Digital Africa: Understanding the Next Steps in Water Governance

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Introduction

Rapid urbanization, climate change, foreign direct investment, and demographic and population changes have reshaped the African continent over the last half century. At the core of these changes has been water. While abundant in some regions, water is often scarce or mismanaged across the continent. In order to better understand future water management on the continent, we have examined the intersection between water, government, and data via four case studies on: Morocco, Nigeria, Kenya, and Egypt. Urbanization, the digital economy, agriculture, and water, sanitation, and hygiene (WASH) are all examined.

While water risk is heterogeneous, it is amplifying and spreading across the world, and in particular along equatorial regions where climate change is most pronounced. Given the particularly chronic nature of water risk in Africa, a deeper understanding and greater level detail of the hydrologic and associated socioeconomic conditions is necessary and urgent. In addition, understanding the intersection between water, governance, and data in Africa, and where investments in water can have the most impact and chances of success is vital. Future advancements in water management will require better data and good governance, by focusing on digital trends in addition to traditional metrics are water management, we can better identify inflection points where interventions and/or investments can better amplify existing on-the-ground resources.

Approach

To gain a better understanding of water risks across Africa, we screened the four sub-regions of North Africa, East Africa, Sub-Saharan & Western Africa, and Southern Africa. Through the initial scan, we narrowed the potential countries to Egypt, Kenya, Morocco, and Nigeria for the case studies. We broadly analyzed three indicators of water risk: governance risk, physical risk, and infrastructure risks in the regions. All of three metrics contain quantitative indicators but are primarily qualitative in nature. In addition, we examined how data and the digital capabilities on the continent play a role in water and water-risk management, highlighted the rate of urbanization, reviewed the current situation in WASH, and took into account the economic and human effect of the COVID-19 epidemic.

Information on the four countries is included in this report. The report concludes with an analysis of trends and opportunities in digital water and areas to explore additional investment or interventions.

Definition of Water Risk Indicators

Governance issues are defined as risks associated with the laws and politics surrounding water delivery. The overall functionality of the government at various levels of administrative unit are analyzed. The government's ability to secure funding, enforce existing laws, and plan

for the future also played a role in this metric. Regional demographic and population changes are taken into consideration: has the government planned for future growth in their water delivery plans, for example. A government's ability to plan for climate related events also plays a role in this metric.

Physical water risks are defined as risks associated with the naturally occurring quantity and quality of water. A region with a high physical water risk score may be experiencing shortages due to overexploited aquifers, changes to surface water sources, or drops in water quality due to naturally occurring events (salinification). In addition, areas prone to drought or floods will be ranked as having a higher physical risk. The effects of climate change are also captured in this metric.

Infrastructure health risks are defined as risks associated with the storage, treatment, and delivery of water. Regions and municipalities with high Non-Revenue Water (water lost to infrastructure systems) are ranked as higher risk regions. In addition, a region's ability to treat incoming water for human and business consumption is also considered. Finally, this metric also captures the ability of wastewater treatment systems to handle regional demands and takes into consideration the age of all existing infrastructure. The area's capability to store water, especially during drought or floods, also played a role in the assessment.

Case Study: Nigeria

Nigeria is the most populated nation in Africa, with one of the largest economies on the continent, and has a fast-growing urban population. The country's high growth rate and size means that water delivery and sanitation systems are constantly playing catch-up to the expanding population. Nigeria's geography and geopolitical structure are primarily driven along a north-south divide, with the current government led by President Muhammadu Buhari, hailing from the northern region. This will likely flip after the election of 2023.

The country is driven by a vast, young urban population and has a strong entrepreneurial spirit. The drier north's water and sanitation situation is governed by the weather patterns of the Sahel region, while the southern tropical region is much wetter, containing the Niger Delta, one of the largest river deltas in Africa. The economy is driven primarily by the agriculture, services, and oil sectors, but the national government relies primarily on oil and gas revenue for its operating budget.

COVID-19

Nigeria reported its first COVID-19 case in February 2020 and is now facing a weakening economy, mostly due to the decreased demand of oil. With oil and gas accounting for an estimated 90% of total export earnings, real GDP is expected to contract between 4.4% and 7.2%. The pandemic has had a devastating economic effect on the population, with an estimated 10 million people facing the potential of slipping into poverty.[1]

Governance Risk

Nigeria's government is primary dominated by two political parties, the People's Democratic Party (PDP) and the All Progressives Congress (APC), which is aligned along a north-south divide. The post-colonial period, beginning in the 1960s, saw a civil war from 1967–1970 and military rule with minor democratic periods until 1999. Since 1999, the nation has mostly stabilized and seen democratically elected incumbent losses without a major conflict, although minor civil strife around elections in the nation remains a problem. Traditionally, the nation rotates presidencies between the north and the south every eight years.[2]

