or future pollution problems not always identified; • Potentially large economic costs associated with "potable water" delivery; implications for governance, management and technology.

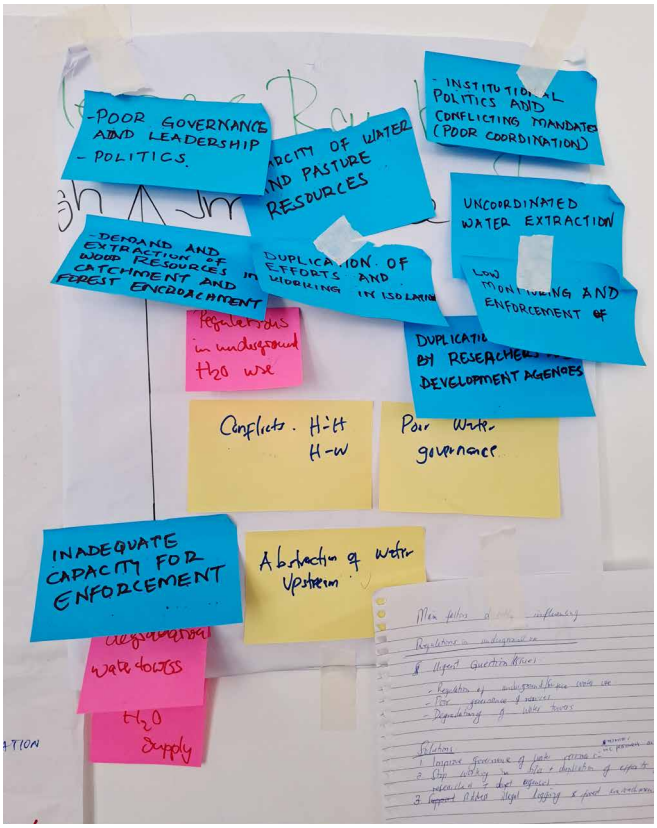
Session 1

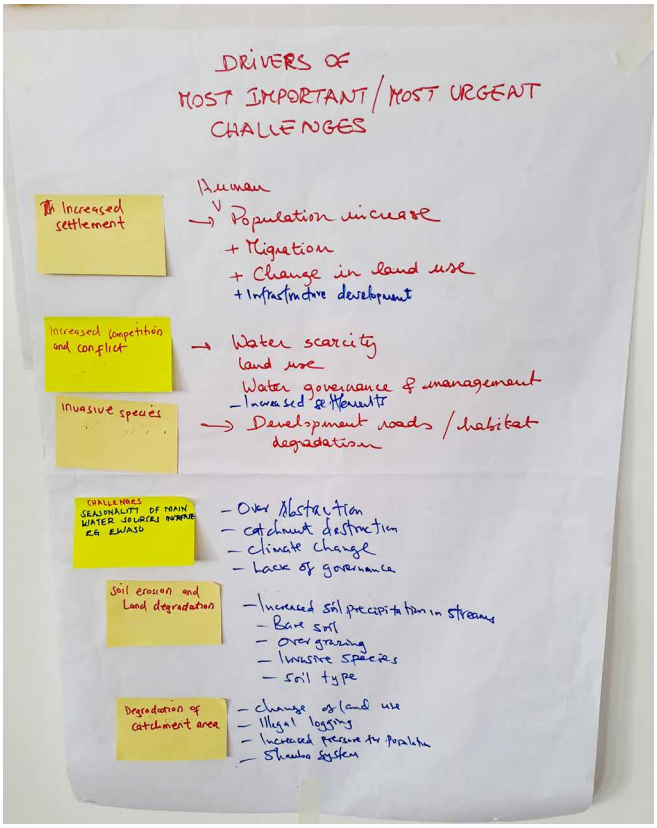
Water Scarcity and Climate Change in the Ewaso Ng'iro North River basin

Dr M-E Demory (lead of the Water Scarcity project, Wyss Academy for Nature at the University of Bern) outlined the inter-disciplinary (ID) nature of the Water Scarcity Research Project that focuses on the nexus between human population size, natural resource management and governance, climate, land-use and environmental changes, all jointly interacting to result in either sustainable or unsustainable water resources across the Ewaso Ng'iro basin. Both observational data and modelling will be used to answer key research questions that include understanding how climate change interacts with the other main drivers of water availability, and how Nature-based Solutions (NbS) can be used to counter water scarcity, restore biodiversity, and increase livelihood opportunities in the area. In particular, Dr Demory stressed the need for a network of reliable, long-term monitoring to be collaboratively developed across the basin in order to parameterise models and increase confidence in their outputs.

Dr Okita explored how climate change and human population growth up until 2100 might impact both wildlife and livestock in Arid and Semi-Arid Landscapes (ASALs). ASALs are important. They cover 89% of the country, account for 38% of human population and are home to over 90% of wildlife, which supports tourism and contributes to 12% of Kenya's GDP (State Department for the ASALs and Regional Development, https://www.asals.go.ke/). ASALs are also fragile. The annual rainfall is 150–550 mm in arid areas, and 550–850 mm in semi-arid areas, with high interannual variability. Dr Okita highlighted the necessity for the Government of Kenya's Vision 2030 flagship project on securing wildlife migratory routes and corridors to mitigate the potentially deleterious drivers of climate change and human population growth in both human livelihoods and biodiversity. Priority objectives of this work are to 1) build consensus and stakeholder buy-in regarding the implementation of wildlife movement corridors across the landscape; 2) use regional climate projections to explore environmental change across the ASALs through to 2100; 3) simulate optimal connectivity (movement corridors) between critical resources for wildlife and livestock against the resulting vegetation changes using resistance mapping, and superimposed on known and/or predicted human landscape use and existing or planned corridors; 4) include multisectoral approaches to wildlife viability alongside human well-being under climate change through to 2100; 5) develop policy and implementation guidelines for land-use strategies

with stakeholders to strengthen resilience by conserving environmental services and ecological infrastructure. The intention is that the above science-based analyses of wildlife viability alongside community-informed socio-economic needs will be integrated and synthesised to ensure human well-being alongside wildlife space and connectivity.





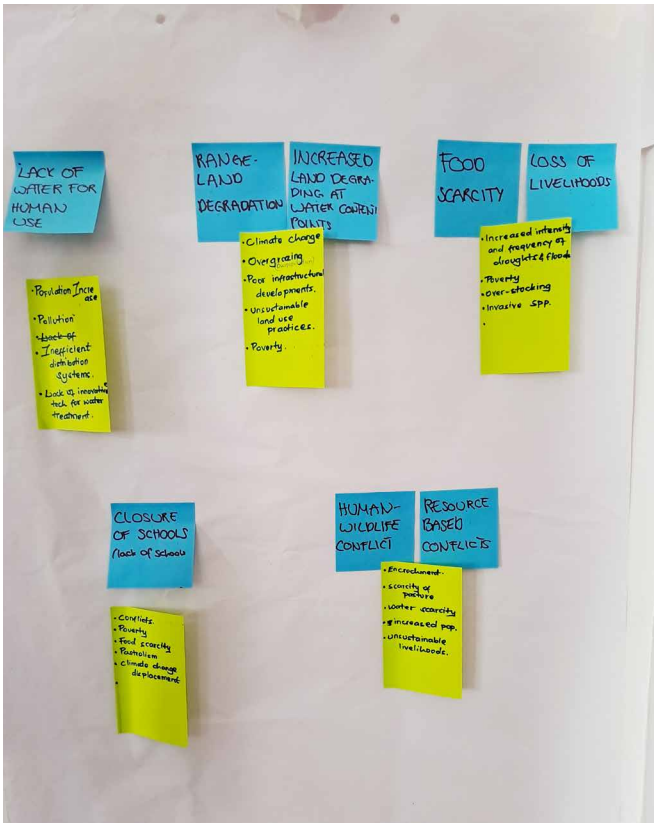


Figure 2: Example output of co-creation session 1 on challenges in the Ewaso Ng'iro Basin. The summary and identified challenges can be found in Box 1.

Box 1: Co-creation session on challenges of water scarcity in the Ewaso Ng'iro

These introductory talks provided the initial background by which all the attendees could participate in a *co-creation session* that explored the **challenges of water scarcity in the Ewaso Ng'iro** in the face of major global environmental change (global warming, an increasing human population, alongside declining natural resources and reduced access to such resources).

The most important and urgent challenges identified consistently amongst the "break-out groups" were:

1. Poor governance relating to natural resources, especially water;
2. Land and water catchments degradation (i.e. deterioration of the quality and functionality), soil erosion and invasive alien plants;
3. Climate change;
4. Lack of alternative livelihoods together with an increasing human population.

