

Analysis of Quality Infrastructure Services Offered in Uganda and Potential for Development

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On behalf of



On behalf of the Federal Government of Germany, the Physikalisch-Technische Bundesanstalt promotes the improvement of the framework conditions for economic, social and environmentally friendly action and thus supports the development of quality infrastructure.

1. Main findings from the Uganda country study

A brief overview of the overall level of relevance of key sectors at the national level, their priority in terms of climate change and opportunities identified for further development of quality infrastructure in Uganda is presented in the following.

Recommendations

Based on the results from the Uganda country study, three main recommendations can be deduced in relation to the overall relevance of analysed key sectors at the national level, their priority in the context of climate change and opportunities for future development of quality infrastructure therein.

1. In Uganda, the forecasted impacts of climate change are taken very seriously. An institutional framework has been built during the past years and relevant policies and strategies are in place. Today, the Climate Change Department (CCD) (under the Ministry of Water and Environment) is in charge of developing, controlling and monitoring strategies and interventions built around both climate change mitigation and adaptation to climate change. From a central perspective, the integration of quality infrastructure aspects has not been considered so far in the country's overall framework of responding to challenges posed by climate change. Creating awareness about the relevance of quality infrastructure and fostering cooperation between the Climate Change Department and the quality infrastructure organizations as an entry point for supporting the development of the needed quality infrastructure services in relevant sectors (particularly agriculture, water and renewable energies) can be seen as an important opportunity in this context.
2. Agriculture remains the main source of livelihood and income for the rural population. At the same time, the sector a) is increasingly affected by climate variability and extremes, while b) agricultural inputs (pesticides, fungicides and climate-robust seedlings) needed for preventing crop damage and losses are of low quality. Basic quality infrastructure services needed by the sector are already offered, but they could be further expanded and improved. Therefore, putting a focus on quality infrastructure services related to climate change in the agricultural sector appears to be most

relevant and promising for supporting vulnerable population groups in Uganda. Due to the close linkages between agriculture, water and meteorology, possible joint approaches should be evaluated.

3. A further opportunity for cooperation exists in the renewable energy sector, which represents a focus area of BMZ in Uganda. The importance of expanding and diversifying energy generation from renewable sources to ensure the country's energy self-sufficiency and reduce vulnerability to climate change is understood by Uganda's government. Quality infrastructure services for the sector are currently lacking. The gradual development of necessary services from an early stage of sector development could help Uganda to avoid negative experiences with new technologies, build trust and support their rapid expansion. Especially services in metrology and testing to detect sub-standard product quality of imported goods and for system installation, operations and monitoring are important in this context. This could represent one work package in a project supporting quality infrastructure for adaptation to climate change with a focus on multiple sectors.



	Relevance at the national level	Priority in climate change context	Opportunities for QI development
Renewable Energies	<ul style="list-style-type: none"> Use of biomass energy in Uganda is unsustainable, and natural resources are continuously depleting. The government is attempting to become energy self-sufficient (focus on hydropower and other renewable energy sources). 	<ul style="list-style-type: none"> With a high dependence on hydroelectricity, the whole power sector suffers from a shortage of generating capacity due to prolonged drought conditions, especially in the northern and north-eastern parts of Uganda. 	<ul style="list-style-type: none"> Currently there is low development of quality infrastructure and limited demand for services. Extension of services is not planned in the near future due to limited availability of funding. Renewable energies and energy efficiency is a focal area of BMZ in Uganda.
Energy Efficiency	<ul style="list-style-type: none"> Energy efficiency has no central priority in Uganda's present energy policy. Currently, there is a strong need to increase the efficiency of energy production and to reduce network losses. 	<ul style="list-style-type: none"> No priority in climate change context. 	<ul style="list-style-type: none"> Low quality infrastructure development status in metrology and testing. Standards as basis for labelling requirement currently under revision. Increase in demand for services is expected.
Meteorology	<ul style="list-style-type: none"> Uganda National Meteorology Authority (UNMA) is important for providing information to most of the key sectors and to the rural farming population. There is a need for a) digitizing climate data, b) increasing the network of weather stations and c) improving their maintenance. 	<ul style="list-style-type: none"> Within UNMA, there is a climate change unit working as "technical arm" of Uganda Climate Change Department. UNMA provides trimestral seasonal weather forecasts to decentralized government structures across the whole country and monitors the success rate of forecasted weather events. 	<ul style="list-style-type: none"> Some basic services offered. Sector is actively looking for international cooperation partners. Potential for stronger collaboration between meteorology and metrology as contact is already established.
Agriculture	<ul style="list-style-type: none"> Even though the vast majority of the Ugandan population depends on agriculture as the main source of its livelihood and income, development of the sector appears not to be important for the government's economic growth strategy (but is rather linked to the poverty reduction strategy). 	<ul style="list-style-type: none"> Agricultural soils of the country are considered rich and fertile, but climate change is forecasted to lead to declining production levels. Need for improved soil and land management, climate-robust seeds, high quality pesticides and fungicides. 	<ul style="list-style-type: none"> Basic quality infrastructure services already offered. Clear priority for improvement and development of additional services. Importance of services in the climate change context well understood. Agricultural and rural finance is a focal area of BMZ in Uganda.
Water	<ul style="list-style-type: none"> Uganda's water sector faces enormous challenges caused by a) the high rate of population growth, b) increasing urbanization, c) pollution of water sources, d) degradation of ecosystems and e) an overall lack of enforcement of water regulations. A national Strategy for the development of the water sector is in place. 	<ul style="list-style-type: none"> Climate change in Uganda a) severely affects water regimes and water resources, b) leads to environmental degradation along with negative social and economic consequences for the population, c) damages the supply infrastructure and d) deteriorates water quality and quantity. Climate change could potentially undermine Uganda's successes made in providing water to its population. 	<ul style="list-style-type: none"> Basic quality infrastructure services offered. Some remaining gaps and opportunities for improvement (e.g. accreditation of testing laboratories). Water and sanitation is a focal area of BMZ in Uganda.
Human Health	<ul style="list-style-type: none"> Achieving Vision 2040 of a healthy and productive population by providing Universal Health Coverage is a key priority of Uganda. Successes were made in terms of reducing maternal mortality and under-five mortality. 	<ul style="list-style-type: none"> Climate change has significant health implications for Uganda. Diseases which are already endemic in some places are expected to proliferate in regions where they have been sporadic so far. There is potential for diseases which are not yet established in Uganda to be introduced because of climate change. Climate change threatens human health through its effects on food security and malnutrition. 	<ul style="list-style-type: none"> Some basic services offered. Limited demand for quality infrastructure services.
Status of relevance/priority/opportunities	High	Medium	Low

