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Irrigation and Drainage Engineering: Kenya's Water Management Imbalance

By Yvonne Madahana

It is February 2026, and Kenya is already feeling the first breath of what is coming. This morning, the Kenya Meteorological Department issued its forecast for the week of February 24 to March 2: "Isolated heavy rainfall events may occur in the Central Highlands, Lake Victoria Basin, Rift Valley, South-eastern Lowlands, Coast, Western, and North-western Kenya." [1]Residents of Nairobi have been told to stay updated and exercise caution. Farmers in Nandi, Kericho and Nyamira are watching their skies. Along the shores of Lake Victoria, the afternoon thunderstorms are already arriving. The anticipation is mixed - as it always is at this time of year in Kenya. On one hand, the rains bring life. The long rains season, running from March through May, is the country's primary agricultural season. For millions of smallholder farmers across the highlands and rift valley, these months determine whether the year will bring enough food. But on the other hand, the rains also bring dread. Because in Kenya, rain does not simply fall and nourish. It falls, it overwhelms and it destroys. Even before the long rains have properly begun, the bigger worry is not whether the rain will come. It is what will happen when it does.

DEAR READER

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Inside this Issue!

When the Rains Come: A Nation on Edge

Every long rain season delivers a familiar sequence. It begins with relief, the dust settles, the soil softens and farmers' plant. Then, usually by mid-April, the rains intensify. Rivers begin to rise. A road swallowed. A bridge gone. A house collapsed. Children unable to get to school. Workers unable to get to jobs. Hospitals cut off. And then, the assessments. The Kenya Red Cross counts the displaced. The Kenya Meteorological Department explains the El Niño or La Niña pattern. The National Disaster Management Unit dispatches relief supplies. County governors hold press conferences.

The 2024 long rains season left no room for doubt about the scale of this recurring failure. Between March 1 and May 16, 2024, flooding affected all 47 counties of Kenya. The death toll reached 291 people. Another 188 were injured. A staggering 278,380 people, more than 55,000 households, were displaced from their homes.[3] Forty-seven thousand acres of farmland were destroyed. Roads in 42 counties were rendered impassable. Schools, health facilities and small businesses were swept away or submerged.[4]

In Nairobi's Mathare Valley, more than 7,000 people were displaced in a single night following the April 24 floods.[5] These were not remote communities or outlying counties. Mathare is four kilometres from the central business district of East Africa's most connected city. The crisis was not hidden - it was broadcast, documented, mourned and then, as it always is, eventually forgotten. Until the next season.

The Farm: Between Hope and Ruin

Away from the city, the relationship between the rains and the land is even more complex. For the smallholder farmer in Nyeri tending half an acre of maize and beans, the long rains are the year's defining event. Approximately 95% of Kenya's agricultural production is rain-fed,[6]. When the rains come on time and in the right amounts, there is real abundance. Markets fill. School fees are paid. Children eat.

But the rains rarely arrive as a farmer would script them. They come too early, or too late. They come in short, violent bursts that waterlog fields and wash away topsoil rather than sustained gentle soaking that builds soil moisture. They come unevenly: the valley receives a month's rain in a weekend while the ridge goes dry. Soil erosion strips nutrients accumulated over years from unprotected slopes. Crops that took root after the first rains drown in the second week. And the same overloaded drainage channels that flood the city wash nutrients off farmland and into rivers, leaving the ground poorer than before.

This year, the Kenya Meteorological Department has warned of *"generally poor to fair temporal and spatial distribution of rainfall, with intermittent dry spells"* even within the above-average forecast zones.[2] Isolated heavy events are expected. Flooding risks are real.

When It Dries, Our Worry Is Food

Within months of the floods, Kenya's arid and semi-arid lands (ASALs), covering approximately 80% of the country's landmass, return to crisis conditions.[4] By January 2025, the National Drought Management Authority (NDMA) reported that 1.8 million people remained acutely food insecure, primarily in Turkana, Marsabit, Wajir, Garissa and Mandera counties.[5]

The depth of the crisis in these counties is staggering. In Turkana South, Global Acute Malnutrition (GAM) rates exceed 30%, meeting the IPC Acute Malnutrition Phase 5 (Extremely Critical) classification.[6] Marsabit County, where up to 40% of the population has been classified as Crisis (IPC Phase 3) or above, continues to require emergency food distributions.[7] Children aged six to 59 months and pregnant or breastfeeding mothers are disproportionately affected: as of early 2025, 479,498 children and 110,169 mothers were acutely malnourished.[5]

The ASAL region's vulnerability is not simply a product of low rainfall. It reflects decades of underinvestment in water infrastructure, the absence of on-farm water storage, collapsed livestock herds following successive droughts, and an agricultural system almost entirely dependent on seasonal rains. When the rains fail even briefly, the consequences are catastrophic.

Where Does the Water Go?