Poor governance in particular, at both national and local levels, was seen as a "wicked problem" leading to further challenges such as illegal (i.e. not permitted by water regulations) or over-abstraction (i.e. beyond the permitted limit set by water regulations or beyond the natural resource potential) of water upstream, lack of available water downstream, water pollution, nature-resource related and human-wildlife conflicts, and loss of livelihoods. Few constructive solutions were suggested, although targeted environmental education for members of Water Resource User Associations (WRUAs) was seen as a useful way forward. However, excessive abstraction by "upstream users" was viewed as a legal issue that required "government intervention" and was unlikely to be easily resolved.

There was a general awareness that land degradation, mostly due to overgrazing, deforestation and unsustainable land use practices, leading to reduced land productivity, food scarcity and poverty, could be prevented and, in some cases, reversed. The reversal can be done through invasive alien plants (mostly *Prosopis*) clearance followed by appropriate grazing regimes, but the extent of alien plant invasion in some areas would require dedicated government intervention. Examples were raised where communities had successfully slowed erosion and rehabilitated some of the degraded land. On the other hand, the degradation occurring in the "water towers" was seen as requiring legislative intervention that was actively enforced.

A linkage was made between the increasing size of human populations and the extent to which habitats were degraded, together with the observation that there was generally little opportunity for alternative livelihoods to be taken up in these rural areas. Climate change, leading to increased intensity and frequency of droughts and floods, was generally seen as exacerbating an already difficult situation inherent of weather patterns found in arid and semi-arid environments.

Session 2

Impact of Climate and Land Use Changes on Water Resources and Wildlife

The talks focused on providing overviews by the programme managers leading the Financing Locally-Led Climate Action (FLLoCA) Programmes in four of the counties. This national programme of locally devolved climate adaptation supports partnerships between local governments and their respective communities to assess climate risks and identify socially inclusive solutions tailored to local needs. In particular, the key remit of the FLLoCA programme is to ensure that climate resilience reaches those most at risk, including women, youth, persons with disabilities, elders, and other traditionally marginalized groups. The World Bank (co-founders of FLLoCA) state that "*investments may focus on activities that support livelihood diversification, or community-level preparedness for multiple risks. Depending on what communities prioritize, investments may also promote water conservation and more efficient use of water, support natural resource management, rehabilitate degraded lands, or promote early warning systems.*"

Ms J Ahatho (Director of Environment and Climate Change, Marsabit County) emphasised how both erratic rainfall and increasing temperatures were negatively impacting livelihoods and biodiversity in the county. An increasing human population both up- and down-stream, alongside detrimental land practices such as sand-mining within river beds, excessive water abstraction, land clearance for farming and the cutting of trees for charcoal were all seen to be major challenges in ensuring adequate flow of water in the Ewaso Ng'iro. Invasive species along the river banks (especially *Prosopis* – already highlighted as a challenge in the previous session) and soil erosion were seen as further challenges needing urgent attention. The need for catchment-scale Integrated Water Resource Management was emphasised as a realistic way of tackling the unsustainable abstraction of water by stakeholders across the basin. Ms Ahatho highlighted the need of a participatory approach to involve the local community and explain climate risks in terms of social life and livelihood, reminding that about 80% in the Marsabit County have not gone to school.

Ms Z Dida (Director of Environment and Climate Change, Isiolo County) reflected on the experience of delivering FLLoCA to the residents of Isiolo County, who experience higher temperature and more frequent droughts and floods that exacerbate water scarcity, insecurity, human and livestock death, environmental degradation and high cost of disaster

management. In 2018 Isiolo County Council had enacted the "Climate Change Funds Act" that authorised committing 2% of the Development budget to finance climate interventions. This has allowed climate change to be mainstreamed within the County's annual planning and budgeting responsibilities, and led to a dedicated FLLoCA unit with funded staffing. To date, this unit has conducted participatory Climate Risk Assessment reports that have informed the county's Climate Change action plan 2023–2027, with practical build plans such as dams, boreholes, or water tracking for downstream water delivery. However, Ms Dida also listed a number of challenges that were already familiar from the co-creation exercise carried out earlier, namely excessive and/or illegal upstream abstraction of water, unplanned drilling of boreholes in both Isiolo and neighbouring counties, water infrastructure vandalism, inadequate resources, pollution and loss of livestock due to conflicts. Ms Dida concluded that climate change is a cross-cutting issue that requires considerable political goodwill at all levels, support and collaboration, that the Ewaso Ng'iro does not recognise political boundaries and that an inter-county approach in water management is critical to achieving equitable (and sustainable) access to water resources.

Ms J Kipkazi (Director of Environment, Natural Resources and Climate Change, Baringo County) stressed that both livelihoods and economic activities were highly dependent on the utilisation of climate-sensitive natural resources. This susceptibility to floods, droughts, and unpredictability of seasonal planning exacerbates conflict over the use of natural resources. People in Baringo are experiencing drying of all water sources (rivers, swamps, boreholes, lakes such as Lake Bogoria National Reserve), reduced water in existing irrigation schemes (e.g. Perkerra), loss of wildlife (e.g. white crocodile) and thus tourism revenue, and increase in human-wildlife conflicts such as with crocodiles, snakes, elephants, hippos, monkeys. Legal frameworks and platforms that informed the current County Integrated Development Plan resulted in climate issues being mainstreamed and strategies developed to improve resilience. Opportunities were developed to bring climate change awareness and sensitization programmes to local communities, and at a practical level, to financially assist in conservation initiatives that protected water catchments and critical forest ecosystems. "Model tree nurseries" were also supported, providing additional income and employment opportunities to local tree nursery vendors. Resources were also found to support national and international development initiatives within the county. Across all the FLLoCA talks was the observation that **there is considerable duplication in both effort and activities between differing actors (government and NGOs) in the water sector. Better communication between groups may increase the efficiency and effectiveness of the work being undertaken.**

These challenges highlighted by the FLLoCA delegates were placed in perspective by **Dr A Lutta** (University of Nairobi and Stockholm Environment Institute), who is part of a large EU-funded multi-disciplinary

project developing climate services for agro-pastoralists across the Horn of Africa drylands (Down2Earth/D2E). Given that the Intergovernmental Panel on Climate Change is predicting that droughts will increase in frequency and severity across this region (IPCC, 2023), the project seeks to facilitate community-centred adaptation and resilience to climate change impacts by improving data, model seasonal predictions and long-term projections and regional climate services (2016 climate change report) relevant to mitigating the impacts of water scarcity and food insecurity as a result of climate change. Dr Lutta presented another project, DRIER, which sought to understand how local communities are affected by droughts. The project highlighted that, although infrastructures such as dams and reservoirs may have a beneficial short-term impact to counter droughts, they alter natural hydrological flows that may be more damageable to the ecosystem in the long-term. A policy coherence analysis also emphasised that many policies are currently not coherent and do not support each other. There is therefore a need to address the challenges already discussed above in the co-creation session and in the FLLoCA presentations by developing improved water and land management processes that are focussed on water storage and water-harvesting techniques, alongside developing appropriate and coherent policy frameworks and governance structures.

Box 2: Co-creation session on data availability, quality and access

The above presentations were followed by a *co-creation session* exploring **data availability, quality and access** using the following six disciplines to order these data, namely i) Climate; ii) Biodiversity; iii) Hydrology; iv) Soil; v) Agriculture and pastoralism; and vi) Traditions and social structure.

Table 2 lists currently available data, sources and gaps. This list is not exhaustive and would benefit from regular updates Although some datasets may already be available on a public platform and processed in a format that is user friendly, most may be in raw format and would require quality checks and validation by experts. On the face of it, there appeared to be a large amount of data already available and covering many relevant areas. CETRAD was listed as an important source of hydrological data, whilst a number of government organisations (e.g. Directorate of Resource Surveys and Remote Sensing (DRSRS), Kenya Wildlife Service (KWS)) and multi-lateral agencies (e.g. ILRI regarding livestock) hold relevant data on biodiversity and additional information (shapefiles, etc.) on protected areas and government forests. The National Museums of Kenya, alongside its affiliated regional museums, hold data and artefacts across a wide range of topics, including an internationally recognised herbarium, and collections of invertebrates, birds and mammals amongst its specimens, as well as information on cultural areas of research.

Gaps in the data were also listed, with two notable areas being i) the lack of long-term data relating to a number of necessary environmental, climatological and hydrological data, and ii) that information pertaining to ecological infrastructure and nature-based solutions were often lacking, being neither

adequately mapped and delineated, nor having appropriately estimated values (monetised). Furthermore, even where data are available in a digital format, these databases have not been cleaned. The most useful access to the available data will probably be realised through collaborative undertakings.