Table 24: Relevance, priorities and opportunities for quality infrastructure development in relation to climate change in Uganda

2. Uganda's background

Political and economic context of Uganda

Following decades of power struggles after Uganda gained its independence from Britain in 1962, President Yoweri Museveni took over the country's leadership in 1986. Since then, Uganda has rebounded from civil war and economic catastrophe to become relatively peaceful, stable and prosperous. The impoverished northern districts, where until 2009 the Lord's Resistance Army operated under rebel leader Joseph Kony, which have been the scene of much ethnic conflict, have been the focus of reconstruction since 2009 (GIZ 2017).

Uganda needs a renewed growth momentum to achieve its vision of attaining middle-income status by 2022 – this, however, will only be achievable if the economy can grow at annual rates above 10% per annum (Muloni 2012). Since the late 1990s, the country has experienced sustained economic growth averaging 7% annually. Since 2010, growth rates have been lower but remained reasonably positive. However, despite economic growth stemming mainly from its natural riches (Uganda has substantial natural resources including oil, natural gas, copper and cobalt), the country's growth has not resulted yet, nor reflected, improvement in the livelihoods of its people. The United Nations categorize Uganda as a least developed country (LDC). Its Human Development Index (HDI) is ranked below its neighbours Kenya, Rwanda and Tanzania and in fact the index is below the Sub-Saharan Africa average of 0.502 (EPRC 2017).

The recent annual economic growth rate of 3.6%, coupled with high population growth and rising inflation aggravates the situation for the almost 37 million Ugandans. Against this background, it is likely that Uganda is facing poor prioritization of resources. Having plenty of fertile soils and land, agriculture provides jobs for more than 80% of the workforce, making it the single most important source of income. However, agriculture has remained at rather low values in terms of contribution to Uganda's GDP (22.5%). In terms of subsistence crops, small-scale and rain-fed farming and livestock production represent the majority of Uganda's agricultural output while, in terms of cash crops mainly being produced for the export market, the country produces coffee, cotton, tea, tobacco and sugarcane.

Evidence of climate change in Uganda

Effects of climate change and relevant hazards

Climate change is expected to adversely impact Uganda by a change in temperature of over 2°C by the year 2030 while the start of rainy seasons may change by 15 to 30 days and the length of seasons by 20 to 40 days. December, January and February are expected to become wetter. Extreme weather conditions might increase, further exacerbating frequent and severe droughts, floods and unpredictable patterns in rainfall (USAID 2013).

Climate change impacts are therefore likely to exacerbate some existing stresses, for example land degradation. The main impacts however are likely to be (Hepworth 2008:12):

- Increased food insecurity;
- Shifts in areas affected and increased incidence in some areas of diseases, such as dengue fever, malaria and water-borne diseases associated with floods;
- Elevated rates of erosion and land degradation because of increased mean rainfall or higher intensity events;
- Greater risks of flood damage to infrastructure, property and settlements;
- Shifts in the viable area for coffee cultivation with increased temperature;
- Reduced output in the maize crop;
- Reduction in the grazing potential within the cattle corridor;
- Biodiversity loss and extinctions as niches are closed out by temperature increases and pressure on natural resources;
- Implications for Lake Victoria levels and Nile flows.

Impacts of climate change on different areas

Climate change is expected to have severe consequences in all sectors, specifically in the agricultural and water sectors (USAID 2013).

Agriculture and food security: The agricultural sector is forecasted to be particularly susceptible to the impacts of climate change. With agriculture being mainly rain-fed in Uganda, absence of rain can lead to crop failure, food insecurity, famine, mass migration and result in negative national economic growth. Examples cited in the report

were recent poor farm yields and occurrence of pests and diseases, mainly caused by a shift of inter-annual and seasonal precipitation patterns. This is all the more important as agriculture in fact remains the first opportunity to achieve sustained economic growth and well-being of Uganda's poor population, which is predominantly active in the farming sector. However, even without climate change, the agricultural sector is struggling to cope with outdated production methods and the threats of ongoing deforestation and soil depletion.

Water: Climate change in Uganda severely affects water regimes and water resources. This leads to environmental degradation along with negative social and economic consequences for the Ugandan population. Damages of supply infrastructure, same as deteriorating water quality and quantity, are expected for the water sector. Furthermore, climate change could potentially undermine Uganda's successes made in providing water to its population (with 64% rural access and 72% urban access in 2014; while at the same time, water supply is lacking behind especially in the northern and eastern parts of Uganda). However, even without climate change representing a new layer of risk, the country's water sector already by now faces enormous challenges caused by the high rate of population growth, increasing urbanization, the pollution of water sources, the degradation of ecosystems such as forests and wetlands and an overall lack of enforcement of water regulations (IWaSP 2017).

Energy: Uganda is heavily dependent on biomass and hydroelectricity for energy production. At the same time, changes in average water (lake) levels will affect the availability of water for hydro-electric power production (Hepworth 2008). Without major investments made in other sources of energy production, including renewable ones, Uganda's energy sector will remain heavily dependent on favourable climate conditions. Decreasing hydroelectricity generation could lead to higher prices and an even greater use of fossil fuels, which increases greenhouse gas emission even further.

Human Health: Climate change has significant direct and indirect health implications for Uganda. Malaria is endemic in 95% of Uganda and higher temperatures will allow it to proliferate in regions where it has been sporadic. Climate change is also expected to increase the prevalence of many other endemic and imported infectious diseases, such as soil-transmitted helminths, trachoma and

waterborne diseases such as cholera and typhoid. Other diseases which Ugandans experience in a more localized or epidemic nature include plague, sleeping sickness and yellow fever. Additionally, there is also potential for diseases which are not yet established in Uganda to be introduced because of climate change, such as dengue fever, chikungunya and Rift Valley fever. Finally, climate change threatens human health through its effects on food security and malnutrition (Zinszer 2014) and through the direct physical effects of natural disasters.