The north-south division is driven by ethnic,

1   African Development Bank. (2020). African Economic Outlook 2020: Supplement Amid COVID-19.

2   Council on Foreign Relations (2011). Nigeria: "Credible" Elections Reinforce the Divide
     https://www.cfr.org/blog/nigeria-credible-elections-reinforce-divide

religious, and geographic considerations, with the largely arid north being primarily Muslim and favoring the APC, and the mostly wet south, primarily made up of Christians, being dominated by the PDP. The three largest ethnic groups, the Hausa-Fulani, Yoruba, and Igbo, tend to dominate regional and national politics, but the nation has over 250 distinct ethnic groups. The current president, Muhammadu Buhari is from the APC party. A military veteran, he previously ruled the country after a military coup from 1983-1985. He will be facing term limits in 2023, and the next election will likely see two candidates from the south.[3]

Nigeria is by far the most populous country in Africa and faces a number of challenges due to ethnic and religious divisions. In addition, Boko Haram is active in the northeast corner of the nation, further complicating the nation's situation. The national government is primary funded by oil and gas proceeds, even though oil and gas only made up 9% of the nation's GDP in 2018[4]. As a result, fluctuations in oil and gas prices, such as occurred with COVID-19, create particular problems for the national government's ability to fund itself.

As a result of the large dependence on groundwater and large river systems, the major water governing bodies are effectively divided between surface and groundwater, and rural and urban management. At a national level, the Federal Ministry of Water Resources is tasked with providing safe access to water for all and overseeing most sub-agencies. The Nigeria Hydrological Services Agency (NIHSA) and Nigeria Integrated Water Resources Management Commission (NIWRMC) assess and regulate water resources, respectively. Rural water management falls mostly under the Ministries of Water Resources and their Rural Water Supply and Sanitation Agencies

(RUWATSSAN) and the River Basin Development Authorities. State water boards are responsible for direct management of water resources at the state level but take direction from the Federal Ministry and interact with local governments, especially concerning rural water access.[5]

Physical Risk

The nation has vast water resources, with the Niger and Benue rivers culminating in the Niger Delta in the south. It also has large groundwater reserves, and most of the nation's water resources are a mix of surface water and groundwater sources. Pollution due to the oil and gas industry has been a historic problem for the nation, but international pressure driven largely by massive failures by Royal Dutch Shell and other international oil and gas companies has helped drive a movement to clean and to protect the delta[6]. Nonetheless, pollution from the industry remains a large problem.

Climate change is expected to alter weather patterns in southern Nigeria over the next fifty years, leading to more frequent but less predictable rainfall, which will pose flooding and pollution risks. In the north, the Sahel is expected to continue to inch southward as the desert region expands. As a result, the nation will need to rely heavily on groundwater resources or build better wastewater and water treatment facilities. Locally, groundwater resources can fluctuate due to surface water changes, such as wet and dry seasons. It is expected that the nation will have to continue to drill deeper wells in the future, especially in the north, as water resources diminish. However, it is not expected that nation will face a major shortage due to physical water supply, but it will experience supply shortfalls due to inadequate delivery and infrastructure systems.[7]

3   BBC (2019) Nigeria election 2019: Mapping a nation in nine charts *https://www.bbc.com/news/world-africa-47149528*

4   World Bank (2021) *https://data.worldbank.org/indicator/NY.GDP.PETR.RT.ZS?locations=NG*

5   World Bank (2015) *State Water Agencies in Nigeria*

6   Parker for Circle of Blue (2009) War on Water: A Clash Over Oil, Power and Poverty in the Niger Delta *https://www.circleofblue.org/2009/world/war-on-water/*

7   Pokhrel, et al (2021) *Global terrestrial water storage and drought severity under climate change*

Infrastructure Risk

Like much of Africa, a rural and urban divide dominates water delivery systems and complicates national strategies. As of 2015, 57.3% of the rural population had access to improved drinking water, while 80.8% of the urban population had access[8]. Nigeria's ever-expanding population and rapid urbanization rates means that urban water delivery systems are mostly inadequate to keep up with demands. In urban settings, only about 25% of households have piped water supplies and water delivery is intermittent; and, because the government cannot keep up with the urban growth rate, that percentage is diminishing, not growing.[9]

In addition to formal urban growth, nearly 50% of the Nigerian urban population live in informal slums, making water management even more difficult. For example, in Lagos, the country's largest city, population growth rates and slum growth rates make it difficult for the nation to even keep track of population size, with population estimates ranging from 14-20 million people.[10] Outside of the water sector, Nigeria has highly developed road, energy, and telecommunication infrastructure when compared to its regional neighbors.