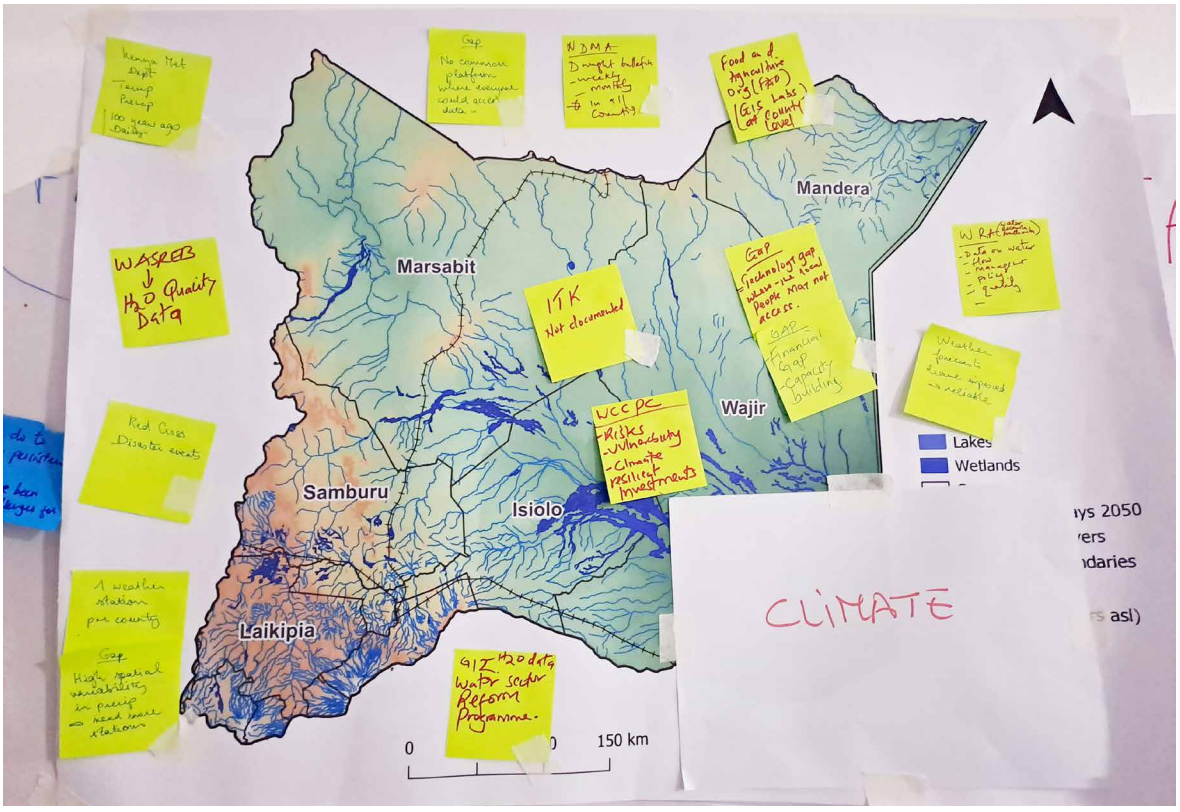


Figure 3: Example output of co-creation session 2 on data availability, quality and access (see box 2 and Table 2).

Table 2: Overview of data availability, sources and gaps identified during the co-creation session

	Data	Sources	Gaps
Climate	• Daily precipitation, temperature over last century • Disaster events • Drought bulletin (weekly, monthly) • GIS data at county level • Climate resilient investments, risks, vulnerability • Automatic weather stations	KMD KRC NDMA FAO WCCPC CETRAD	• No coordination for monitoring, no common platform to access data, no easy access for locals; • Not enough weather stations in Ewaso Ng'iro to capture high spatial variability of precipitation; • Weather forecasts have improved: need to transfer knowledge to locals, while ensuring preservation of traditions
Biodiversity	• GPS tracking of elephants, wild dogs, lions, cattle, zebra • Mortality of elephants, road kills, distribution of illegal activities (e.g. illegal wildlife trade) for key catchments, human-wildlife conflicts • Wildlife and livestock • Distribution and number of wildlife, aquatic biodiversity, • phytoplankton, macro/ micro inverts, citizen data-science for avifauna, water birds • Natural asset mapping and attributes	STE / GZT / WA / CETRAD WRTI / KWS NRT NMK WA	• Skewed species (lots of elephants monitoring and zebras but very little or none for others); No GPS coordinates; • Lack inventory of all natural resources in all counties; • No soil biodiversity data; • Need species distribution models for aquatic ecosystems and drylands; • Need natural infrastructure mapping and economic valuation; • Lack of centralized database, difficult to access data (little information on how to access data), need biodiversity access permits => need more collaborations • Better use of technology and citizen science for data collection
Hydrology	• Lots of data on surface water: 28 river gauges and 8 weather monitoring stations from Mt Kenya to downstream, river shapefiles (Laikipia, Isiolo, Samburu, Marsabit), wetlands, abstraction points upstream • Streamflow, boreholes, water management policy, water quality, weather stations • Weather stations • Water quality	CETRAD web-based data sharing platform WRA KMD WASREB	• No data for Mandera, Wajir, Garissa, Marsabit; No data for lower catchment => need to extend monitoring network to lowland; • Lack of groundwater data => make use of modelling tools; • Limited data access, e.g. number and location of weather stations unknown (available at KMD but need partnership framework to access data); • Need gridded datasets; • Need to map rivers; • Need mapping and assessment of wetlands; • Need to update and extend abstraction data

	Data	Sources	Gaps
Soil	• Physical-chemical properties (0–30 cm soil)	KALRO / ICRAF / UoN	• Few soil profile data from 30 cm downward; miss emission data of greenhouse gases (CO2, N, N2O, CH4); Difficult to access data
Agriculture & Pastoralism	• Livestock productivity and density; • Human density (to understand human needs); • herd sizes (yearly inventory); • camel milk value chain	FAO (GLW); FAO (WorldPop) CETRAD	• Could develop early warning systems for crops (CETRAD has many projects that aim to disseminate information better); • Could use crop modelling to assess where data is needed for water demand; • Need data for prevalence of disease; • Need crop suitability information and data
Traditions & Social Structure	• Some data but not for Ewaso Ng'iro	NMK	• Need collaborations with institutions; copyrights to prevent misuse; documentation of traditional practices; highlight culture in education

Acronyms of listed institutions: **CETRAD** Centre for Training and Integrated Research in ASAL Development; **FAO** Food and Agriculture Organisation; **GLW** Gridded Livestock of the World; **GZT** Grevvy's Zebra Trust; **ICRAF** International Center for Research in Agroforestry; **KALRO** Kenya Agricultural and Livestock Research Organization; **KMD** Kenya Meteorological Department; **KRC** Kenya Red Cross; **KWS** Kenya Wildlife Service; **NDMA** National Drought Management Authority; **NMK** National Museums of Kenya; **NRT** Northern Rangelands Trust; **STE** Save The Elephants; **UoN** University of Nairobi; **WA** Wyss Academy; **WASREB** Water Services Regulatory Board; **WCCPC** Ward Climate Change Planning Committee, ADA Consortium; **WRA** Water Resources Authority; **WRTI** Wildlife Research & Training Institute.

Session 3

Impact of Changes in Water Resources on Biodiversity and Human Livelihoods

Prof N Oguge (University of Nairobi) presented the role of citizen science in a number of projects that use Earthwatch Institute volunteers from different countries in Africa and other counties within Kenya, as well as local community members to provide information and assist with ecosystem and biodiversity monitoring and mapping in the Samburu landscape. Information was collected across a range of topics, including the distribution of carnivores in relation to human habitation; land use and land-use change across Samburu county; water sources mapping; faecal contamination of differing water sources (100% in dams, 90% in rivers, 20% in streams, 2% in pipe systems and 0% in boreholes); phytochemical composition of medicinal plants; and the importance of communal lands as a factor in the conservation of Grevy's Zebra. Prof Oguge highlighted the importance of capacity building amongst community members, such as by reporting back on scientific findings.

Dr C Handa (Technical University of Kenya) provided an overview of wetlands and their importance in the drylands of Kenya. Wetlands represent 3–4% of Kenya and grow up to 6% during rainy seasons. They are vulnerable to climate change (more frequent and intense droughts) and can further contribute to local temperature warming as they release CO_2 stored in the soil when they dry (Lake Ol'Bolossat almost dried up in 2022). Nature-based Solutions are considered as an effective solution to prevent further drying of wetlands (International Union for Conservation of Nature).

