Engineering in KENYA

ISSUE 005

PUBLISHED BY THE INSTITUTION OF ENGINEERS OF KENYA | OCTOBER 2021

Engineering, Agriculture and the Environment

ISSN : 2710-3951

Testing using 330 kV Series Resonance Tester, 30 - 300 Hz at Thika Road 220/66 kV GIS Substation

ARM Engineer commissioning at 132/33 kV GIS Substation in Basrah - Iraq

Testing and Commissioning of Efacec Protection Panels at 132/33 kV Naivasha Substation

Installation of 200 MVA 400/220/11 kV AutoTransformer at Isinya 400/220 kV Susbtation

9000l/hr Oil Filtration Machine with 2140 m3/hr Double Stage Vacuum Pump

ARM Engineering Company Ltd is a leading 100% Kenyan Owned EPC Company incorporated in June 2006 to undertake Electrical Engineering Projects with experience in East and Southern Africa.

Our Services:

- EPC Projects up to 220 kV.
- Testing and Commissioning of Power Systems including Generation, Transmission and Distribution.
- Engineering, Testing & Commissioning, and Training in Substation Automation including IEC 61850 and SCADA.
- Power Transformer Assembly, Servicing and Maintenance including BDV Testing, Oil Filtration and SFRA Tests.

***** All Testing and Commissioning Services are done using our in-house test equipment.***

Some of our Major Projects include:

- EPC Contract for KPLC Naivasha and Makutano 132/33kV Substations
- Electromechanical Installation Works at KETRACO Isinya 400/220kV Substation
- Construction of 83 MW Triumph HFO Power Plant.
- Rehabilitation and Construction of EDM's Mafambisse 110/22 kV Substation, and Dondo 220/110 kV Substation in Mozambique
- Electromechanical Installation Works at Bujagali 132/220 KV Substation in Uganda
- Substation Automation Protection and Control System Commissioning Services for 132/33 kV GIS Substation in Basrah - IRAQ

04 Funzi Road, off Enterprise Road
Industrial Area

+254 740 197 233
+254 733 676 036

info@armengineering.co.ke
www.armengineering.co.ke

In this **Issue**

Engineering in KENYA

PUBLISHER Institution of Engineers of Kenya

EDITORIAL BOARD

CHAIRPERSON Eng. Prof. Lawrence Gumbe
MEMBERS Eng. Nathaniel Matalanga (Ex-Officio)
Eng. Margaret Ogai (Ex-Officio)
Eng. Paul Ochola (Secretary)
Eng. Prof. Meoli Kashorda
Eng. Sammy Tangus
Eng. Jane Mutilili

SECRETARIAT REPRESENTATIVES Eng. Linda Otieno
Nick Gatirima
Maria Monayo
Anne Ndung'u

PRODUCTION TEAM

TEAM LEADER Justus Agumba
TECHNICAL EDITOR Godfrey Ombogo
STAFF WRITER Jepkoech Kiptum
Gor Ogutu
DESIGN & LAYOUT Sherry Ayuma
ADVERTISING SALES James Ngala/Jane Njeri
PROJECT ADMIN Violet Asiaba
DISTRIBUTION Zablon Joel

CONTRIBUTORS *Prof. Elijah K Biamah*
Eng. Richard Munyao Kanui
Eng. Dr. Jedidah W. Maina
Eng. Michael Kamau and John Miano
Eng. Anthony Sang
Samwel Ogola
Dr. JPO Obiero
Carol Koech
Eng. Christine Omina Mutayi

DESIGN & PRINTING Michimedia Limited
info@michi-media.com

Call for Papers

Engineering in Kenya Magazine - December 2021 Issue

The Institution of Engineers of Kenya (IEK) publishes Engineering in Kenya magazine, whose target audience includes engineering professionals, practitioners, policymakers, researchers, educators and other stakeholders in engineering and related fields. The publication is distributed to its target readers free of charge through hard and soft copies.

IEK hereby invites you to contribute articles for the next and future editions. The articles should reach the Editor not later than 10th of December, 2021 for our next issue whose theme shall be *"Engineering, Roads and Housing"* and related sub-themes across all engineering disciplines. An Article can range from engineering projects to processes, machinery, management, innovation, news and academic research.