Kenya is not a water-scarce country. The Kenya Meteorological Department forecasts rainfall across large parts of the country four times a year, season after season, decade after decade. The country receives an estimated 630 billion cubic metres of rainfall annually.[9] What Kenya lacks is the capacity to hold that water - to slow it, store it, and redirect it across time and space so that the water that floods Mathare in April becomes the irrigation water that feeds Turkana in August.

Kenya's irrigation potential is estimated at 1.3 million hectares, but the country has equipped only a fraction of this.[9] FAO data notes that irrigated agriculture accounts for just 2.4% of cultivated area, yet contributes 18% of national agricultural production, demonstrating the immense return on irrigation investment.[10] Despite this productivity advantage, expansion has been consistently below target due to insufficient funding and poor infrastructure planning.

The infrastructure that does exist often lacks integration with drainage systems. During floods, water that could recharge aquifers, fill storage reservoirs, or be directed to irrigation schemes instead overwhelms inadequate drainage channels and rushes to the sea. Urban areas like Nairobi compound this problem: impermeable surfaces from rapid unplanned urban growth accelerate surface runoff, channelling stormwater into rivers that lack adequate capacity. In Nairobi, locally blocked and poorly maintained drains in informal settlements transform seasonal rains into urban catastrophes.[11]

The Repetition Problem: Why Is This a Cycle?

The flood-drought cycle in Kenya is not a natural inevitability; it is a governance and engineering failure that has been repeatedly documented and inadequately addressed. Several interlocking factors perpetuate it.

i. Overreliance on Rain-Fed Agriculture

Approximately 95% of Kenya's agricultural production is rain-fed, with an estimated 76–80% of crops planted during the long rains season.[12,13] This monocausal dependency makes the sector fundamentally vulnerable to rainfall variability. When rains arrive early, crops flood. When they arrive late, they fail entirely. A climate-resilient food system requires decoupling agricultural production from rainfall seasonality through irrigation - but Kenya has not achieved this.

ii. Inadequate Urban Drainage Planning

Nairobi's drainage infrastructure was largely designed for a city of under one million people. Today, Nairobi is home to over five million people and large portions of the city lack any engineered drainage at all. Human Rights Watch documented that the government failed to act on flood warnings issued by the Kenya Meteorological Department in 2023, and that an KES 10 billion emergency response fund ($80 million) allocated before the 2024 rains came without a detailed plan of action.[11] This is not a resource shortfall alone; it reflects a planning gap.

iii. Weak Integration Between Irrigation and Drainage Systems

Kenya's seven national irrigation schemes Mwea, Bura, Hola, Perkera, West Kano, Bunyala and Ahero, cover a combined commanded area of 18,200 hectares.[14] These were largely developed as standalone food production projects, disconnected from urban drainage planning, watershed management, or flood mitigation systems. Drainage and irrigation are treated as separate engineering disciplines addressing separate problems, when in fact they are two sides of the same water management challenge.

iv. Limited Investment in Storage Infrastructure

Kenya's Vision 2030 plan called for an increase in irrigated area to 1.3 million hectares by 2030, roughly 10 times the 2010 area. This objective required adding approximately 40,000 hectares per year, demanding public expenditure on irrigation equivalent to at least 5% of the annual national budget.[10] These targets remain largely unmet and the storage dams and reservoirs needed to smooth water availability across seasons have not been built at the scale required.

v. Fragmented Water Governance

Water management in Kenya spans multiple institutional actors, the National Irrigation Authority, the Water Resources Authority, county governments, the NDMA and various line ministries, without a single integrated authority responsible for connecting flood management, irrigation development and drought response. This fragmentation produces siloed responses to interconnected problems.

Do We Have Systems - Or Just Infrastructure?

Kenya possesses elements of water infrastructure: irrigation canals in Mwea, drainage channels in Nairobi, policy frameworks like the National Water Master Plan 2030, and institutions such as the National Irrigation Authority. But infrastructure is not the same as a system. A system implies integration: the capacity to sense, respond to and redirect water flows in a coordinated way across seasons, scales and sectors.

Kenya's existing infrastructure often fails this test. Flood retention basins that could absorb stormwater during rain are absent in most cities. Controlled drainage systems on farms, which could prevent waterlogging during wet seasons and preserve soil moisture during dry periods, are rarely implemented. Hydrological modelling, which could predict where and when floods will occur and where irrigation water can be sourced, is insufficiently embedded in planning processes.

The result is that Kenya's infrastructure, such as it is, amplifies rather than manages the natural variability of its rainfall. Flood victims in Mathare lose their homes because drainage infrastructure was not built. Farmers in Marsabit lose their livestock because water storage was not built. Both failures share the same cause: water was allowed to leave the system without being captured.

What Should Irrigation and Drainage Engineers Be Doing?