Dr M Ochuka (Adaptation Consortium) provided an overview of the County Climate Change Fund Mechanism (CCCFM). The CCCFM aims to facilitate the flow of climate finance to county governments, thereby strengthening public participation in the local management and use of these funds. Critical to this is the establishment of Ward Climate Change Planning Committees (WCCPCs) whereby members are elected to represent differing locations (each county needs different planning), social groups and livelihood systems in each ward. Some funding is available to support communities analyse their resilience to present and future climate risks and use these findings to prioritise investments that the fund can support. The County Climate Change Planning Committee (CCCPC – members from the technical departments of the county government and other stakeholders that represent each ward and each county) provide technical support and

advise the WCCPCs. The principles guiding the CCCFM include that it represents community-driven, bottom-up planning; is anchored within, and supportive of, devolution; adopts a flexible learning approach and focuses on investing public goods; and explicitly includes climate-vulnerable people, including women, in decision-making. The efficacy of this approach is demonstrated by a recent review documenting that over 85% of the "water investments" were still operational seven years after they were handed over to communities. In Isiolo County, 44 "public good" investments were made in 5 wards, including constructing and rehabilitating sand dams, boreholes and rock catchments. In addition, communities have drawn up seasonal grazing plans for their livestock with distinct grazing areas for wet and dry seasons and an area to be utilised only under drought conditions.

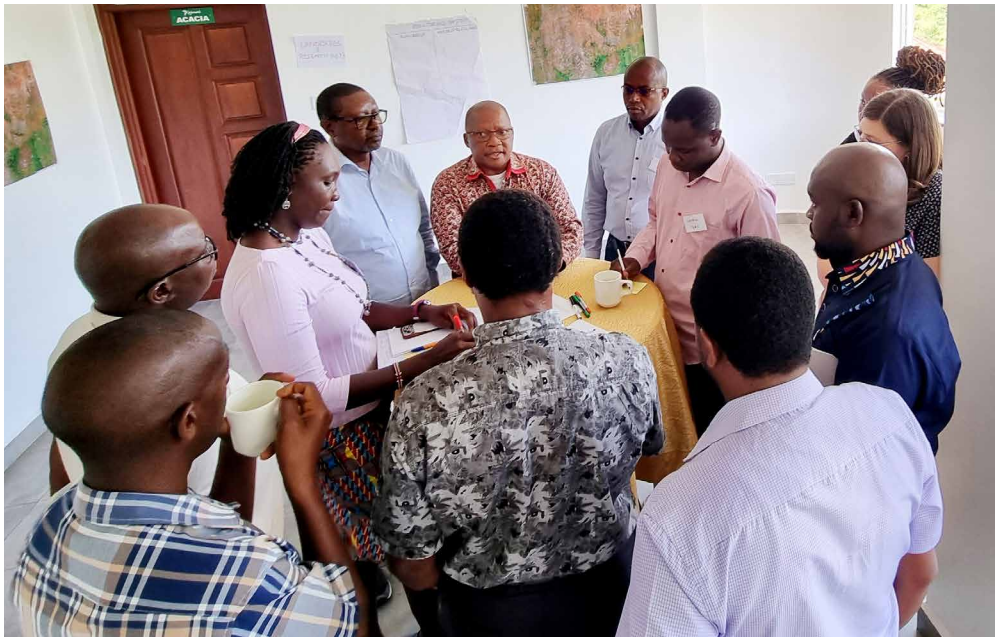
Dr J Odebe (Wildlife Research & Training Institute, WRTI) summarised the functions of the Kenyan WRTI, established in 2018 and operational since 2020. It is based in Naivasha, and its main functions include undertaking wildlife research, enhancing capacity in wildlife conservation & management through training, and establishing a comprehensive wildlife database (National Wildlife Census, 2021).

Session 4

Water Resources Restoration and Monitoring

Dr C Okello (deputy of the Water Scarcity project, Wyss Academy) provided an overview of Nature-based Solutions (NbS) for water resource management. NbS are "actions to protect, sustainably manage, and restore natural and modified ecosystems that address societal challenges effectively and adaptively, simultaneously benefiting people and nature." This broad concept includes the more specific concept of "Ecosystem-based Adaptation", which refers to "the use of biodiversity and ecosystem services as part of an overall adaptation strategy to help people adapt to the adverse effects of climate change". NbS (and so EbA) use "green infrastructure" to provide ecosystem services that benefit humans by reducing the impacts of major challenges like climate change, disaster risk reduction, food and water security, biodiversity loss and human health, and are critical to equitable and sustainable economic development. Specifically, regarding water resource management, Dr Okello highlighted how watershed restoration projects, protection and recreation of riparian buffer zones, and sustainably managed aquifer recharge can increase water capture and retention within basins and provide natural flood management co-benefits. These latter include environmental, social and economic co-benefits, such as enhancing water quality, flood mitigation and groundwater recharge.

NbS therefore appears as a clear win-win scenario, but there are implementation constraints whereby limited funding, technical expertise,



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and site-specific limitations can pose challenges to the widespread adoption of NbS. Specifically, many ecosystem services have already been negatively impacted by ongoing human activity, and in many such instances it is easier/cheaper in the short-term to continue with the deleterious actions rather than consider the longer-term benefits that may accrue from changing existing behaviour/activities. Change is only likely when either the current situation becomes too costly (e.g. Nairobi, day-zero in Cape Town), or legislative changes are actively enforced. Further, many people and policymakers are still unaware of the benefits and effectiveness of NbS in water resource management. Regarding the Ewaso Ng'iro basin, the ID Water Scarcity project, in partnership with CETRAD and other stakeholders, specifically aims:

1. To map out and establish state-of-the-art of NbS interventions across the Ewaso basin
2. To identify opportunities, constraints and possible scenarios for implementing NbS
3. To co-design and implement the selected set of NbS under the most suitable scenarios
4. To strengthen the enabling environment, improve governance and build stakeholder capacities for the sustainable implementation and upscaling of NbS
5. To develop strategies for investment in scaling up sustainable NbS
6. To disseminate and communicate findings, lessons and NbS actions to key stakeholders and project partners to support sustainability and policy around NbS

In collaboration with JustDiggit (an international NGO) and a local community (Naibunga), the Wyss Academy has explored the feasibility of digging and seeding semi-circular bunds to stop erosion and loss of top-soil, increase vegetation, and ultimately increase the grass cover sufficiently to allow grazing in previously denuded areas. In 2023, more than 5000 bunds were dug by the community over 6 sites. If successful, funding will be sought to roll out this approach using soil bunds more widely to counter soil erosion and increase grass/herb cover.

Dr J Göpel (Wyss Academy) presented the modelling concept of the ID Water Scarcity project to understand the contributions that NbS could offer in the drylands under various climate change and socio-economic scenarios. The modelling framework would involve climatic, hydrological and land use (inc. crop) models at different spatial scales in order to understand the impact of various drivers on water resources and land use, as well as exploring scenarios of NbS deployment. The models would need to be adapted for ASALs, community inputs and monitoring data (climate, land cover, hydrology). To address the sustainability of NbS in long-term scenarios, monitoring data of NbS is essential. A modelling case study will first be developed using the Naibunga semi-circular bunds.

Mr H Rotich (JustDiggit) provided examples of JustDiggit's practical experience in water-harvesting techniques and land restoration. As he emphasised, it is not just drought and flooding that is the problem, it is the intensity of the extreme events whereby heavy rains after droughts wash away soils and the seedbanks, causing extreme erosion and preventing natural restoration from occurring. Physically creating semi-circular bunds (typically 6m long and 3m wide, depth depends on terrain – bunds can be washed away if not deep enough – and orientation depends on surface flow direction) reduces surface runoff during heavy rains and retains water within the bund walls, thereby increasing soil moisture, seed germination and ultimately grazing quality and quantity whilst reducing flooding, soil erosion and gully formation. Other JustDiggit approaches include Farmer (or Pastoralist) Managed Natural Regeneration (FMNR/PMNR) where the focus is on finding old tree-stump and root systems in farmland and pasture and carefully nurturing their regeneration. Because of the existing root systems, such trees tend to regenerate more quickly compared with new sapling growth. Recreating seedbanks for grasses and harvesting the resultant seeds is also an important process in regenerating vegetation in badly denuded/eroded areas, generally coupled with digging soil bunds. All of these projects that are enabled by JustDiggit occur with the full involvement of the communities and their elders.

Repeatedly during the workshop, **calls for the modelling of the water cycle within the Ewaso Ng'iro basin have been made in order to understand sustainable abstraction of water and the impact of climate change on water availability. Both ground and surface waters are key components of such water cycle modelling.** Two talks explored the importance of the groundwater element in the hydrological cycle in the basin. **Dr D Maringa** (Lewa Wildlife Conservancy) summarised the preliminary results of his study into the chemical signatures of water samples abstracted from boreholes across the region (data on borehole location, depth, water level and abstraction are available). Cations and anions (sodium and potassium, and bicarbonates respectively), and also isotopic ^{18}O, are useful indicators of the source, flow and recharge of groundwater in the region, and water level trends in boreholes can provide climate indicators. These data will be used to investigate and map the status and trends of groundwater resources in Lewa so that awareness amongst communities and other stakeholders can be developed regarding groundwater recharge areas and flow characteristics so that a sustainable groundwater management plan can be developed across the upper (Mountain and Agricultural) and Lower (Conservation and Pastoral) parts of the landscape. This presentation laid the practical foundations for **Dr H Otieno** (South Eastern Kenya University) who provided detailed information on the actual technical process of modelling groundwater and linking the simulations to the overall water cycle. One of the most commonly used groundwater models is MODFLOW developed by the United States Geological Survey. The model needs information on topography, land cover and land use, soil type, and climate (temperature, precipitation). With such information, the model can for example be used to simulate water levels at boreholes (Costelloe, 2015). It therefore also needs observational data at boreholes for further calibration

in order to provide reliable projections of water level changes. Dr Otieno presented several application ideas specific to the Ewaso Ng'iro basin, such as to simulate the spatial and temporal variability of water recharge in the aquifers, to evaluate the impact of climate and land use change on groundwater recharge, to simulate groundwater dynamics and groundwater level trends, to perform a risk assessment of groundwater quantity and quality through a long-term monitoring programme. Such activities would require an observational network of groundwater.