The articles must be well researched and written to appeal to our high-end audiences and to be informative to the public in Kenya and beyond. The magazine reserves the right to edit and publish the article in line with its editorial policy. The articles should be "500-1000" words, font type "Times New Roman" and font size "12".

Send your article today and get a chance to feature in the magazine!

Send your article to:
iek@iekenya.org and cc:
ceo@iekenya.org;
editor@iekenya.org and
engineeringinkenya@michi-media.com.

EcoStruxure™
Innovation At Every Level

Process Instrumentation

Process Instrumentation

100+ years tradition of excellence and innovation in process instrumentation.

Magnetic, Coriolis, and Vortex Flowmeters
Volume Flow, Mass, And Density Measurement of Liquid, Gas, and Steam

Pressure Transmitters
and Accessories

Temperature Transmitters
Sensors and Thermowells.

Level Measurement
Free Space Radar, Guided Wave Radar and Buoyancy Transmitters

Process Liquid Analytical
PH, Conductivity, ORP, DO On-Line Sensors, Analyzers, and Transmitters

Gas Analyzers
Gas Chromatograph, FTIR, Near Infrared, Mass Spectrometer, ANALECT, RPM

Wireless Information Network Solutions (WINS)

We have: BLE (Bluetooth Low Energy) + Wireless HART for short range, 2.4GHz for mid-range and 4G or satellite for long range.

Instrument Area Network
Wireless HART + BLE for Plant-Wide Network Capability

Accutech
2.4 GHz (ISM bands) for Wide Area Secured Communication Infrastructure

Data Loggers
4G LTE- Dominant IIOT Solution Offering Modularity and Flexibility

Centeron
5G and Satellite Wireless Solution For Tank Level Monitoring, Asset Tracking and Data Provision

Trio Data Radios
Licensed: Q, M Series (400MHz – 518 MHz UHF/ 135MHz – 175 MHz VHF)

Trio Data Radios
License Free: J, O&K Series (915MHz – 2.4 GHz)

Process Valves, Valve Positioners, Actuators & Accessories

With our range of Valves, Valve Positioners, Actuators, & Accessories we complement any application in industry.

MVR20
Severe Service Control Valve

VTX10
General Service Control Valve

BAV90
General Service Ball valve

TVT60
High Performance Butterfly Valve

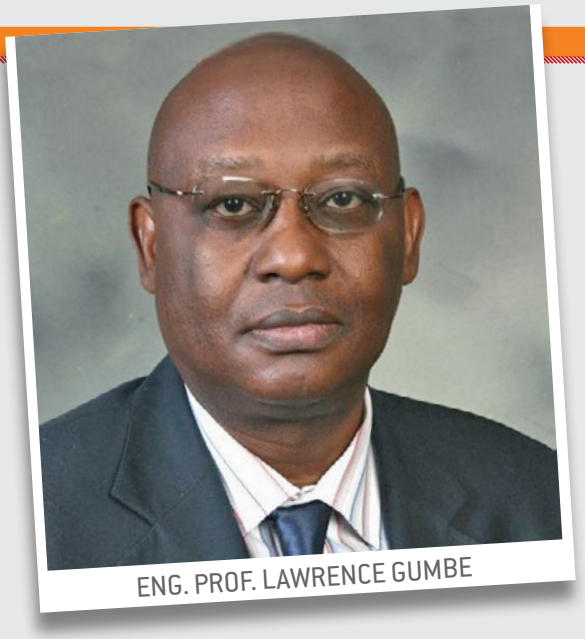
Positioners
SRD998, SRD991, SRD960, SRI983, SRI986, SRI990, SRI983, SRP981

Actuators
ASP, APR Actuators

Accessories
Filter Regulators, Volume Boosters, Limit Switches and Feedback, Pneumatic Relays, IP Converters

www.se.com/processautomation
support.pa.ea@se.com

Life Is On Schneider Electric™



ENG. PROF. LAWRENCE GUMBE

Engineering, Agriculture and the Environment

THE modern world has largely been an engineering project. The structures, machines, processes and organisation, which have led to increased affluence, increased life expectancy, comfort and enlightenment are all largely due to engineering efforts.