Data & Digital Capabilities

The digital and data sector in Nigeria has continued to be strong in the country's economy, contributing as much as 14% of GDP in 2019. The recent economic downturn caused by COVID-19 remains concerning, but the country is still regarded as Africa's largest digital market, comprising 82% of the continent's mobile subscribers and 29% of internet usage. In addition, Nigeria's government continues to prioritize the digital and startup economy.[11]

However, several hurdles could still be present for this sector of the country's economy, including a complex regulatory and taxation environment, theft of fiber infrastructure, and high cost of new technologies. Multiple multinational companies have invested in the county, including Cisco, IBM, and Facebook. As in other countries in the region, there does exist a widening digital divide, especially in infrastructure, between urban and rural and semi-urban areas. Overall, Nigeria presents multiple opportunities in the digital sector, including in cloud computing, education and skilling, digital infrastructure (especially in rural areas), and cybersecurity.

Water, Sanitation, & Hygiene

Nigeria's fast-growing population and high rate of urbanization mean that water delivery systems and water treatment facilities are severely lacking. As of 2019, 51.16% of Nigeria's population resided in urban areas, with a rate of urbanization of 4.17%.[12] Both an urban-rural divide and a north-south divide are present in water and sanitation access. In the urban south-west around Lagos, 31% of the population has access to safely managed drinking water, while in the north-east that number is only 2% of the population. According to UNICEF, nearly 171 million Nigerians are not on track to have access to safely managed drinking water by 2030.[13]

Sanitation and hygiene services follow similar trends, with 42% of the population having access to sanitation services. In rural regions open defecation is still practiced by nearly 29% of the population,

8   British Geological Survey, Earthwise (2021). *http://earthwise.bgs.ac.uk/index.php/Hydrogeology_of_Nigeria*

9   World Bank (2015). *State Water Agencies in Nigeria*

10   CNN (2020). How Makoko, Nigeria's floating slum, went digital with new mapping project.
     https://edition.cnn.com/2020/02/26/africa/nigeria-makoko-mapping-intl/index.html

11   International Trade Administration. (2021). Nigeria – Country Commercial Guide – Telecommunications.
     https://www.trade.gov/knowledge-product/nigeria-information-and-communications-technology/;
     Economist Intelligence Unit. (2016). Building a digital Nigeria.

12   World Bank Group. (2021). Data. *http://data.worldbank.org/*.

13   UNICEF (2019) WASH NORM Report 2019

which presents a host of challenges for surface water quality. Between 63% and 66% of all households have thermotolerant coliform contamination present in their drinking water supplies. Currently, the Federal Ministry of Water Resources administers an annual survey on national WASH issues and has a high political will to improve the situation but is lacking in capacity.[14]

Case Study: Egypt

Egypt's water situation is dominated by the Nile River Basin, with the majority of its water supply coming from the river system. However, the Nile River Basin, including tributaries, encompasses eleven countries including Ethiopia. With Ethiopia constructing and filling the Grand Ethiopian Renaissance Dam (GERD), Egypt faces the prospect of diminishing water availability. This could negatively affect agriculture in the country, which currently comprises 11% of Egypt's total GDP, 28% of all jobs, and over 55% of employment in Upper Egypt.[15] With agriculture currently accounting for 70% of water use in Egypt, any reduction in supply could have devastating consequences.[16]

COVID–19

Egypt's first confirmed case of COVID–19 came in February 2020. Under a baseline scenario, real GDP growth is expected to slow to 2.2%. The consequences of COVID–19 have been harsh throughout Africa, but in Egypt, with consumption accounting for 84% of GDP on average, economic growth is still possible. However, the pandemic is expected to have a dire impact on those below the poverty line, informal workers, and the vulnerable.[17]

Governance Risk

Over the past ten years, Egypt's political situation has been affected by the social and political instability of the Arab Spring protests that began in Cairo on January 25, 2011. The protest led to what has been generally become known as the "Egyptian revolution," which ended with President Hosni Mubarak being ousted after almost 30 years in power. Following elections in May and June 2012, Mohamed Morsi, the leader of the Freedom and Justice Party, was sworn in on June 30 as president of Egypt, a position that he held until July 3, 2013.[18] General Abdel Fattah el-Sisi succeeded him via a coup in 2013 and is presently governing the country.

Decision-making on water is centralized within the Ministry of Housing, Utilities, and Urban Communities (MHUUC), while The Ministry of Environmental Affairs is responsible for environmental planning, policy setting, and legislation. Additional ministries with some responsibilities on water include the Ministry of Finance, The Egyptian Water and Wastewater Regulatory Agency, and the Ministry of Water Resources and Irrigation.