Dr H Ndithia (Ornithology Section, National Museums of Kenya) presented an analysis of waterbird count data on some of the Kenyan lakes and wetlands that are important habitats for waterbirds, including the iconic flamingos sought after by tourists. Some of the important lakes in the area (L. Baringo, Nakuru, Solai and Bogoria) had all experienced regular increases/decreases in their water levels, area, and volume since 1980, with an increasing trend starting in 2010 and attributed to rainfall variability and increased surface runoff (Herrnegger et al, 2021). As a consequence, since 2010, significantly fewer waterfowl have made use of these lakes. Increasing water levels dilute the salinity of the lakes, which in turn promotes the growth of cyanobacterial toxins causing mortality in flamingos and other waterbirds, and a change in the elements they feed on (less carotenoids induce less pronounced pink colour of flamingos), which in turn has an impact on tourism. Several solutions could help mitigate the increase in lake volumes: NbS to improve rainfall infiltration upstream and reduce surface runoff; afforestation and reward to farmers through carbon credits, construction of flood protection dams. Long-term data for biodiversity monitoring (part. aquatic) is also desirable.

Box 3: Co-creation session on monitoring needs and data collection

A following *co-creation session* specifically addressed the topic: **"What needs to be monitored to track water resources and biodiversity, and how should these data be collected?"**. The session was divided into four working groups represented by: Universities/Research institutions, Local communities, NGOs/ Private sector, Government. A synthesis across all sectors made us realise that an extensive network of water and biodiversity monitoring is already put in place but not easily accessible to universities and local communities. Moreover, there is an urgent need for continuous and reliable monitoring of groundwater, particularly relevant to support water resources management efforts.

Table 3 highlights the identified monitoring gaps in water and biodiversity. Terrestrial and avian biodiversity was thought to be well recorded, both through the game counts undertaken by the various conservancies, and also through the aerial counts organised by Kenya Wildlife Service. Aquatic biodiversity, however, was considered to be poorly sampled, and calls were made for a concerted effort to be made to increase freshwater assessments and for training to be developed in the appropriate methodology and the identification of key indicator species (Dallas, 2021). Other informational gaps flagged as important included data

pertaining to land use and land cover (LULC) change in the ASALs, alongside data on wetland area and status. Long-term monitoring of water (quality and quantity, including flow rates and recharge for ground and surface waters) was also stressed as high priority data needs.

The drivers of some of these landscape changes needed further investigation, particularly habitat change (and species-specific changes) and the spread of invasive alien plants and bush encroachment. The extent of land degradation needed to be delineated too. Some of these data were already being recorded as part of specific studies, but the opinion was that there was insufficient sharing of these studies and that many were restricted to very specific areas – certainly in the case where remote sensing data were analysed, it could be highly cost-effective to use the algorithms to extract data across larger areas. Moreover, to include local communities in monitoring development, apps are not considered as a viable solution: communities often do not have smartphones, proper network or data access. Communication platform and events (such as this workshop) were seen as important dissemination opportunities and an effort should be made to ensure that such get-togethers occurred more frequently and reliably.

Table 3: Identified monitoring gaps in water and biodiversity.

Water	Biodiversity
• Lake levels & Impact on ecosystems • River flows vs. Farm production upstream • Water pollution • Water Quality • Water microbes • Water Abstraction • Below ground water capacity (aquifers) • River discharge • Water salinity in the pastoral areas • River & spring Flow • Carbon levels in the Ewaso Ng'iro ecosystem • Groundwater hydraulic load • Surface water infiltration and discharge • Level of water rise/drop • Rainfall water levels and patterns over time • Distribution of water sources • Water pollution • Water catchment health status • Differentiated taxa monitoring • Water depth • Evapotranspiration • Flow rate turbidity (P.H.) • Water Use • Policy and law efficacy	• Changes in habitats over time • Changes in wildlife numbers over time • Livestock value chain • Species population/abundance • Species richness (No of species in an area) • Aquatic species population dynamics • Aquatic biodiversity distribution other than birds • Soil components and its micro components changes • Soil chemical and physical properties • Level of degradation of community lands • Land cover changes • Monitor Ecosystem health • Wildlife movement in search of water • Biodiversity numbers and distribution of animals and vegetation • Land Use Land Cover changes • Vegetation composition and diversity • Invasive species • Diversity Change/Habitat change • Below ground biodiversity including fungi • Impact of human-wildlife conflicts on communities

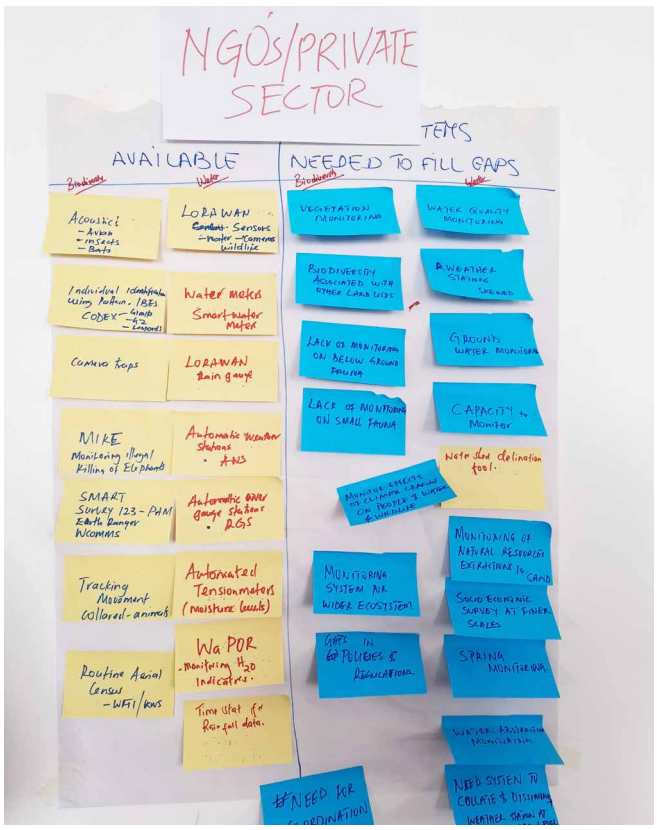

Figure 4: Example output of co-creation session 3 on monitoring needs and data collection (see Box 3 and Table 3).

Session 5

Governance and Human Well-being in Water Resource Management

Dr Kiteme started his presentation on water governance by quoting from a document written in the late 1940's regarding the state of water utilisation from the Ewaso Ng'iro – it probably bears repeating: "*... though most of the country in the Uaso Nyiro watershed is dairy or ranching country, the Europeans have started to grow crops, such as maize, which they irrigate with water from the tributaries of Uaso Nyiro. Many furrows have been made without permission of the Water Board (actually, they have been made in total defiance of it). These are not lined with cement (nor is the quantity of water measured), and in many cases the water is allowed to run into waste in the bush instead of being returned to the rivers, as it should be, so that what remains of it can benefit the natives living in the Northern Frontier District (NFD). ... because of this shameful treatment, even the great Lorian swamp itself is drying up ... Kenyans will not like what I am writing – some of them – but those who know the facts will be grateful that some publicity is being given to this misuse of the precious waters from the Uaso Nyiro river.*" Dr Kiteme then illustrated the increasing demands being made on the catchment using the following slide:

Many more users are increasing their offtake of water. The purpose of water regulation (especially the Water Act 2016, and the creation of a Ministry of Water & Irrigation) is therefore to "increase efficiency, equity and peace". However, the Act fails to provide a framework for equitable