Kenya's Vision 2030, which aims to transform the country into a newly industrialised, middle- income country economy, providing high quality of life to all its citizens by the year 2030, is largely an engineering project. This vision recognises agriculture as a key sector.

> Official figures indicate that most Kenyans (**75 per cent**) are employed in agriculture. Agriculture accounts for about **26 per cent** of the GDP. This means the efficiency and effectiveness of our agriculture must be urgently increased. This can only be done through engineering.

We have all been often reminded that the degradation of the environment during production is a serious challenge in modern times. Climate change and its adverse effects can be directly attributed to lack of respect for prudent environmental management through responsible production in agriculture, extractive industries, transport and manufacturing.

Engineering inputs in agriculture are effected through agricultural mechanisation. Agricultural mechanisation aims at increasing the power inputs to farming activities, hence, intensified production and enhanced value addition, resulting to decreased cost of production and reduction of drudgery in farming activities.

The different sources of agricultural power available include human, animal, mechanical, electrical and renewable energy. Use of farm machinery and equipment is determined by the production systems, including farm size and availability of power. For successful agricultural mechanisation planning and implementation, a holistic approach should be used to encompass private sector involvement, economic profitability and creation of an enabling environment.

In 1900, farmers represented 38 per cent of the US labour force. By the end of the century that number had plunged to three per cent – a dramatic evidence of the revolution in agriculture brought about by mechanisation. Beginning with the internal combustion engine and moving on to rubber tires that kept machinery from sinking in muddy soil, mechanisation also improved the farm implements designed for planting, harvesting and reaping. The advent of the combine harvester, for example, introduced an economically efficient way to harvest and separate grain.

As the century closed, "precision agriculture" became the practice, combining the farmer's down-to-earth know-how with space-based technology. **1902**, First US factory for tractors driven by an internal combustion engine. **1966**, Electronic monitoring devices allowed farmers to plant crops more efficiently.

Attached to mechanical planters and air seeders, the devices monitor the number and spacing of seeds being planted. The devices monitor the planting of up to 96 rows at a time. During the **1990s**, similar devices were used at harvest time for yield mapping, or measuring and displaying the quality and quantity of a harvest as the combine moves through the field. **1994**, Farmers began using Global Positioning System (GPS) receivers.

Ushering in the new "precision agriculture," farmers began using GPS receivers to record precise locations on their farms to determine which areas need particular quantities of water, fertiliser and pesticides. The information can be stored on a card and transferred to a home computer. Farmers can now combine such data with yield information, weather forecasts, and soil analysis to create spread-

sheets. These tools enable even greater efficiency in food production.

In the 21th century, agricultural mechanisation is changing, precision agriculture to ensure efficiency of inputs such as water and fertiliser application, and to maximise productivity, quality, and yield, tractor performance, soil type and soil tests and other equipment by use of satellite imagery, GIS tool and GPS devices, use of Internet of Things (IoT), driverless tractor.

Agricultural production consists of crops, livestock and fisheries systems.

Intake section connecting intake to the headworks canal in Lower Nzoia Irrigation Development Project (Photo Courtesy - NIA)

In Kenya, crop production systems consist of small, medium and large-scale farms averaging 0.2 to 5, 5 to 100 and over 100 hectares, respectively. Small-scale farmers are predominant in the high and medium rainfall areas that produce over 75 per cent of agricultural production.

Use of machinery on small-scale systems is very low in relation to the medium and large-scale agricultural production systems.

In Africa, most of the livestock is raised in extensive systems with communal grazing and free ranging of rain-fed rangelands. Intensive production is practised in the high-rainfall areas, semi-intensive systems are found in semi-arid lands and extensively in arid areas. Use of mechanised livestock production systems is very low. However, potential for mechanisation is high to meet the growing demand for livestock and livestock products.

> Fisheries production systems include capture, which takes place in the marine waters, inland waters, and aquaculture, which can be land-based in ponds or water-based in cages. Production systems in capture fisheries are categorised into artisanal fishing and semi-industrial fishing. Aquaculture systems are categorised as semi-intensive, intensive and extensive depending on the inputs and production system. However, adoption of mechanised production system is low.