Egypt faces many challenges in terms of maintaining a secure source of water. The most recent example is the Grand Ethiopian Renaissance Dam, a source of immense tension between Ethiopia and Egypt. Ethiopia is building the dam mainly to generate electricity. However, Egypt, the downstream country, is concerned the dam will reduce its supply of water. In the past, both counties have threatened armed conflict to ensure their interests are addressed. Sudan, the state between Ethiopia and Egypt, generally sides with Ethiopia in negotiations concerning the dam, as

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14   UNICEF (2019) WASH NORM Report 2019

15   USAID. (2020). Egypt. *https://www.usaid.gov/egypt/agriculture-and-food-security*

16   African Development Bank (2019). Egypt: Combined mid-term review country strategy paper 2015-2019 and country portfolio performance review. *https://www.afdb.org/en/documents/document/egypt-combined-mid-term-review-country-strategy-paper-2015-2019-and-country-portfolio-performance-review-109713*

17   African Development Bank. (2020). African Economic Outlook 2020: Supplement Amid COVID-19.

18   PPP for Cities. (2016, November). New Cairo Wastewater. *https://www.unece.org/fileadmin/DAM/ceci/documents/2016/PPP/PPP_for_Cities-Barcelona/Case_study_AQUALIA_WW_Egypt.pdf*

they hope to receive cheap electricity from the dam. Actual armed conflict over the dam is highly unlikely, as talks between the three counties remain underway. However, no consensus has been reached, and tensions among Egypt, Ethiopia, and Sudan remain high.[19]

While president el-Sisi continues to have strong control over Egyptian policy, with all indications that he will remain in power until 2030, the centralization of power and suppression of dissent pose increasing risks to political stability, especially with the socioeconomic uncertainty of COVID-19. Improving water infrastructure also remains a priority for Egypt, but the potential for disruptions caused by the GERD remain.[20]

Physical Risk

Egypt receives 69% of its water from the Nile. However, the Nile, a north-flowing river, is the most downstream portion of the Nile River Basin. The river only reaches Egypt after passing through upper basin counties, including Sudan, Ethiopia, and Kenya. Historically these upper basin countries have not made significant use of the water leading to the Nile, as colonial-era treaties had discouraged them from affecting the river's flow in any way. However, as each of the upper basin countries develops and increases its demand for water, each country in the Nile Basin is looking toward the river as a source of water, which will decrease the amount of water available for Egypt. This is especially evident with the construction and looming filling of the GERD. Egypt's remaining water sources consist of groundwater, rainfall, and desalination.[21]

Infrastructure Risk

With Egypt's current water infrastructure, the country is experiencing a supply deficit, with demand outstripping supply over 30%. In an effort to decrease the country's water stress, desalination and water reclamation are being increasingly used to augment supply and create a water source that is independent of international politics and climate. Egypt may be planning additional projects, but due to their on-going negotiations with Ethiopia over the GERD, the country is secretive about their water resources and future infrastructure projects.

Despite its large water deficit, Egypt is still performing relatively well in terms of access to improved water and sanitation, as well as drinking water quality. However, their Non-Revenue Water (NRW, or water lost to leaky infrastructure) percentage is very high and is one of the prime reasons for the supply deficit. While the water quality of both the Nile and groundwater is mostly permissible for drinking, there has been a downward trend in the overall quality of both. Increased inspection and monitoring of industrial, irrigation, and domestic discharge facilities to ensure compliance with Egyptian laws will play a large role in reversing this trend. Egypt has begun to introduce new water regulations and replace outdated and ineffective treatment techniques to improve the quality and availability of treated wastewater. A new code for the reuse of treated wastewater according to its quality has also been issued.[22]

Data & Digital Capabilities

The Information and Communications Technology (ICT) sector in Egypt is outperforming the rest of the economy, and investment in the sector continues to be robust. This has been due, in part, to the Egyptian governments focus and commitment to the sector.

19 Al Jazeera. (2020, January 26). What's behind the Egypt-Ethiopia Nile Dispute? Start here. *https://www.youtube.com/watch?v=JdizUoarrJo*

20 The Economist Intelligence Unit. (2020). Egypt: Country Outlook, November 2020.

21 USAID. (2020). Egypt. *https://www.usaid.gov/egypt/agriculture-and-food-security*

22 Fanack Water. (2019, January 2). Water Resources in Egypt. *https://water.fanack.com/egypt/water-resources/*

With the COVID-19 pandemic, the country's digital transformation plan has accelerated, with both internet and mobile usage increasing. Some of the areas that offer opportunities include E-education, Cybersecurity, Smart Cities Solutions, and Artificial Intelligence.[23]

Water, Sanitation, & Hygiene

As is the case throughout the world, and especially in Africa, the state of Water, Sanitation, and Hygiene (WASH) in Egypt is split between urban and rural, and developed urban centers and urban slums. As of 2019, 42.73% of Egypt's population reside in urban areas, with a rate of urbanization of 2.04%.[24] According to UNICEF, 7.3 million people do not have access to safe water in Egypt, with 5.8 million living in rural areas and 1.5 million living in urban areas. In urban slums, only around 77% of households have access to piped water, with many of the pipes illegal.[25] The situation in Egypt's slums is sometimes worse than in rural areas. Lack of access to safe water and proper sanitation has significantly and negatively impacted the health of the population, especially among children.