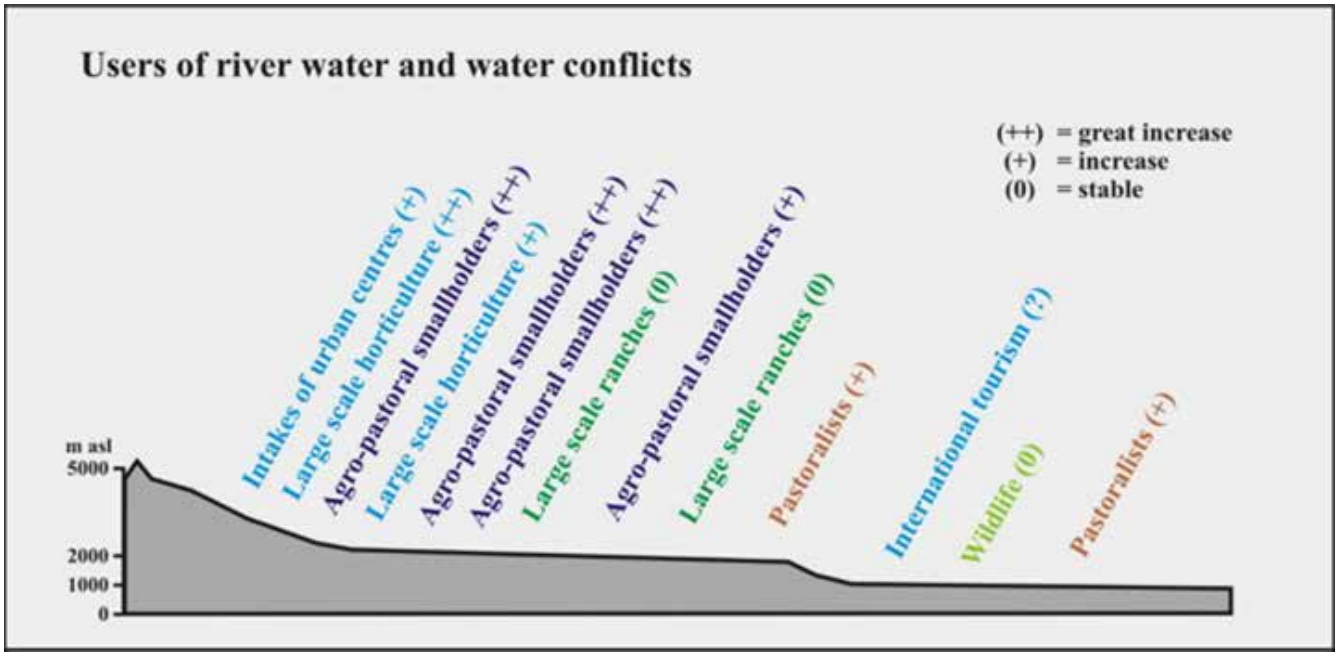

Figure 5: Transect through the Ewaso Ng'iro catchment showing the different uses of river water (courtesy of Dr Kiteme; main source: Urs Wiesmann, 1998).

resolution of conflict, especially between sectors. Furthermore, the 2010 Constitution of Kenya enshrined devolution and separated various related institutional arrangements between national and county governments. Critically, at the local level also sit the Water Resources User Associations (WRUAs) and the Water Services Providers (WSPs). However, for these to be effective, there needs to be basic capacity building regarding water governance to increase the efficacy of the WRUAs: long-term monitoring systems (e.g. groundwater, hydromet stations, early warning systems) to support WRUAs practical applications management plans; policy and planning supports at national, county and catchment levels (Waso Mara sub-catchment management plan, 2022–2032, Kiteme 2020). In addition, communities within the local catchments need to understand the importance of these bodies and recognise the value of their involvement in them: within the Ewaso Ng'iro North catchment, there is the potential for 272 WRUAs: in 2014, there were only 66 active associations, but by 2018 this number had doubled, and today there are more than 122 WRUAs. Progress is therefore being made.

Dr T Thenya (Wangari Maathai Institute for Peace and Environmental Studies, University of Nairobi) presented an overview of his work on "Biodiversity and Governance in Ol'Bolossat". The wetlands of Nyandarua and Laikipia Counties are heavily utilised by wildlife and humans, with human use deleteriously impacting vegetation, soils and wildlife, and ultimately the sustainability of these wetlands into the future. Focussing on the proposed Ramsar site Ol'Bolossat, the impact of local communities on the wetland viability was studied. Ol'Bolossat wetland and lake is an important bird area and forms part of the Africa-Eurasian Waterfowl Movement agreement. It is a high altitude wetland (2,340–2,400 m above sea level) located on the Satima escarpment and fed by runoff from the Aberdares, before its outflow enters the Ewaso Ng'iro River to the north. Prior to the GoK Protected Status conferred on the lake/wetland in 2018, the area faced various challenges including water abstraction, overgrazing, human encroachment, deforestation of catchment areas and siltation.

Furthermore, the size of the lake had declined from over 10'000 ha to 3'000 ha over a 10-year period. The land surrounding the wetland has a high human density in excess of 200 persons per km^2, who are predominantly small-scale farmers growing subsistence crops and rearing livestock on land parcels ranging from 0.2–3 ha. Analysis of remote sensing imagery shows major loss of wetland area and a marked increase in settlements and cultivated land between 1986 and current images. Consequently, as part of the County Council interest and the nomination of the wetland and lake as a Ramsar site, an Integrated Management Plan was drawn up between government institutions, civil society organisations, the private sector and local communities. Eight guiding principles were established at the beginning of the discussions, namely i) Legitimacy; ii) Transparency; iii) Accountability; iv) Inclusiveness; v) Fairness; vi) Integration; vii) Capability; and viii) Adaptability: each of these led to specific actions and

activities between the differing stakeholders, and from the perspective of the central non-governmental community-based (NGO/CBO) organisation, the Lake Ol'Bolossat Community Conservation Group (LOCCOG), these steps were essential for establishing a series of system processes that integrated planning, resource bases and knowledge, skills development, leadership and training that covered a range of governance needs and could be sold to the local communities as a credible outcome that embraced their culture and needs, and their long-term future. The consequences of this process that led to the Integrated Management Plan for Ol'Bolossat are hoped to provide clear local benefits, but also impact a far larger area through which the Ewaso Ng'iro travels.

Dr D Odeny (National Museums of Kenya) presented a concrete example of how to engage with local communities to assist in participatory mapping of natural assets, water and drainage resources in drylands, which experience low rainfall and overgrazing. The approach consists in first gathering natural assets data. Baseline maps are produced using remote sensing imagery that can be used to calibrate the modelled drainage system. For landscape features that cannot be mapped (or are not easily recognisable) from the remote sensing imagery), participatory field mapping is undertaken. The participatory mapping requires the identification of various landscape features of interest and determining their respective "Geographic Information System (GIS) shapes" (Table 4). In this instance, these data are entered into the ArcGIS Survey 123 app, available on smartphones. A detailed drainage network can then be built with features including permanent rivers and surface water, ponds and earth dams, plus

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natural assets and less tangible features such as grazing areas, livestock and wildlife corridors. This network will for instance help monitor the sub-systems that receive more/less precipitation and the links with animal movement. Finished mapping products are available for Laikipia, Isiolo, Samburu and Marsabit Counties, and are available on demand via the Wyss Academy ArcGIS Portal.

Table 4: Participatory approach for mapping various landscape features.

Landscape feature	Feature Type	Tool
Salt Licks	Point	Community participation & Mobile App
Swamps and Wetlands	Point	Community participation & Mobile App
Rock Catchments	Point	Mobile App
Springs	Point	Mobile App
Lagas (Laggas)	Polyline	Mobile App & Satellite Image
Dry Season Grazing Areas	Polygon	Community participation
Livestock Routes	Polyline	Community participation
Wildlife Concentration Areas	Polygon	Community participation
Sand dams	Point	Mobile App
Wildlife Corridors	Polyline	Community Participation
Ponds	Point	Mobile App & Satellite Image
Shallow wells	Point	Mobile App
Mining sites	Point	Mobile App

Ms C Machungo (Natural State) presented how to make use of Information and Communication Technologies (ICT) for "Restoring the Natural World". Natural State uses innovative financial models to support land restoration projects with high-tech monitoring for impact. Through large-scale restoration and rewilding projects using NbS, it attempts to increase revenue, secure biodiversity, sequester and store carbon, and help achieve the Sustainable Development Goals and decrease the area of degraded land to 50% by 2050. Where participatory approaches would be too slow, Natural State aims to develop accurate, efficient, near-real time, low cost and verifiable monitoring systems for assessing biodiversity and quantifying green infrastructure, and hopes to increase efficiency and transparency to access the voluntary carbon markets that will ultimately be used to manage and run large-scale carbon and restoration projects to facilitate transition to the new Green Economy. Examples of monitoring systems used by Natural State are lidar technology (for above ground carbon, up to 30 cm resolution), soil sampling surveys (for soil organic carbon), remote sensing of human development indicators, digital social surveys of human well-being, acoustic sensors and camera traps (for wildlife), as well as machine learning to rapidly process large datasets. The data collected will be accessible on the Natural State dashboard.