Institutional and policy framework for climate change adaptation and mitigation

In Uganda, the policy framework for climate change mitigation and adaptation to climate change is mainly based on the goal to "ensure a harmonised and coordinated approach towards a climate-resilient and low-carbon development path for sustainable development (...)" (Maitkut 2014). The main objective is to "ensure that all stakeholders address climate change impacts and their causes through appropriate measures, while promoting sustainable development and a green economy" (ibid.).

A Climate Change Unit (CCU), now known as the Climate Change Department, as one of the national measures to ensure action was created in 2008, directly under the office of the Permanent Secretary within the Ministry of Water and Environment. The main objective for the establishment of the CCU is to strengthen Uganda's implementation of the UNFCCC and its Kyoto Protocol.

The key functions of the Climate Change Department are, among other areas:

- To play the role of National Focal Point for the UNFCCC and its Kyoto Protocol;
- To coordinate national climate change actions (mitigation and adaptation) in different sectors, including the creation of awareness among various stakeholders;
- To monitor the implementation of mitigation and adaptation activities and progressively update the Ugandan Government, the Uganda population and the COP to the UNFCCC;
- To provide technical support to the Permanent Secretary of the Ministry of Water and Environment to enable him/her to coordinate climate change issues more effectively as part of the mandate of the Ministry;

- To initiate the development and review of appropriate policies, laws and programmes necessary to ensure effective implementation of adaptation and mitigation activities in Uganda.

Considering the cross-sectoral nature of climate change interventions and the broad functions and tasks under the mandate of the Climate Change Department, strategic frameworks have been created, including the Climate Change Policy Committee and the Inter-Institutional Climate Change Technical Committee:

- Climate Change Policy Committee (CCPC): The CCPC, chaired by the Permanent Secretary Ministry of Water and Environment, has 14 members from various public and private institutions. The Commissioner of the Climate Change Department is the Secretary to the Committee. The main functions of the Climate Change Department are:

- To offer policy guidance to the Ministers of Water and Environment on matters related to climate change;
- To assist the Minister of Water and Environment to take decisions on carbon finance activities in her capacity as the CDM Designated National Authority (DNA) for Uganda;
- To reconstitute themselves into a Project Steering Committee to guide implementation of climate change projects in the Ministry;

- Inter-institutional Climate Change Technical Committee (ICCTC): The ICCTC is constituted by the Climate Change Desk Officers from various public and private institutions. Its main functions include:

- Bridging the gap between the Climate Change Department and the respective institutions, facilitating exchange of information and by focusing efforts on:
 - Technical capacity of Climate Change Department, including through increased numbers and skills of personnel as well as equipping the office and scaled up facilitation of operations;
 - Development of a climate change policy and mainstreaming guidance documents to facilitate harmonized national action;
 - Development of climate change awareness raising

materials and the associated strategic awareness creation at all levels;

- Piloting and rolling out National Adaptation Programme of Action (NAPA) implementation;
- Conducting climate change-related research.

Climate change mitigation

In terms of climate change mitigation, the Climate Change Department under the Ministry of Water and Environment serves the following purposes:

“To promote and cooperate in the development, application and diffusion, including transfer of technologies, practices and processes that control, reduce or prevent anthropogenic emissions of greenhouse gases in all the relevant sectors including energy, transport, industry, agriculture, forestry and waste management.”

(Ministry of Water and Environment CCD 2017)

Burning of renewable resources provides approximately 90% of the energy in Uganda (Wandera and Sanya 2015), though the government is attempting to become energy self-sufficient (Muloni 2012). Electricity access is currently below 5% in rural areas. While the country strongly depends of hydroelectricity for about 60% of its total power generation output, the whole power sector suffers from a shortage of generating capacity due to prolonged drought conditions, especially in the northern and north-eastern parts of the country.

Whereas in Uganda the Renewable Energy Policy of 2007 reinforces the government’s commitment to the development and utilization of renewable energy resources and technologies, little has been done to attract investment in this area, despite several opportunities in the sector (Muloni 2012). The overall aim is to make renewable energy a substantial part of the national energy consumption and increase its availability. It thus makes a case for stronger investment in the sector, while revealing the relevant aspects of the legal regime governing the sector and the challenge of the un-updated laws.

The government has put in place a comprehensive plan to address the current energy deficit and meet long-term energy needs. The plan is to enhance public-private partnerships in power generation and supply and the sustainability of the power sector.

The strategies include:

- Energy loss reduction in the power system,
- procurement of additional thermal generation capacity,
- energy efficiency/demand side management,
- renewable energy generation projects including small hydro plants,
- cogeneration in sugar mills and biomass-gasification plants,
- promotion of solar water heating in both homes and commercial enterprises, and
- construction of the Bujagali (250MW) and Karuma (150–200 MW) projects.

The long-term measures include development of four large hydropower sites, use of indigenous petroleum resources for thermal generation, interconnection of the regional power grid and the use of geothermal, peat and other renewable sources of energy.

Climate change adaptation

Uganda already developed its National Adaptation Programme of Action in 2007 (The Republic of Uganda 2007). A particular focus for adaptation action has been put on agriculture and on water resources, also as cross-cutting topics. All in all, eight intervention areas are prioritized in the National Adaptation Programme of Action: 1) Land and land use, 2) Farm forestry, 3) Water resources, 4) Health, 5) Weather and climate information, 6) Indigenous knowledge documentation and awareness creation, 7) Policy and legislation and 8) Infrastructure.

In terms of adaptation to climate change, one of the main functions of the Climate Change Department is:

“To prepare for adaptation to the adverse effects of climate change by guiding the development of elaborate, appropriate and integrated plans for key sectors as well as the rehabilitation of areas affected by drought, desertification and floods.”

(Ministry of Water and Environment CCD 2017)

In Uganda, the Climate Change Department plays a central role for the planning and coordination of international cooperation activities related to priority areas identified under the National Adaptation Programme of Action. Presently, four ‘implementing partners’ have been acknowledged by the Climate Change Department to pilot

the implementation of the priority areas identified under National Adaptation Programme of Action. These include the Agency for Sustainable Development (ASDI), the Development Network of indigenous voluntary Associations (DENIVA), the Production Departments of Nakasongola District Local Government and Bundibugyo District Local Government.