Case Study: Morocco

Morocco is the sixth largest economy in Africa and is driven primarily by the tourism sector. Agriculture plays a major role in employment, however, with up to 35% of the workforce employed in the sector, which accounts for around 12% of the nation's GDP. A naturally water scarce country, Morocco has substantially invested in its water infrastructure to capture, store, and redistribute water throughout the nation. After the Arab Spring, a series of reforms helped modernize the country; however the nation is still technically a monarchy and is classified as a hybrid constitutional monarchy. In the short-term, migration issues with Europe and within Africa pose the largest risks to the nation. In the long-term, climate change is set to make the country both drier and wetter depending on the area.

COVID-19

Morocco reported its first COVID-19 case in March 2020, altering the country's economic outlook. With Morocco's main trading partners of Spain, France, Italy, and Germany affected by the pandemic, exports have taken a big hit. Coupled with confinement measures affecting tourism and agriculture, already hindered by below average rainfall, Morocco is expected to enter a recession. However, GDP growth is expected to return by the end of 2021 if trade and tourism return to normal.[26]

Governance Risk

Morocco is a hybrid constitutional monarchy and is in the process of reforming into a full constitutional monarchy. As a result of the Arab spring uprising in 2011, King Mohammed VI introduced a series of reforms to liberalize the country and increase individual rights. However, the King remains an integral part of the political system, and the current Prime Minster Saadeddine el-Othmani shares some executive powers with the King. In the current system, the Prime Minster is appointed by the King but is chosen from the party that wins the most seats in the parliamentary elections. In theory, the judiciary is independent, but the King retains the power to dissolve parliament, call for new elections, and exerts influence over the courts via the Ministry of Justice.[27]

23 International Trade Administration. (2020). Egypt Country Commercial Guide.
    https://www.trade.gov/country-commercial-guides/egypt-information-and-communications-technology-and-digital-economy

24 World Bank Group. (2021). Data. *http://data.worldbank.org/*

25 UNICEF. (2021). Water, Sanitation and Hygiene: Egypt. *http://unicef.org/egypt/water-sanitation-and-hygiene*

26 African Development Bank. (2020). African Economic Outlook 2020: Supplement Amid COVID-19.

27 Hanafi, L. (2020) The Legal System of Morocco

Since the Arab Spring, Morocco has been generally stable; however, migration issues from within Africa and into the European Union (EU) remain flash points in the country. The nation is the jumping off point for both legal and illegal migration in Europe from many African countries, due to its close proximity to Europe. In addition, the robust agriculture sector in the nation employs legal and undocumented immigrants from across northern Africa. As a result, the EU is keen to aid Morocco's immigration issues in order to prevent immigration into the block[28]. The status of the Western Saharan in relation to Morocco is also a point of contention[29].

Water governance is mainly codified by the 1995 "Loi 10-95", and the legal structure governing water has allowed Morocco to make vast improvements in the delivery, storage, and processing of water in the last two-and-a-half decades. At the national level, the Ministry of Energy, Mines, Water and Environment oversees policy; however, the legal structures in place only dictate water resource management, and the current structure does not have the means to deal with wastewater treatment. The national water company, National Office of Electricity and Drinking Water (ONEE), along with a series of private suppliers, directly manages most urban and rural water systems.[30]

Physical Risk

Morocco is home to a mix of climates, including coastal Mediterranean regions, mountains, and desert regions. As a result, Morocco has complex water distribution issues and challenges. Moving and storing water are the primary ways that the country manages its limited water resources. The country relies on groundwater resources for about 25% of its overall supply, with the rest of the nation's water coming from surface water, primarily via a series of dams. Morocco's main challenge is an unequal distribution of water resources, especially when considering its population centers.

The economy is dominated by tourism (nearly 50% of GDP), but the nation also has a robust mining and agriculture sector. About 12-15% of the nation's GDP is driven by the agriculture sector, but farming employs nearly 35% of the population. Pollution from the farming sector and saltwater infiltration are major problems for groundwater sources. Climate change is expected to exacerbate Morocco's water resource issues, with the country getting drier and hotter over the next 50 years. To date, proper water management has mitigated many of the shortfalls facing the nation, but at a substantial financial cost (see Infrastructure).[31]

Infrastructure Risk

With its robust economy, the sixth largest in Africa, Morocco has made substantial investments in its water resource management over the last 20 years, often with the help of international donors or via loan schemes with various development banks. As a result, the nation boasts 140 large-scale dams, with the capacity to store 17.6 billion meters cubed of water, a complex groundwater recharge system, and a 1.5-million-hectare irrigation system.[32]

28 Oduor, M and AFP (2020) Spain Reach out to Morocco to Curb Illegal Immigration.
    https://www.africanews.com/2020/11/20/spain-reach-out-to-morocco-to-curb-illegal-immigration/

29 Al Jazeera (2021) Western Sahara: What's at stake for Joe Biden
    https://www.aljazeera.com/news/2021/1/11/western-sahara-whats-at-stake-for-joe-biden