It is often argued that as agriculture employs the vast majority of our labour force, it is therefore our most significant economic sector. Implicit in this statement is that this state of the affairs has to be maintained, at least for the foreseeable future. What is the validity of this argument?

As stated above, the primary objective of agriculture is to provide food and other raw materials. This process must obviously be carried out in the most efficient and cost-effective manner. Employment is created in this sector because we require human labour intervention in the production process.

Mechanisation leads to more labour and process efficiency, resulting in better energy utilisation and lower production costs. In an industrialising economy, labour requirements are reduced in various industries as production systems are progressively mechanised. The workers displaced in such industries are absorbed in other industries where they are required. In fact, the lowest unemployment rates are in the most industrialised countries, which have the highest levels of agricultural mechanisation.

Mechanising our agriculture will displace some labour from the sector. This is actually desirable in a modem industrialising economy. In such an economy, labour is required in many other areas.

The challenges facing agricultural mechanisation in Kenya include inadequate machinery, inadequate staff – plant operators and mechanics, inadequate mechanisation extension, inadequate access to mechanisation technologies, inadequate credit and finance to farmers and private contractors, inadequate after sales and service back-up, decreasing land sizes, enterprises that does not support mechanisation business model, vast area of coverage for the Government mechanisation stations, inadequate resources/funding for stations, gender and youth imbalance in agriculture, aged farming citizens, among others.

As we mechanise our agriculture, we must ensure that the environment is protected.

This issue of ***Engineering in Kenya*** is dedicated to ***Engineering, Agriculture and The Environment***. We welcome you and hope that we will receive your feedback.


ENG.NATHANIEL MATALANGA

We Must Work Together To Grow Our Agriculture And Fight Climate Change

AGRICULTURE remains the backbone of the Kenyan economy. According to IFAD, the agricultural sector employs up to 80 per cent of Kenya's rural population and accounts for about 65 per cent of exports. Further, agriculture contributes immensely to the reduction of poverty and the country's economic growth. According to a World Bank report, from 2013 to 2017, the agriculture sector contributed on average 21.9 per cent of Kenya's gross domestic product (GDP), with at least 56 per cent of the total labour force employed in agriculture in 2017.

First, Kenya's agriculture is largely rain-fed. While 83 per cent of Kenya's land area is arid and semi-arid, only two per cent of arable land is under irrigation compared to an average of six per cent in Sub-Saharan Africa and 37 per cent in Asia (World Bank report). This means our agriculture is susceptible to drought shocks. We have seen now and again crops wilting in the fields when rains fail and livestock dying from lack of water and pasture.

Evidence has shown that investing in irrigation and agricultural water management for smallholder farmers can reduce productivity shocks and raise the sector's total factor productivity. The government and stakeholders should therefore make deliberate concerted efforts to invest in irrigation. Engineers can come in by designing affordable irrigation machinery such as water pumps and generators.

Secondly, one of the biggest threats to agricultural practice is climate change. This has led to erratic weather patterns that have disrupted agricultural seasons and led to low yields, especially for smallholder farmers who depend on rains. As the world converges in Glasgow, UK, for COP26, our engineering fraternity needs to contribute significantly to the fight against this monster. Even as we strive to mechanize agriculture, we need to design machines that do not add to the problem of carbon emissions. This is the future of machinery, and we must not be left behind.

Thirdly, market access is still a mirage for many farmers in the rural areas. In most cases, the road networks are poor and inaccessible, making transportation of agricultural products expensive. In the end, some crops are either left to rot in the farms due to lack of market or brokers take advantage and make a large profit at the expense of the poor farmer.

Finally, agricultural engineering as a programme in our universities still attracts dwindling numbers of students. If we continue to treat agriculture as an activity for the poor, old, rural dwellers and cannot get our young people interested in the mainstay of our economy, then the sector may never grow.

The Institution of Engineers of Kenya (IEK) through our various branches undertakes to conduct career guidance talks in schools to encourage young people to accept agricultural engineering courses at our universities to help create the critical mass of engineers required to move the country forward at an accelerated rate. Engineers are at the core of infrastructure development. Real development will only be achieved if the national and county governments embrace engineers.