Most of the ministries represented in the National Council on Climate Change are in the process of elaborating, or have recently elaborated, guidelines for dealing with the impacts of climate change within the framework of their respective jurisprudence. The elaboration of such guidelines remains the task of individual, sector-specific Focal Points and/or Desk Officers.

The ultimate goal is to develop sector strategies for climate change, yet this process has not started yet in most of the line ministries. Related to these strategies, the Ministry of Agriculture has already started to draft a sector-related national adaptation plan while the Ministry of Health is presently in the phase of preparing health-related vulnerability analyses from the national down to the local level in order to better understand the nature and scope of climate change-related risks.

Even though the relevance of climate change to unfold its negative impacts on sectoral development goals is clear to the vast majority of actors, discussions on how to approach and respond to climate change have not involved aspects of quality infrastructure and quality assurance yet. Subordinated entities, such as quality assurance departments of line ministries, research institutes and laboratory systems are widely kept out of the political discussion.

Considering the prevalence of climate- and climate-related hazards in the Ugandan farming sector in particular, stakeholders are aware of an increasing need for elaborating approaches for dealing with quality challenges: In recent years, crop diseases have increasingly caused damages and destroyed crops while pesticides and fungicides have turned out to be inefficient and not be of necessary quality.

In the context of multilateral and bilateral cooperation in Uganda, activities are manifold in all domains covered by the study presented here, including energy (efficiency), agriculture, water, human health and meteorology – including a vast range of climate change-related projects.

The Climate Change Department under the Ministry of Water and Environment of Uganda monitors all cooperation programmes, projects and interventions of different scope and scale related to climate change mitigation and adaptation to climate change: Currently, 275 projects have been implemented – or are in their implementation phase – by various multilateral and bilateral international cooperation partners and NGOs.

Within this context, there is a clear opportunity for fostering the position and the role of quality infrastructure services and the possibilities it provides to relevant government institutions concerned with climate change.

Multilateral and bilateral cooperation activities

In the National Climate Change Implementation Strategy of Uganda, policy goals and their interrelated objectives are addressed. The Strategy provides a basis for the coordination and cooperation of, and between, multilateral and bilateral donor and funding organizations supporting Uganda's response to challenges posed by climate change.

Multilateral cooperation

United Nations Development Programme (UNDP): UNDP has been active in Uganda for more than four decades. Relevant fields of cooperation and support include renewable energies and energy efficiency, agriculture and meteorology. Three main programmes of UNDP relevant in the context of the study in Uganda are called “Low Emission Capacity Building”, “Adaptation to Climate Smart Agriculture Practices” and “Strengthening Climate Information and Early Warning Systems” (UNDP 2017).

World Bank Group (WBG): Major programmes are currently implemented in areas related to renewable energies, energy efficiency and human health. Among WBG initiatives relevant in the context of this study is the “Uganda Rural Electrification Programme” which was approved in its third phase in 2016 and has a funding volume of USD 13.7 million, the Grid Expansion and Reinforcement Project (GERP) which was also approved in 2016, with the objective of increasing the availability and efficiency of bulk electricity supply in northern Uganda and the West Nile region with a total cost of USD 127.3 million. Additionally, the Reproductive, Maternal and Child Health Services project which has a duration of five years until mid-2021 aims at improved utilization and better access to essential health services with a focus on reproductive, mater-

nal, new-born, child, but also adolescent health service in target districts. The total project cost is USD 140 million (World Bank 2017).

Bilateral cooperation

In 2007, the German Federal Ministry for Economic Cooperation and Development (BMZ) declared Uganda a priority country for development cooperation. At the bilateral negotiations between the Ugandan and German governments held in Kampala in May 2013, both sides agreed that this cooperation should focus on three priority areas:

- Renewable energies and energy efficiency
- Sustainable economic development/rural and agricultural finance
- Water and sanitation

It was also agreed that good governance and adherence to human rights, including the rights of vulnerable groups and sexual minorities, were fundamental principles for Ugandan-German development cooperation.

Further projects are also ongoing in the areas of transparency and accountability, climate change mitigation, the preservation of peace in the country's northern regions and capacity development for evaluation and governance statistics.

German Society for International Cooperation (GIZ): The water and sanitation, energy and agricultural sectors comprise most of GIZ's funding volume in Uganda. Relevant GIZ activities in the agricultural sector focus on a project on “Adapting agricultural cultivation methods of the Karihojong to climate change in the Karamoja sub-region”, while activities in the water sector are focussed on and around the programme “Development of the urban water and sanitation sector”. In relation to renewable energies and energy efficiency, GIZ currently implements three major projects, namely “Maximising the benefits of access to energy”, “Promotion of renewable energy and energy efficiency (PREEEP)” and “Global Carbon Market – Uganda”.

German Development Bank (KfW): KfW supports Uganda in areas relevant to the study presented here, including a) drinking water supply and sewage disposal and b) “GET FiT” which is a programme aimed at further development of renewable energies.

3. Analysis of thematic focus areas

Renewable energies and energy efficiency

Uganda still faces problems in providing universal energy access to its population. Presently, only 15% of the population is connected to the power grid. In rural areas, the figure drops to 6%. While demand is growing steadily by around 8% per annum, as population increases and economy grows, production and transmission capacities are stretched. According to KfW, there is also a strong need to increase the efficiency of energy production and to reduce network losses.

Burning of renewable resources provides 90% of the energy supply in Uganda. While much of the hydroelectric potential still remains untapped, the government decision to expedite the creation of domestic petroleum capacity coupled with the discovery of large petroleum reserves in northern Uganda holds the premise of a significant change in Uganda's status as an energy-importing country (Grøtnæs et al. 2014).

During the past years, Uganda has been employing a number of different strategies to expand its electricity supply. There is general awareness that the lack of electricity slows down social development and economic growth on the one hand, while widespread use of wood and charcoal accelerates deforestation.

Besides hydropower as a main source for power generation, stronger focus has been put particularly on solar power and energy from the sustainable use of biomass. For promoting the further development of renewable energies, regulatory barriers for private investments are currently in the process of being overcome. Structurally, Uganda's energy sector is increasingly well positioned. The privatization of electricity production and distribution has already led to some initial successes (KfW 2017).