Box 4: Co-creation session on Nature-based Solutions in the Ewaso Ng'iro

The *co-creation session* that followed was concerned with further **exploration of Nature-based Solutions in the Ewaso Ng'iro**, specifically i) examples of NbS solutions in the catchment; ii) the engagement of local communities in the design, implementation and monitoring of future NbS in the Ewaso Ng'iro; iii) how to strengthen collaboration between local stakeholders, the Wyss Academy and other partners to maximise the impact of NbS and monitoring; and iv) the major co-benefits and risks impacting livelihoods and socio-economic opportunities. Participants came up with a large number of examples of current NbS, such as fish-farming, tree planting and reforestation, bio-enterprises (*Aloe vera*, tree seedlings, harvesting *Spirulina* (algae) for food, *opuntia*), biological control of invasive species (e.g. cochineal beetle breeding on cactus), water harvesting techniques (e.g. water bunds, sand dams for water storage, water retention ditch, stone lines), alternative livelihoods (bee keeping), and eco-tourism (e.g. camel safaris, cottage industry, connectivity with conservancies), although most of these examples lack quantitative measurement of relevant benefits (and any costs).

When first engaging with local stakeholders, a community entry point was considered a prerequisite, followed with an iterative process of meetings and trainings so ideas can be developed by local communities, including underrepresented groups. It was also considered essential that agreed guidelines (inc. the legally required PIC-MAT to ensure communities benefit from the work) are co-developed alongside transparent engagement and communication. Meaningful capacity building was also stressed, as was budgetary support (e.g. carbon credit incentives) to the community members supporting the NbS work in the field and beyond.

Several ideas were further discussed to maximise the impact of NbS, such as stakeholder mapping, technique mapping, natural resource mapping, site visits, contact sharing, information and data sharing platform, exchange programmes and other events to bring the communities together, and policy planning (e.g. planned grazing against land degradation).

Benefits of NbS were seen to considerably outweigh the potential costs: benefits include an increase in livestock production, increased employment opportunities, higher tourism benefits, better ecosystem services, less pollution, fewer conflicts, lower domestic violence, lower infant mortality, better education, and greater knowledge sharing with community. The main risks identified include the potential of introducing invasive alien plants or other genera, an increase in soil erosion due to inappropriate farming techniques advocated in community lands. "New methods" may also interfere with prey-predator relationship, disturb everyday life and culture and bring disagreements and possible conflicts, particularly if there is no policy developed together with the NbS. The issue of sustainability of the NbS when the project ends was finally highlighted, enhancing the necessity for a community-based monitoring to support the NbS.

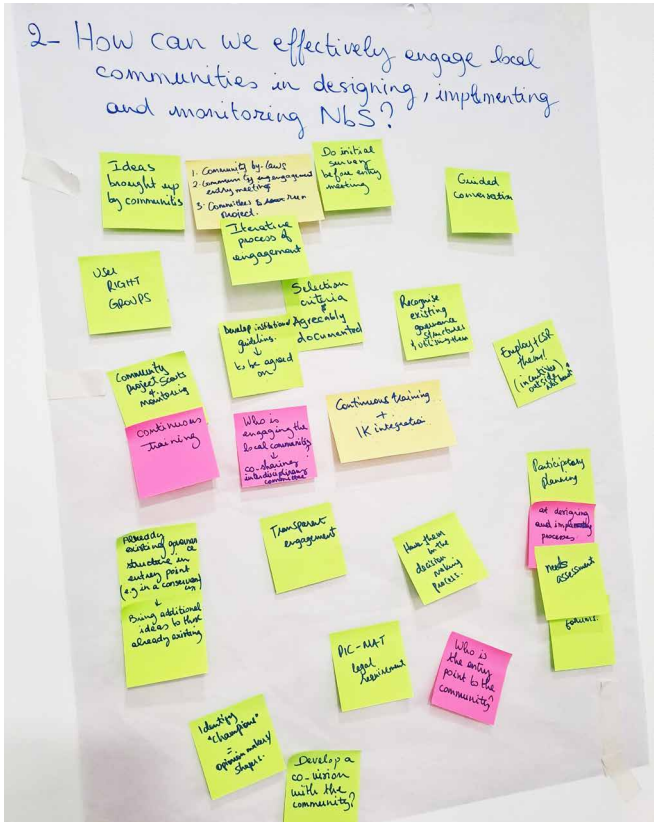

Figure 6: Example output of the co-creation session 4 on Nature-Based Solutions in the Ewaso Ng'iro.

Session 6

Biodiversity and water into the future

Dr G Otieno (IGAD's Climate Prediction and Applications Center, ICPAC) presented the hydrological modelling effort being undertaken under the EU Horizon 2020 DOWN2EARTH project and its application to communities living in three areas of the East African Horn's drylands (Isiolo county in Kenya, Meiso district in Ethiopia and Odweine district in Somalia). DOWN2EARTH is a four-year (Sep 2020-Aug 2024) project led by Michael Singer (Cardiff Univ.) to address food security and water scarcity by developing and refining a new hydrological model specifically for the drylands of East Africa, focussing on i) spatially restricted, short-lived rainfall; ii) high losses of precipitation by evapotranspiration; iii) very brief and spatially variable runoff events in ephemeral drainage networks; iv) groundwater recharge via leaky ephemeral streams through transmission losses; v) as focused recharge; and vi) as diffuse recharge. This model is based on the DRYP-1.0 model developed for local catchment areas (Quichimbo et al. 2021).

The objective is to further develop that model into a final model, called CUWALID (Climate into Useful Water and Land Information in Drylands) and developed for the large-scale drylands of Kenya, Ethiopia and Somalia by combining DRYP-1.0 with climate variables and stochastic rainfall and potential evapotranspiration values generated from state-of-the-art regional climate models. The CUWALID model will simulate groundwater levels and recharge, streamflow and soil moisture, which can be linked with a crop yield model. The output from seasonal forecasts for all of Horn of Africa drylands will be included in the East Africa Hazards Watch output and especially in a new mobile phone app targeting rural communities and extension workers. Of particular importance here was the emphasis on "the last mile" – inclusion of the voices from the 'last mile' rural (agro-pastoralist) communities, which in turn will support the development of the mobile phone app, the emergent properties of the agent-based modelling, and provide new climate adaptation policy frameworks.

The final presentation of the conference was given by **Dr C Kaua** (The Nature Conservancy, TNC), who provided an overview of TNC's work in Kenya and highlighted the fact that they are directly involved in the Ewaso Ng'iro basin. Dr Kaua focused on two areas, specifically the "Freshwater landscape" in Kenya and the Project Finance for Permanence (PFP) support for the Convention on Biological Diversity (CBD)'s 30×30 that aims to ensure that at least 30% of global land and sea areas, especially areas of particular importance for biodiversity and its contribution to people, are conserved by 2030. TNC is active in helping relevant government and NGO

bodies interested in conserving Kenya's freshwater resources to develop conservation planning. This is a participatory and data-driven process aiming to i) develop an appropriate national spatial plan, ii) identify a portfolio of priority conservation sites, and iii) strengthen and expand Kenya's conservation network and climate mitigation activities with strongly conserved and connected freshwater ecosystems. PFP, on the other hand, is an international initiative being driven by TNC, WWF, The Pew Foundation and others to provide "durable conservation at scale". To date, some 25 countries have been chosen as flagships to drive this concerted effort to conserve in perpetuity 30% of their respective land mass, with Kenya being one such approved country. It is perceived as a single transformative agreement that:

- brings everyone to the table to protect nature and sustain livelihoods;
- enables full and permanent funding, conservation, and community development commitments to be made all at once; and
- ensures that protected and conserved areas are effectively managed, sustainably financed, and provide equitable benefits.

Figure 7 below, summarising the potential of the CBD's 30×30 vision, ended the formal presentations.