The engineering profession has both the technical tools and the professional responsibility to address Kenya's water imbalance. The interventions required operate at three interconnected levels: urban, agricultural, and policy.

i. **In Urban Areas**

a. **Sustainable Urban Drainage Systems (SUDS).** Urban drainage design must shift from the conventional 'pipe-and-drain-away' model to systems that slow, store and use urban stormwater. Permeable pavements, bioswales, rain gardens, and green roofs can reduce peak surface runoff by 30–70% in well-designed systems. Nairobi's informal settlements, where drainage is most catastrophically inadequate, should be priority zones for low-cost engineered interventions.

b. **Flood Retention Basins.** Strategic retention ponds and detention basins within and around Nairobi and other flood-prone cities can capture peak stormwater flows, allow controlled release and reduce downstream flood risk. Several cities across sub-Saharan Africa including Dar es Salaam and Addis Ababa, have piloted such systems with demonstrable flood risk reduction.

c. **Urban Water Harvesting.** Stormwater captured in retention systems need not be wasted. Urban water harvesting - linking stormwater capture to groundwater recharge or urban irrigation - can turn flood mitigation infrastructure into a productive asset, supplying water for urban agriculture, landscaping, and non-potable urban uses.

ii. **In Agricultural Areas**

a. **On-Farm Water Storage.** Kenya's ASAL farmers need engineered water pans, subsurface dams and rock catchment systems that capture rainfall during wet periods for use in dry ones. Research in Turkana has proposed exactly these technologies, macro catchments, rock catchments and subsurface dams as practical, scalable solutions to drought vulnerability.[15] FAO data demonstrates that water harvesting for crop production can increase yields from 1 tonne per hectare to 3– 4 tonnes in areas where rain harvesting is implemented.[16]

b. **Controlled Drainage Systems.** On irrigated and rain-fed farms in higher-rainfall areas, controlled drainage allows farmers to retain water in the root zone during dry spells while enabling rapid drainage after heavy rains. This single intervention addresses both waterlogging during floods and water stress during dry periods, and is among the most cost-effective tools in the irrigation-drainage engineer's toolkit.

c. **Irrigation Expansion Beyond Rain-Fed Systems.** With irrigated agriculture producing 18% of national agricultural output from only 2.4% of cultivated area, the economic case for irrigation expansion is clear.[10] Kenya's irrigation potential of 1.3 million hectares remains largely unrealised. Engineers must design cost-effective gravity-fed and solar-powered drip irrigation systems that smallholder farmers can afford and manage.

iii. **At Policy and Planning Level**

a. **Integrated Water Resource Planning.** Engineers must work with planners, policymakers, and communities to develop basin-level water management plans that explicitly connect upstream catchment management, on-farm storage, urban drainage, and downstream irrigation. The Tana River basin, for example, connects Nairobi's stormwater drainage to downstream irrigation schemes and the coast.

b. **Climate-Resilient Design Standards.** Kenya's design standards for drainage and irrigation infrastructure must be updated to reflect climate change projections. The 2024 floods were intensified by El Niño conditions, which meteorologists had warned about months in advance.[11] Infrastructure designed to historical rainfall norms will be increasingly inadequate as rainfall intensity and variability increase under climate change. Engineers must incorporate 50–100-year return period

flows into urban drainage design and build adaptive capacity into irrigation systems.

c. **Data-Driven Hydrological Modelling.** Kenya needs a national hydrological monitoring and modelling programme that provides real-time data on river flows, soil moisture, groundwater levels, and reservoir storage. Such data, fed into predictive models, enables early warning, adaptive irrigation scheduling and evidence-based infrastructure planning. The Kenya Meteorological Department has demonstrated the capacity to provide accurate seasonal forecasts - the challenge is translating these forecasts into engineering decisions and operational responses.

Conclusion

Kenya is not a water-scarce country, it is a water-imbalanced one. The same water that floods Mathare and washes away crops in Tana River could, with better management, irrigate the dry fields of Marsabit or recharge the aquifers that Turkana communities depend on.

Flood and drought in Kenya are not opposites, they are two symptoms of the same disease: a water management system that lacks integration, storage capacity and seasonal continuity. The country receives rainfall; it simply fails to retain it, store it and redirect it where it is needed, when it is needed.

Irrigation and drainage engineering, properly practiced, is not simply about building canals or digging drains. It is the science and practice of governing water across time and space - capturing it when it is abundant, storing it across seasons, distributing it where it is scarce and protecting communities from its excess. In Kenya's context, this means treating flood management and drought response as a unified engineering challenge rather than separate sectoral crises.

Engineers, planners, policymakers and communities must collaborate to build an integrated water management system for Kenya - one in which today's floodwater can genuinely become tomorrow's irrigation supply. The technical knowledge exists. The engineering tools exist. The evidence of need is overwhelming. What remains is the political will, institutional coordination and sustained investment to build the systems Kenya urgently requires.

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