Meteorology

In Uganda, the institution in charge of meteorological services is the Uganda National Meteorology Authority (UNMA), formerly the Department of Meteorology under the Ministry of Water and Environment. UNMA is a semi-autonomous government institution for weather and climate services and a focal institution to the IPCC. With a staff of 192, its mandate is "to monitor weather and climate as well as provide weather predictions and

advisories to the Government and other stakeholders for use in sustainable development of the country" (UNMA 2017q).

UNMA is responsible for establishing and maintaining Uganda's weather and climate observing stations network, collection, analysis and production of weather and climate information, including warnings and advisories. The key sectors served by UNMA include transport (mainly aviation and marine), defence, agriculture, disaster preparedness, environmental and water resources management, tourism and construction industry. UNMA accomplishes these responsibilities in collaboration and coordination with the World Meteorological Organization (WMO) and its member states and other global and regional meteorological centres.

The Meteorology Authority consists of five strategic departments. Within the institutional structure, Applied Meteorology, Data & Climate Services is concerned with monitoring and assessing long-term climatic trends in the country and in the region. Within the department, there is also a climate change unit. Climate data are organized along 14 meteorological zones in Uganda. Data range back to 1896, with most of the data (>60%) being still "on paper". Supported by GIZ, data are continuously becoming digitized.

The department also provides for Seasonal Climate Outlooks which are published on a trimestral basis and handed over to all parliament members. These publications are translated into 35 local languages. Seasonal Climate Outlooks are prepared by UNMA staff in cooperation with IGAD in Nairobi, Kenya and by sharing data and information at the regional and biannual Great Horn of Africa Climate Outlook Forum.

Meteorological information is mainly gathered through 80 weather stations (48 are manual and 32 are automatic). It is obvious that the stations network was severely impacted by twenty years of civil war and a severe lack of maintenance during that time – until the 1970s, the stations network consisted of more than 1,000 weather stations. For the time being, the priorities of the Government of Uganda for the meteorological sector are a) to continue digitizing historic climate data, b) to increase the network of weather station, c) to improve management and maintenance services for the country's network of weather stations and d) to develop cooperation and exchange with

international partners and meteorological service departments.

Water

Over the last decade, Uganda has made great strides in providing water to its population (with 64% rural access and 72% urban access in 2014) (IWaSP 2017:1). However, the Government of Uganda already sought to achieve its national goal of providing 100% of its urban population with an improved water source and access to safe, hygienic sanitation facilities by 2015. In terms of sanitation, 84% have access to sanitation facilities which are often of questionable hygiene. Only 6% are connected to a sewerage system.

Urban Uganda is still characterized by inadequate sanitation services and high population growth rates. Increasing urbanization adds to the fact that, especially in poor urban areas and informal settlements, access to sanitation is inadequate and collection, transport as well as treatment of faecal sludge remain great challenges (GIZ 2016c:1).

The situation is even more dramatic in rural Northern and Eastern Uganda. Twenty years of civil war and ethnic conflict have resulted in a severe lack of water infrastructure and sanitation facilities, which means that people often fall sick and cannot look after their families. According to official data, twice as many people suffer from diarrhoea in Northern and Eastern Uganda than in other regions. Diarrhoea leads to malnutrition and contributes to a high infant mortality rate (KfW 2016a:2). Just under one third of the urban population has access to clean drinking water, compared to more than 70% within the whole country (KfW 2016a:1). In addition, the lack of access to safe drinking water is a threat to food security (KfW 2016a:1).

It remains clear that the sector needs to improve further on its institutional, regulatory and managerial capacities (GIZ 2016a:1). Indeed, the Government of Uganda initiated reforms in the urban water supply and sanitation sub-sector with the long-term objective of providing sustainable and affordable water supply and sanitation services to all segments of the population living in urban areas. The major elements of these reforms were the commercialization of water supply and sewage service operations and the promotion of private sector participation in delivery of services which follows the regime of regulation by contract (GIZ 2016b:1).

Large and highly expensive investments into infrastructure are needed, such as an ongoing programme for providing water for two million more people in Kampala by 2025 than today. In reality, this means that the water treatment capacity must be increased by a total of 165 million litres per day. This is being done by the rehabilitation of existing water plants on Lake Victoria and by constructing a new water treatment plant in the east of the city (KfW 2016b:2). This is even more necessary since other existing sewage treatment plants are already over 70 years old and no longer have sufficient treatment capacity (KfW 2016c:1).

Agriculture

According to the 2016 Agriculture Sector Strategic Plan (Ministry of Agriculture, Animal Industry and Fisheries 2016), the agricultural sector average growth rate was 2.2% between 2010 and 2015. It was lower than the average annual GDP growth rate of 5.2% during that time and the average annual population growth rate of 3% over the same period. Overall, the contribution of the agricultural sector to GDP declined from 25.4% in 2010 to 23% in 2015. Agriculture has remained at rather low values in terms of contribution to Uganda's GDP, but is the single most important source of income as it provides jobs for more than 80% of the workforce (with small-scale and rain-fed subsistence farming and livestock production representing the majority of Uganda's agricultural output).

Gains were especially made in the production of five major commodities (coffee, tea, cotton, cocoa and milk). Out of 16 major food crops, only five registered an increase in yields, i.e. maize, potatoes, beans, cow peas and sesame seeds, while cereals, sugarcane, root crops and bananas remained relatively stable – but some of them even declined in yields, particularly in some areas and regions. This means that even without climate change, the agricultural sector is struggling to cope with outdated production methods and the threats of ongoing deforestation and soil depletion. Other challenges include poor post-harvest handling and processing constraints; poor stakeholder coordination – including public-private partnerships; human resource challenges including inadequate staff, lack of training and poor equipment; poor markets and marketing infrastructure; and funding constraints.

Human Health

The Health Sector Development Plan for Uganda (Ministry of Health 2015), which sets the country's medium-term strategic direction, development priorities and implementation strategies, is the second in a series of six 5-year plans aimed at achieving Uganda Vision 2040 of a healthy and productive population which contributes to socio-economic growth and national development. The goal of this Plan is to accelerate movement towards Universal Health Coverage (UHC) with essential health and related services needed for the promotion of a healthy and productive life.

The achievements realized under the sector development plan include among others:

- The reduction in maternal mortality ratio from 438/100,000 (UDHS) live births in 2011 to 360/100,000 (WHS estimates) live births in 2014;
- The reduction in under-five mortality from 128/1000 live births in 2006 to 90/1000 live births in 2011 to 69/1000 (WHS estimates) live births in 2014 and the reduction of the infant mortality rate from 71/1000 live births in 2006 to 54/1000 live births in 2011 and 45/1000 (WHS estimates) in 2014.