30 Fanack (2019). Water Management in Morocco https://water.fanack.com/morocco/water-management-in-morocco/

31 British Geological Survey, Earthwise (2021) Hydrogeology of Morocco and Western Sahara (Moroccan Sahara)
    http://earthwise.bgs.ac.uk/index.php/Hydrogeology_of_Morocco_%26_Western_Sahara_ (Moroccan_Sahara)

32 Afilal, C. (2017). Water security in Morocco. https://blogs.worldbank.org/arabvoices/water-security-morocco

Investments in city infrastructure, too, have limited the amount of Non-Revenue Water (water lost to pipes via leaking) to about 20% in many urban areas[33]. Overall, Morocco's water infrastructure is perhaps the most advanced in Africa. All of this advance infrastructure has come at a cost, however, with the nation facing at $37 billion USD infrastructure spending gap by 2040[34]. The loss of tourism money due to COVID-19 in 2020 and through part of 2021 will also play a major role in infrastructure planning over the next three to five years, particularly in rural areas.

Data & Digital Capabilities

Morocco's data and digital capabilities are among the most mature in the region. Mobile penetration is about 130%, and internet use reaches over 74% of the population.[35] In addition, the country's government has prioritized and invested in the sector with investment in telecommunication networks and higher education.[36] The World Bank in June 2020 approved $500 million USD to support Morocco's digital sector, focusing on inclusion and spurring private-sector growth for startups and youth-led enterprises.[37] The urban versus rural divide may prove difficult but also may offer opportunities. Overall, Morocco presents multiple opportunities for partnerships between industry and government in the sector, including digital education, skilling, and cybersecurity.

Water, Sanitation, & Hygiene

Water, Sanitation, and Hygiene (WASH) in Morocco has seen major improvement over recent decades, but there remains a large disparity of services between urban and rural areas. As of 2019, 37.01% of Morocco's population reside in urban areas, with a rate of urbanization of 2.08%.[38] In urban areas, 99% of the population has at least basic access to sanitation, while that number is 80% in rural areas. The figures are similar with access to at least basic water service, with 98% in urban areas and 79% in rural.[39] While Morocco has actively been trying to rehouse and resettle urban populations living in slums, the problem still persists, with these areas suffering limited access to WASH facilities. The state of WASH both in rural areas and urban slums continues to put the population at high risk of waterborne diseases, as well as COVID-19.

Case Study: KENYA

Kenya has sufficient water to meet its citizens' needs. However, the water supply is not located where the population lives. This obstacle is caused by infrastructural, societal, financial, and governance limitations, and has resulted in a large water supply deficit. In an effort to reduce the water supply deficit caused by a lack of infrastructure to bring the water to locations where it is needed, dams, inter-basin water transfers, intra-basin water transfers, small dams (water pans), and borehole wells are supposed to be

33 UNESCO (2020). Water Scarcity Mitigation in Northern Morocco, Press Conference.
    https://en.unesco.org/sites/default/files/fer_0.pdf

34 Ballard, B. (2020) Morocco's infrastructural investment gap is hitting rural areas hardest
    https://www.worldfinance.com/featured/moroccos-infrastructural-investment-gap-is-hitting-rural-areas-hardest

35 International Trade Administration. (2021). Morocco – Country Commercial Guide – Telecommunications.
    https://www.trade.gov/knowledge-product/morocco-telecommunications/

36 Infomineo. (2017). The development of Morocco's IT Sector.
    https://infomineo.com/the-development-of-moroccos-it-sector-2/

37 World Bank Group. (2020). World Bank approves $US500 million to support Morocco's financial and digital inclusion reforms.
    https://www.worldbank.org/en/news/press-release/2020/06/22/world-bank-approves-us500-million-to-support-moroccos-financial-and-digital-inclusion-reforms

38 World Bank Group. (2021). Data. http://data.worldbank.org

39 WHO. (2021). Data. https://washdata.org/data/.

commissioned by 2030. This will further facilitate the secure transportation of water to where it is needed the most.

In addition, Kenya's economy is highly dependent on agriculture, constituting roughly 34% of its GDP and employing 53% of its total population[40]. Water management in agriculture remains a serious challenge, with around 90% of the country being arid or semi-arid land with highly variable rainfall patterns. A growing number of water-intensive economic and agricultural activities are also exacerbating these conditions.[41] Thus, agriculture further aggravates the water challenges of Kenya.

COVID-19

With the first case of COVID-19 in March 2020 came both demand and supply shocks that affected all sectors of Kenya's economy, especially tourism, industry, and agriculture. Demand has reduced both exports and imports, and real GDP is expected to decelerate. Supply shocks could lead to inflation, further negatively affecting Kenya's population.[42]

Governance Risk

Kenyan politics were mostly ruled by the Kenya African National Union until 2002, when the National Rainbow Coalition won a landslide victory. Subsequent years saw contentious elections, with violence and legal battles over results. However, since 2018, power at the national level has been held by the Jubilee Coalition, with Uhuru Kenyatta as its leader. This has led to an end to political tensions and an improved

outlook for political stability, leading to an Ibrahim Index of African Governance score of 58.5, in the top quarter of African nations[43].