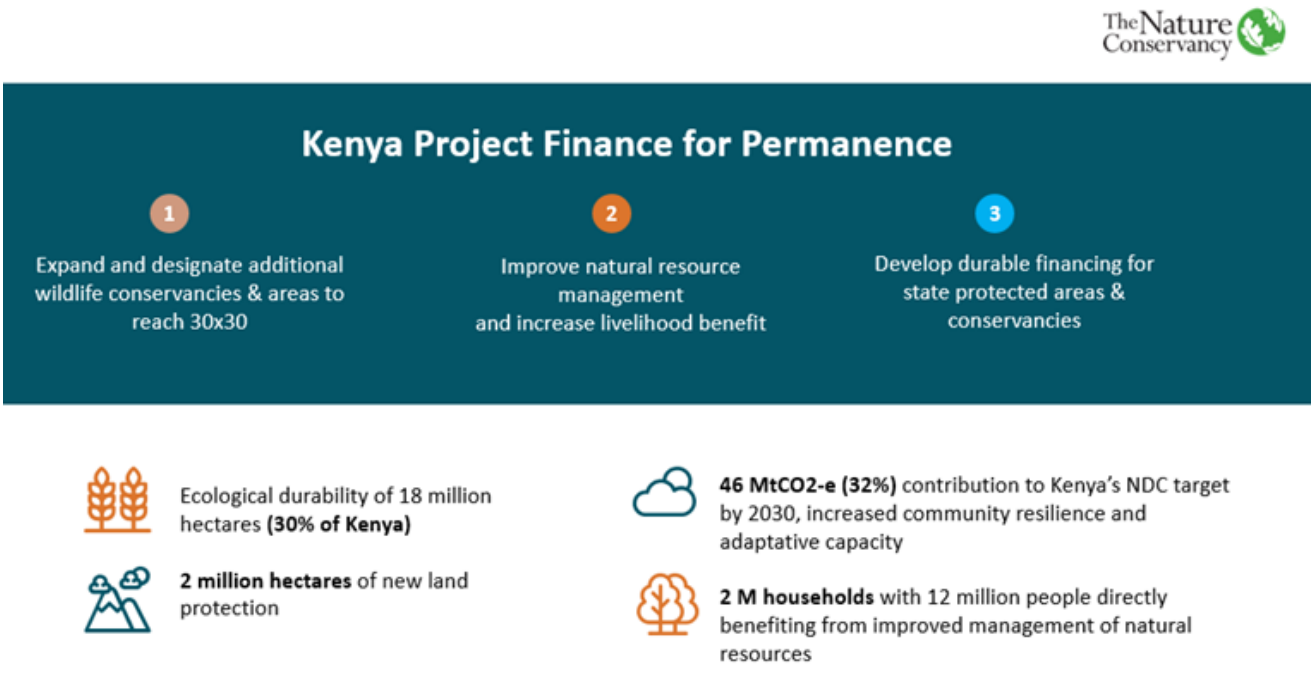

Figure 7: Potential of the 30 × 30 vision (courtesy of Dr. Kaua).

Box 5: Co-creation session on future collaboration and development

The last *co-creation session* concentrated on **future collaboration and development**. Table 5 gives an overview of the discussion.

Table 5: Identified missing stakeholders and opportunities for further collaborations.

Stakeholders missing in this workshop	Methods to enable further discussions & collaborations	Funding opportunities for research & applications
• Kenya Wildlife Service • Kenya Wildlife Conservancies Association • Laikipia Wildlife Forum • Kenya Meteorological Department • Ewaso Ng'iro North Development Authority • Kenya Forest Service • Kenya Forestry Research Institute • Water Resources Authority • Water Resource Users Associations • Kenya Water Towers Agency • Water Service Trust Fund • National Drought Management Authority • National Irrigation Authority • Water Service Providers (e.g. SAWASCO, NAWASCO, MEWASCO) • Mount Kenya Trust • National Lands Commission • Kenya Red Cross • Food Agricultural Organization • Kenya Agricultural and Livestock Research Organization • Regional Centre for Mapping of Resources for Development • Regional Centre on Groundwater Resources Education, Training and Research • Kenya Department of Resource Surveys and Remote Sensing • Kenya Private Sector Alliance • Council of Governors • Social scientists • Soil scientists • Agronomists • Environmental economists • Pastoralist representatives • Youth and women representatives of local communities	• Development of a consortium • Identify thematic groups (water, biodiversity, livelihood, climate, restoration) • Information & communication platform (with synthesis per thematic group, presentations, literature): google drive, WhatsApp, Teams • Diversify experts/ disciplines • Scheduled regular online meetings per thematic group • Annual/bi-annual workshops in person dedicated to outputs • Key action points for follow-ups • Dedicate personnel to do follow-ups • Fields and institutional visits • Data gap mapping • Contact exchange for capacity building • Joint grant applications	• FLOCA funds • National Research Fund • Terra Fund • Government agencies • National Research Fund • Corporates (Safaricom, Cocacola, KCB bank, Shell) • African Development Bank • World bank • World Wildlife Fund • Change Makers Program • FAO grants • Water Sector Trust Fund • The Nature Conservancy • International Union for Conservation of Nature • International Fund for Agricultural Development • Global Environmental Facility • Green Climate Fund • Nature Kenya • Justdiggit co-funding • Good Energies Foundation • National Geographic • Clinton Foundation • US Agency for International Development • United Nations Development Programme • EU Horizon • Swedish International Development cooperation Agency • UK Research & Innovation • Department For International Development • Department for Environment, Food & Rural Affairs • Swiss National Science Foundation • IHE Delft • Norwegian Agency for Development Cooperation • Australian Government Department of Foreign Affairs & Trade • International Development Research Centre • German Development Agency

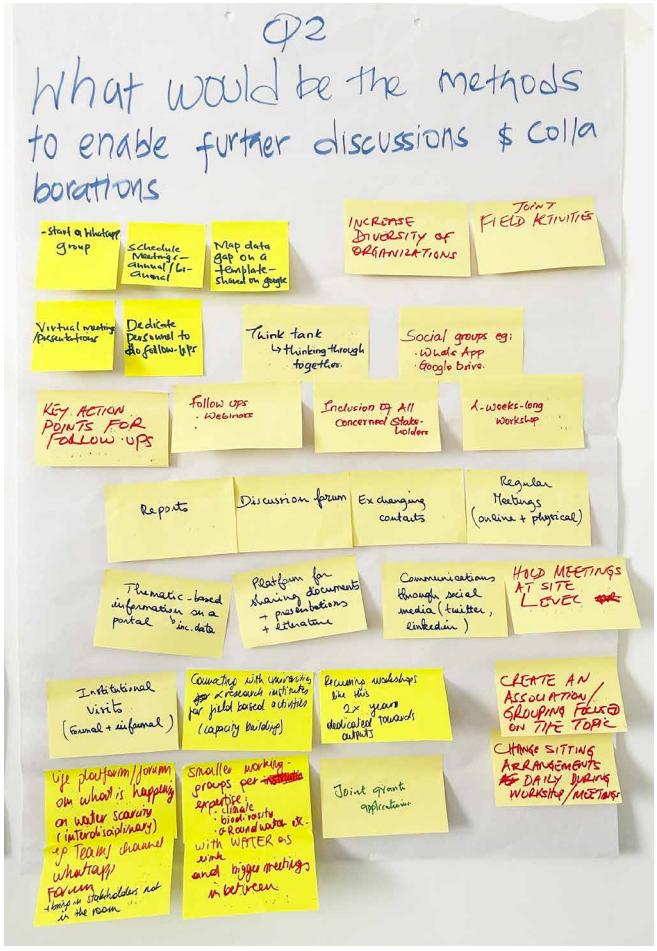

Figure 8: Example output from the co-creation session 5 on future collaboration and development (see Table 5).

Conclusion and next steps

When opening the workshop, Dr Okita described five objectives, namely: i) explore the challenges that stakeholders face relating to water scarcity, climate and biodiversity changes in the basin; ii) identify existing and potential solutions to these challenges; iii) prioritise the critical monitoring activities needed to explore possible outcomes relating to these solutions; iv) identify gaps in knowledge, data and communication; and v) strengthen networks between partners. Informal feedback and targeted assessment of the attendees at the end of the workshop indicated that these objectives had been achieved and that the expectations of the delegates were fully met. The participants acknowledged the workshop programme, which alternated between excellent oral presentations and co-creation sessions, and allowed information sharing, networking and exchanges in a fruitful and dynamic way. However, the programme was tight and intense, and participants highlighted the need for more time for questions and informal discussions (e.g. through outdoor walks). We particularly noticed that the existing knowledge was enormous and participants were keen on sharing it. This workshop highlights the potential for strong collaborative opportunities with regard to water scarcity in the Ewaso Ng'iro North River basin. In fact,

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many expressed the wish that the workshops become a regular feature in their work calendars and that such meetings occur more frequently.

Based on the discussions and ideas collected during the workshop, the ID Water Scarcity project will, in collaboration with its partners:

1. Focus on the following research gaps:
   - Impact of climate change on the regional hydrological cycle and water resources
   - Interactions between upstream surface water and downstream groundwater
   - Aquatic biodiversity distribution
   - Water resources restoration through NbS, considering various climate and socio-economic scenarios
   - Monitoring of NbS
   - Development of socio-economic scenarios (narrative co-creation, quantification of key drivers of socio-economic changes, model-based scenario quantification)
2. Form four working groups (WGs) in **NbS monitoring**, **climate and hydrological modelling**, **aquatic biodiversity** and **socio-economic scenario development**, and initiate regular WG online meetings;
3. Organize annual workshops in Kenya (location to be rotated) – next one planned in **June 2024**;
4. Create a collaboration platform for regular updates within WGs and live documents;

In addition, the Wyss Academy for Nature is working on developing a knowledge and engagement platform that will be used across all projects within the Academy.

For further information and expressing your interest in contributing to the WGs, please contact:

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