The impact of all this has been an improvement in the life expectancy at birth in Uganda, from a low of 47 and 45 years in 2000/01 for females and males respectively, to 57 and 54 years in 2011, and estimated to have improved further since then.

HIV, malaria, lower respiratory infections, meningitis and tuberculosis still are estimated to cause the highest numbers of lost life years in Uganda. In addition to these major causes, the sector has faced challenges with new/re-emerging conditions which cause minimal burden but are significant public health risks, e.g. polio, hepatitis E & B, Ebola, Marburg virus and the idiopathic nodding syndrome.

With health infrastructure, physical access to health facilities (the proportion of the population living within 5 km of health facility) is currently at 72%. Despite this, there are also still major inequities in the availability of facilities, ranging from a low of 0.4 facilities per 10,000 citizens (Yumbe district) to a high of 8.4 facilities per 10,000 citizens (Kampala). A number of health facilities were renovated and equipped, though they still face the challenges

of inadequate and poorly maintained medical equipment. At the same time, the health workforce is still a key bottleneck for the appropriate provision of health services, with challenges in adequacy of numbers and skills, plus retention, motivation and performance challenges.

To date, the pharmaceutical sector has made an improvement in the availability of and access to Essential Medicines and Health Supplies from 43% in 2009/2010 to 63.8% in 2014/2015. There has been an increase in funding for medicines through both the Government of Uganda and donor streams from USD 92 million to USD 410 million (including USD 85 million for procurement of Long Lasting Insecticide Nets) over the same period, resulting in increased public confidence in the health system. However, the greater proportion (81%) of this funding was from Development Partners and largely skewed to HIV/AIDS, malaria and tuberculosis.

Against this background, the Plan sets key objectives to be attained during the 5-year period. These include: (i) contributing to the production of a healthy human capital for wealth creation through provision of equitable, safe and sustainable health services; (ii) increasing financial risk protection of households against impoverishment due to health expenditures; (iii) addressing the key determinants of health through strengthening inter-sectoral collaboration and partnerships; and (iv) enhancing health sector competitiveness in the region and globally.

In order to achieve these objectives, the strategy for the health sector will be to work towards strengthening the national health system including governance; disease prevention, mitigation and control; health education and promotion; curative services; rehabilitation services; palliative services; and health infrastructure development.

4. Quality infrastructure services in relevant areas

Quality policy, regulation and important institutions

As outlined in the Ugandan Standards Act of 1983, the Uganda National Bureau of Standards (UNBS) is the centralised body for quality assurance services in the country (Uganda Parliament 1983). UNBS covers standardization, metrology (including legal metrology), testing, inspection and certification. It is headed by the National Standards Council and amounts to over 300 employees.

QI status	Metrology	Standardization	Testing	Certification and inspection	Accreditation
Renewable energy					
Energy efficiency					
Meteorology					
Agriculture					
Water					
Human health					
Quality infrastructure development status	High	Medium	Low	No information	

Table 25: Development of quality infrastructure in relevant sectors

UNBS receives funding by the national government. According to the report of the auditor general, government funding amounted to approximately 12.5 billion Ugandan Shillings (UGX) (approx. EUR 3 million) in 2015, 80% of which was being used to cover staff salaries. In the same year, the bureau collected non-tax revenue (fees for calibration, laboratory testing, training and consultancy) of 7.8 billion UGX (EUR 1.8 million). (Office of the Auditor General Uganda 2015). The organization's own financial resources generated through the provision of services in the different areas are steadily increasing and now (mid-2017) make up approximately 50% of the budget. Nevertheless, the current levels of funding are insufficient to support the needed development of additional services, the procurement of the necessary equipment and active participation in international organizations.

The Bureau has two directorates and various support functions. The Standards and Compliance Directorates carry out the main quality infrastructure functions and are supported by the following six units: management and financial services, public relations and marketing, quality management, procurement and disposal, the legal office and the internal audit division. It has recently undergone internal restructuring, resulting in the following departments under the Standards Directorate:

- Standards Development Department
- National Metrology Institute
- Testing Department

- Certification Department
- Training and Consultancy

The Compliance Directorate comprises the following:

- Legal Metrology Department
- Imports Inspection Department
- Surveillance Department

The restructuring was carried out in preparation for a more radical reform of the national quality infrastructure and should ultimately facilitate a smooth splitting of the different quality infrastructure functions. Particular emphasis is put on the need to separate standards development from the regulatory function. The legal documents for the restructuring, including a national metrology bill that will establish a separate national metrology institute, have already been drafted and presented to parliament.

Parallely, a draft bill on accreditation and conformity assessment has been submitted to government and is expected to be approved by the end of 2017. With this, the establishment of a National Accreditation Body under the Ministry of Trade, Industry and Cooperatives can be completed. The foundations for this process were already laid through the creation of a National Accreditation Focal Point in 2012, as well as through the National Accreditation Policy published in 2014 (Ministry of Trade, Industry and Cooperatives 2014).

Moreover, a National Standards and Quality Policy has been adopted in 2012, based on which a strategic plan for quality infrastructure is under development (Ministry of Trade, Industry and Cooperatives 2012).

Metrology

Metrology department of UNBS

The metrology department of UNBS is the national metrology institute of Uganda. It offers basic calibration services for mass, volume and temperature. For these three measurements, quality management systems are in place and intercomparison measurements are carried out with other national metrology institutes of the East African Community (EAC). The mass laboratory is accredited by the South Africa National Accreditation System (SANAS); renewal of the accreditation will be required (SANAS 2011). Additional services are available in different areas, including pressure, flow, moisture, photometry and electricity. The metrology department has nine laboratories. Some services are offered in collaboration with the testing laboratories of UNBS (e.g. chemical metrology and electricity), which will be integrated into metrology when the organization is restructured, and with some sector-specific laboratories run by ministries (e.g. Ministry of Energy for petroleum). The metrology department's services are accepted by SANAS to provide traceability for Ugandan conformity assessment bodies which seek internationally recognized accreditation.

The metrology department itself has a total of eight employees who are sometimes supported by research assistants or interns.