Water plays a key role in Kenya. The Kenyan Constitution even guarantees the right to clean and safe water.[44] Despite this, governance and overall performance in the water and waste sectors is lacking. Water management at the national level is handled by the Water Resources Authority of Kenya. Other actors at the national level include the Water Services Regulatory Board, The Water Sector Trust Fund, and the Ministry of Water & Sanitation and Irrigation.[45]

Currently, Kenya's water sector needs investment of about $1 billion USD annually to meet its needs. The majority of the water sector's funding (64%) today comes from outside donors, including other countries, development banks, and Non-Governmental Organizations (NGOs)[46]. The major donors are the African Development Bank, France, Germany, Sweden, Denmark, World Bank, USAID, Italy, Finland, Japan, the Netherlands, and UNICEF. With the emergence of COVID-19 and global government deficits, it is expected that donor money will be limited in the next three to five years.

Physical Risk

Kenya has sufficient water to meet its citizens' needs. However, the supply is not located where the population lives. In addition, with agriculture playing a prominent role in the economy, water management in agriculture remains a serious challenge, with around 90% of the country consisting of arid or

40 World Bank Group. (2020). Data. *http://data.worldbank.org.*

41 KIT. (2020). Smart Water for Agriculture in Kenya. *https://www.kit.nl/project/smart-water-for-agriculture-in-kenya/#:~:text=Water%20management%20in%20agriculture%20remains,are%20also%20exacerbating%20these%20conditions.*

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semi-arid land with highly variable rainfall patterns. A growing number of water-intensive economic and agricultural activities are also exacerbating these conditions.[47] Thus, agriculture further aggravates the water challenges of Kenya. Climate change is expected to bring more variability in rainfall in the region but may actually increase the total amount of terrestrial water storage over the next century.[48]

While Kenya's physical water supply is sufficient to meet the country's needs, geographical considerations, water use for agriculture, and the potential for variable rainfall patterns remain areas to monitor.

Infrastructure Risk

Kenya's water infrastructure differs greatly between urban and rural areas. While 89% of the urban population has access to improved water and 78.8% to improved sanitation, the percentages for rural areas are 60.4% and 41.2%, respectively.[49] Meanwhile, the amount of water loss in the piped system (Non-Revenue Water) is relatively high at 42%.[50] In an effort to reduce the water supply deficit caused by a lack of infrastructure to bring the water to locations where it is needed, a total of 58 dams, eight inter-basin water transfers, six intra-basin water transfers, 17,780 small dams/water pans, and 5,320 borehole wells are supposed to be commissioned by 2030.

Currently, 90% to 95% of piped drinking water meets quality standards.[51] However, even in Kenya's major urban cities, like Nairobi, water delivery to slums and informal settlements remains limited, with piped water reaching only 20% of residents. This deficit leaves a robust, and often exploitative, secondary market for water[52]. The total water available for potential use is much higher than currently utilized. However, due to the difficulty of accessing all available water resources, the infrastructural supply-demand gap remains high.

Data & Digital Capabilities

Kenya is ahead of other developing economies in the region in the deployment and use of digital technology. The adoption of mobile technology by the population is ranked at the top of all African countries. Kenya also is among the top countries of Africa in regard to access to the internet, speed, and security. The country's success is due in part to a strong government commitment to accelerating information technology. In 2016, Kenya's Ministry of Information, Communications and Technology (ICT) was split into the Ministry of ICT and Innovation, and the Ministry of Broadcasting and Telecommunications, the former charged with making Kenya a competitive knowledge-based economy and facilitating universal access to ICT infrastructure and services all over the country.[53]

Kenya was the birthplace of the M-Pesa and microfinance telebanking system, which allows under-banked communities access to easy payment systems and commerce markets. Originating in Kenya in 2005, M-Pesa has since expanded to the Democratic Republic of Congo (DRC), Egypt, Ghana, Lesotho, Mozambique, and Tanzania, where either Vodafone or Safaricom mange the payment system. Current trends

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47   KIT. (2020). Smart Water for Agriculture in Kenya. https://www.kit.nl/project/smart-water-for-agriculture-in-kenya/#:~:text=Water%20management%20in%20agriculture%20remains,are%20also%20exacerbating%20these%20conditions.

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50   Thuita, M. M. (2019). Non-Renvenue Water (NRW) Management in Kenya. World Water Tech Innovation Summit. London.