It is a member of AFRIMETS (AFRIMETS 2017). Moreover, it is planned that the metrology department will join BIPM as an associate member when the necessary funds are available.

Legal metrology

UNBS is also in charge of legal metrology, which is regulated with the Weights and Measures Act Cap. 103 from 1965 and related amendments (ULII 1965). The five main legal metrology offices are located in Kampala, Jinja, Mbarara, Mbale and Lira. The department also has a Prepackage Control division and a Volume and Flow division (UNBS 2017). In total, it has approximately 40 employees who work throughout the country. UNBS' legal metrology

department is a corresponding member of OIML (OIML 2017).

The department verifies weights and weighing equipment including spring balances, platform scales, weights (class M2 and M3), automatic weighers and weigh-bridges. The Volume and Flow division verifies fuel dispensers, depot meters, dispensers and pressure gauges. Correct labelling and quantities in prepackaged goods are checked by the Prepackage Control division. Additionally, measures of length and electricity meters are verified. Expanding UNBS' services to the verification of water meters is under discussion (UNBS 2017).

Relevant metrological services offered by UNBS

In the thematic areas considered in this study, the following metrological services are of interest:

Renewable energy and energy efficiency

Basic metrological services in the area of electricity are available and the legal metrology department carries out verification of electricity meters. Specific services for renewable energies (e.g. calibration of pyranometers to determine solar irradiance) or energy efficiency of fridges and air-conditioning systems cannot be provided at the moment.

Meteorology

UNMA uses calibration services for thermometers and has also contacted UNBS for additional calibration services. So far, collaboration has been limited, as most equipment of UNMA is calibrated in-house by the Directorate of Station Networks and Observations and UNBS does not have the necessary equipment to calibrate advanced technologies. Nevertheless, stronger collaboration between the two institutions could be developed.

Agriculture

Agriculture is one of the focus areas of UNBS. The metrology department currently offers relevant services in mass and temperature. The improvement of moisture meter calibration was mentioned as a priority. This is relevant for many important crops for local consumption and export, including grains and coffee beans. In the area of chemical metrology, some services are offered in collaboration with UNBS' chemical testing laboratory (e.g. pH, purity of honey).

Water

For the water sector, UNBS provides services in volume. Moreover, UNBS has a test bench for water meters which allows the calibration of 0.5 to 2-inch meters. In some cases, the equipment has been adapted to calibrate larger meters. The National Water and Sewerage Corporation currently calibrates the water meters it uses itself. Third-party verification by UNBS is under discussion. For humidity measurements, UNBS owns calibrated humidity meters which are used to qualify the meters brought in by clients. Basic services are also available for pH and conductivity in collaboration with UNBS' chemical laboratory. Most services for this sector are currently not internationally recognized.

Human health

The metrology department receives medical laboratory equipment, such as timers and pipettes for calibration.

Standardization

The Standards Development Department of UNBS is responsible for standardization. At the moment, the department is responsible for both voluntary and "compulsory" standards. With the planned restructuring of the organization, the standard development and regulatory functions will be separated.

The Standards Development Department heads the current 18 national Technical Committees. Private actor involvement in standardization processes has been increasing over the years, as industry actors are gaining a better understanding of the use of standards and are recognizing their importance. Priority areas are agriculture-based trade-related products, steel, textiles and furniture, where the development of small and medium enterprises (for steel, textiles and furniture) is promoted by the government. Nearly 3,000 standards have been developed or adopted so far (UNBS 2016).

UNBS is a member of the ISO, where it participates in 26 and observes 18 Technical Committees (ISO 2017). It is also a member of the ARSO, as well as the EASC. Further, UNBS is the National Contact Point for the Codex Alimentarius Commission and National Enquiry Point for the WTO TBT agreement (UNBS 2016).

With regards to the thematic areas considered, the following can be highlighted:

Renewable energies

Standards for renewable energies are developed by the Technical Committee for electrotechnology. A number of specific standards for solar photovoltaic and solar thermal collectors have already been developed (UNBS 2016). The possibilities to conduct tests against these standards in the country are, however, very limited (see section "Testing" below).

Energy efficiency

Standards for energy efficient devices including light bulbs, refrigerators and motors are currently being reviewed. On this basis, it is planned to introduce a regulation for product labelling. The previously developed standards under an initiative of the United Nations Industrial Development Organization (UNIDO) in collaboration with other countries in the region (see section 3.1 on Kenya) were too stringent for local producers. Also testing against the standard requirements is a challenge, as for some devices necessary testing equipment is not available in Uganda (see section "Testing" below).

Agriculture

As mentioned before, agricultural products are one of the priority areas of UNBS. Over 800 of the nearly 3,000 available standards are related to agricultural produce. Additionally, standards for agricultural machinery and fertilizers are available. At the moment, there is only one standard for bio-pesticides but no standard for conventional pesticides (UNBS 2016). This is an area where improvement is needed, as it was mentioned that pest infestations are increasing due to altered weather conditions caused by climate change (also see the section on "Testing" below).

Water

Relevant standards for water quality are available. The development of national standards for the construction of water reservoirs is supported by the GIZ.

Human health

There is a Technical Committee for medical devices, but at the moment, only a limited number of standards for medical facilities and equipment are available (UNBS 2016). Next to standards developed under UNBS, the Ministry of Health has defined "Service Standards and Service Delivery Standards for the Health Sector". This publication of the Ministry of Health is thought to guide the public health sector in improving quality, safety and the reliability of its services (Ministry of Health 2016).

Testing

Uganda has a limited number of testing laboratories which are mainly run by ministries and universities. A laboratory network or association does not exist. Only a few testing laboratories are accredited: the chemistry and microbiology laboratories of UNBS, four laboratories of the Ministry of Health and some private ones. While several other laboratories are interested in internationally recognized accreditation, the necessary funds are often not available.

Private testing laboratories are mainly run by international conformity assessment providers such as SGS, Bureau Veritas and Intertek (Logistics Capacity Assessments Wiki 2017). Chemiphar is an example of a private laboratory with international accreditation by the Belgian Accreditation Body (BELAC) (Chemiphar 2017a). The laboratory carries out microbiological, chemical, physical-chemical and environment analyses, as well as seed, grain and pulse testing and also tests improved cook stoves (Chemiphar 2017b).

Important public laboratory facilities are the laboratories of UNBS and the Government Analytical Laboratories under the Ministry of Internal Affairs.

UNBS Testing Department

UNBS has four testing laboratories focussed on chemistry, microbiology, electricity, materials and engineering. The chemistry and microbiology laboratories are ISO 17025 accredited by SANAS. Their services are focussed mainly on food products and water. For microbiology, the following scopes have been accredited: staphylococcus aureus, salmonella, vibrio cholerae, escherichia coli, total plate count, total coliforms, yeast and moulds. The accreditation scope for chemistry includes the following:

- Calcium, potassium, sodium and metals for water
- Moisture content for honey
- Ash, moisture and protein content for cereal foods
- Metal detection in fruit and vegetables.

(UNBS 2017 b, c)

Government Analytical Laboratory Department of the Ministry of Internal Affairs

The government analytical laboratories were set up in 1927 and are seen as a reference for laboratory services in Uganda. There are two departments: quality and chemical verification, and criminalistics, both with four divisions.

They cover pesticide residues, water and environment, food and drugs, microbiology and bioterrorism on the one hand, and toxicology, forensics, fraudulent documents and digital fraud on the other. The department also offers some services in regional laboratories and is working on expanding these services. The accreditation process for the laboratories in Kampala has been initiated with KENAS.

For the selected thematic areas, the following information about testing capacities in Uganda is relevant:

Renewable energies and energy efficiency

Testing services for renewable energies and energy efficiency are very limited. Some tests are carried out by the electrical laboratory of UNBS. However, equipment is lacking for many tests. Performance tests of solar photovoltaic modules, for instance, are carried out using sunlight instead of a sun simulator. Climate chambers for testing the efficiency of refrigerators and air-conditioners, for example, are not available.

Meteorology

UNMA runs 80 manual weather stations and 32 additional automatic weather stations are being installed in collaboration with GIZ. This will increase the amount of available meteorological data in the future and, at the same time, increase the demand for calibration services (for example for temperature, humidity, pressure and wind speed).

Agriculture

A number of laboratories for food, pesticide and fertilizer testing are available and some laboratories are internationally accredited for such services. The National Agricultural Research Organisation (NARO) conducts soil analysis. Overall, however, testing capacities and capabilities for the agricultural sector could be improved. It was particularly pointed out that testing for active ingredients in pesticides must be increased. Negative experiences with new pests have been made in recent times probably due to altered climatic conditions which could not be controlled with applied pesticides as the active ingredient levels were too low.

Water

The accredited chemical and microbiological laboratories offer some testing services for the water sector. The National Water and Sewerage Corporation monitors water quality and the Directorate of Water Resource Develop-

ment under the Ministry of Water and Environment is responsible for the assessment of water availability and abstraction. The laboratories of both institutions are still lacking accreditation.

Human health

Compared with other sectors, the health sector has the most accredited laboratories, including the Central Public Health Laboratory, the medical testing laboratory of the National Tuberculosis and Leprosy Control Program and the Ebenezer Limited Clinical Laboratory – all three accredited by SANAS (SANAS 2017). The National Drug Authority tests drugs and devices.

Certification and inspection

Certification and inspection are mainly carried out by government institutions to confirm compliance with compulsory standard requirements or regulations.

As outlined in the Certification Regulation 1995, UNBS carries out product certification to ensure that safety and quality requirements defined in compulsory national standards are met. When this is the case, the product is labelled with the Uganda Standards Certification Mark, also referred to as the quality and safety mark (UNBS 2017d). In the policy development for “buy Uganda build Uganda” it was identified as a weakness that the certification process is costly and laborious and that it is difficult for local micro, small and medium enterprises to comply with requirements (Ministry of Trade, Industry and Cooperatives 2014b).

UNBS also offers systems certification for:

- Food Safety Management Systems (US-ISO 22000:2005)
- Hazard Analysis Critical Control Points (HACCP) Systems (US 130:1999)
- Quality Management Systems (US-ISO 9001:2000 and 9001:2008)
- Environmental Management Systems (ISO 14000)
- Occupational Health and Safety Management Systems (ISO 18001) (UNBS 2017e)

Inspections of imports to Uganda are carried out at the point of entry and in some cases, additional measures such as a Pre-Export Verification of Conformity (PVoC) or destination inspection are required and a Certificate

of Conformity (CoC) needs to be issued. In these cases, UNBS collaborates with international conformity assessment bodies such as Intertek, SGS and Bureau Veritas (CMA CGM 2013).

With regards to the thematic areas considered in this study, the following information is of interest:

- In the area of energy efficiency, electric appliances are inspected to prevent inefficient products from entering the market. Very inefficient refrigerators, for example, are banned. Furthermore, for renewable energies, components are inspected, and substandard quality products are seized and eliminated. In 2016, for example, 1,090 business outlets were inspected and goods worth 6 billion UGX (EUR 1.4 mio.), including solar panels, batteries, compact fluorescent lamps and blenders were destroyed (UNBS 2017f).
- Food products and agricultural equipment as well as agrochemicals undergo inspection and certification according to national requirements. The Ministry of Agriculture carries out seed certification to ensure the quality of seeds used. Moreover, the Agricultural Chemicals Board carries out inspection on pesticides. However, due to limited capacities often it is merely a visual inspection, which has resulted in substandard-quality products being sold.
- For drinking water, compulsory national standards need to be met and companies are required to undergo certification by UNBS. The National Water and Sewerage Corporation is certified in accordance with ISO 9001:2008.
- For medical supplies in the human health sector, the National Drug Authority is in charge of quality assurance for drugs and medical devices. In addition to tests upon arrival, factory inspections also are carried out.

Accreditation

Accreditation-related matters are currently handled by the National Accreditation Focal Point (NAFP), which was established in 2012 under the Ministry of Trade, Industry and Cooperatives. The set-up and development of the NAFP has been supported through the Quality Infrastructure and Standards Programme (QUISP) in collaboration

with the Swedish International Development Cooperation Agency (SIDA).

The NAFP collaborates with KENAS and has approximately 40 trained assessors for laboratory accreditation in accordance with ISO 17025 and about 20 assessors for the accreditation of inspection bodies in accordance with ISO 17020.

As mentioned above, the establishment of a National Accreditation Body is underway. It is planned to focus on services which can complement the partner organization KENAS. A challenge will be to generate sufficient demand for accreditation services in Uganda and neighbouring countries.



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