51   Water Services Regulatory Board. (2018). Impact A Performance Report of Kenya's Water Services Sector - 2017/2018.

52   Sarkar, A. (2020, August 30). Why Kenya's urban poor are exploited by informal water markets. The Conversation. https://theconversation.com/why-kenyas-urban-poor-are-exploited-by-informal-water-markets-144582

53   Republic of Kenya. (2019). About the Ministry. Ministry of ICT, Innovation and Youth Affairs: https://ict.go.ke/about-the-ministry/.

show opportunities for investment in the digital economy in education, healthcare, and cybersecurity.[54]

Water, Sanitation, & Hygiene

Water, Sanitation, and Hygiene (WASH) in Kenya has two prominent distinctions. The first is between urban and rural, with vastly different access to improved water and sanitation. The second distinction is between slum areas and established neighborhoods. WASH in urban areas is typically considered much better than rural areas. However, the situation in Kenya's slums is sometimes worse than in rural areas. With increased urbanization of Kenya, the situation will only be exacerbated without active measures to increase delivery systems to the most vulnerable and to curb the predatory water black market within urban slums. As of 2019, 27.51% of Kenya's population reside in urban areas, with a rate of urbanization of 4.23%.[55]

Conclusion: Trends & Opportunities In Digital Water

Strategic application of technology-driven intelligence, education, planning, and systems operations can not only transform how water is measured and delivered, it can inform and motivate policy, encourage intra-and extra-boundary coordination, create new paths for cross-sector collaboration, and reveal new systemic approaches for managing water-driven issues, such as food security, energy production, and climate change responses.

At this moment, as Africa faces water stress, a changing climate, and rapid urbanization, the imperative demand a nimble response to the water crises is increasing. Across the continent, the private and public sectors have a transformative role to play in digital water through resource management, foresight, data collection and analysis, education, and thought leadership.

Considering opportunities for near-term success – and countries with the necessary digital infrastructure, identifiable challenges, and a motivation to shape their future – Egypt, Kenya, Morocco, and Nigeria are among the ripest candidates. With a deeper understanding and survey matrix of each country's status, capabilities, and receptivity to digital water technologies, NGO and business communities have the opportunity to play a leading role in foresight, intervention, and investment shaping a more water resilient continent. Here are key areas to consider for intervention and further exploration:

A Digital Foundation

Implementation of "digital water" is spotty across Africa, partly due to dramatic differences in digital communications infrastructure, from basic cellular service to high-speed internet. In a country with a commitment to robust, modern digital infrastructure and a high rate of adoption, digital water is poised to become more prevalent. Digital water in this sense can include advanced remote sensing capabilities to public engagement through mobile networks.

Intelligence

Across much of Africa, there is a void of data-driven intelligence on water supply, demand, and quality, as well as availability of basic water, sanitation, and hygiene services (WASH). Information on supply and demand is often isolated, fragmented, or nonexistent. There are wide gaps in systems interactions, such as the competition for water between agricultural and energy sectors. With more people migrating to cities — some of the largest on the planet — increasing population and urbanization are stressing agricultural production and with it the demand for water. Quality of available water supplies is also often unknown, or data comes too late or is out of context for policy and other actions. In rural areas and urban slums, information about WASH services is often disparate.

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54 International Trade Administration. (2020). Kenya Country Commercial Guide.
    https://www.trade.gov/knowledge-product/kenya-information-communications-and-technology-ict

55 World Bank Group. (2021). Data. *http://data.worldbank.org/*.

Education & Skilling

In order to successfully implement digital water tools and strategies, there is a need for wide education across the water and digital sectors. Technology innovators need to understand the problems, political leaders need to understand the incentives and benefits of action, investors need to understand the market and impact potential, and, especially in rural areas, people need the skills necessary to implement and manage digital water tools. And everyone needs to become better listeners, keen to identify the impediments and perils of both inaction and inappropriate action.

· Educate government leaders to make water a top priority.

· Leverage existing networks for push and pull engagement with the public, from sharing information about water supplies and quality via text messaging, to developing the skills necessary for implementation.

· Participate in resilience planning, particularly in cities, to align water demand, wastewater management, and the water footprint of food and energy supply chains.

· Humble leadership with new tools for collaboration also present an opportunity to better connect stakeholder groups.

There is a move toward smarter and more resilient cities, and stakeholder groups are beginning to work together. However, the process is slow, under-informed, and often inadequate. This is a moment of particular relevance, an opportunity to embed new levels of intelligence, education, and technologies as cities are motivated by cascading events, such as droughts and floods.

Opportunities

At the dawn of the Fourth Industrial Revolution, the opportunities to fill gaps in Africa's digital water future are not only real but imperative, and include:

· Centralized, trusted information libraries with real-time and trusted data made actionable

· Precision, technology-monitored agriculture

· Remote sensing/IoT

· Artificial intelligence for identifying trends and systemic influences

· Developing a common operating system of basic, relevant information for governments, NGOs, investors, and other stakeholders

There is no doubt that Africa is on the precipice of change — a defining moment when bad practices are ripe for intervention and new practices can shape the continent's water future.