In addition, there are important agricultural institutions and industries that have collapsed under our noses over the years. For example, what happened to the government-run middle-level agricultural colleges of the 1980s and 90s that trained extension workers? We need to push for their re-introduction now more than ever. The sugar industry has also collapsed as we watch, yet we have the capacity as a country to manage our factories. If we are to successfully revive this industry, the government and politicians must stop politicizing their management. Corruption in the sector must be fought with the zeal it deserves.

The Ministry of Agriculture should also keep a strong presence in the counties through training and deployment of extension workers right to the villages across the country.

This issue of Engineering in Kenya magazine is focused on tackling some of the issues discussed above, under the theme, 'Engineering, Agriculture and the Environment.' We hope you enjoy the read.


ENG. MARGARET OGAI

Message from IEK Honorary Secretary

ENGINEERS cut across the field in all areas of life. Where infrastructure is needed, an engineer will be there to plan, design, supervise and construct. From the earliest times, engineers have been involved in the agricultural sector, redirecting water by building canals and waterways for irrigation purposes. Another application of engineering in this area has been the design of machinery to harvest, thresh and process food.

Climate change is the modern threat to our lives, looming in the horizon but approaching at an uncertain speed. In some places, particularly coastal areas and islands, it has already begun to wreak havoc and alter lives, displacing people. It calls for the concerted efforts of everyone at all levels and spheres of life to see how we can mitigate these adverse effects.

This imminent threat will not be easily thwarted. Agriculture is the mainstay of our economy and many other African economies. Climate change threatens us in a very essential manner because it is our food supply and food security, our very livelihoods, that are endangered.

The Institution of Engineers of Kenya (IEK) is therefore concerned with the impact of climate change and what this portends for humanity. How can we as a profession work to create systems that can help us avert and, if we fail at that, mitigate the effects of climate change? Scientists predict that we are already on the precipice and if our current trajectory continues, it could be too late.

> This edition of our magazine is meant to bring home this message that we cannot continue to be ignorant of these matters or aloof to them. We can do something.

Temperatures are at alarming levels at 1.2°C above pre-industrial (1880) levels and are expected to reach 1.5°C by 2024. These kinds of levels are already shaping the earth as we know it, species are being wiped out and the environment and landscape are changing. Africa as a continent, which is the least emitter of greenhouse gases, is expected to bear the brunt of this failure to see, discern and act.

As I write, the United Kingdom is hosting the 26th UN Climate Change Conference of the Parties (COP26) in Glasgow and President Uhuru Kenyatta is representing our country at this important event. It is important for us, Engineers, to follow this conversation closely and take part in it. We have to see what we can do as a profession, right where we are, here and now.

This edition of our magazine is meant to bring home this message that we cannot continue to be ignorant of these matters or aloof to them. We can do something. We, as inhabitants of this planet and as the one group of people whose profession is to seek solutions and design them, have to start incorporating sustainability into all our projects. We have to work towards green designs, solutions to reduce carbon emissions and do all that we can so that our environment and conditions of living are wholesome to the human race.

As Kenyan engineers, we need to examine the agricultural value chain to identify interventions that we can work on to make the country an agro-processing hub. Value addition in this sector can help us attain our Vision 2030 goals and Big Four agenda by growing the contributions of the manufacturing sector to the Gross Domestic Product (GDP) and at the same time achieve food security. It is time to apply Industry 4.0 aspects such as the Internet of Things to achieve this long-awaited sectoral growth and sustained performance. Happy reading!

Strategic Interventions In Agricultural Mechanisation

By Eng. Richard Munyao Kanui

a. Introduction

AGRICULTURE is the backbone of the Kenyan economy contributing directly 34.1 percent of the Gross Domestic Product (GDP) in 2019 and another 25 percent indirectly, it accounted for 69.7 percent of total exports (KNBS, 2020). The agriculture sector employs over 80 percent of Kenya's rural work force and provides more than 15.5 percent of formal employment (KNBS, 2018). It generates about 70 percent of raw materials for agro-industrial production and generates 45 percent of government revenue. The sector is therefore a key driver towards the realization of the 10 percent annual economic growth envisioned in Kenya Vision 2030.

Agricultural mechanisation aims at increasing the power input to agricultural activities hence intensified production and enhanced value addition resulting to decreased cost of production and reduction of drudgery in agricultural activities. It also improves the timeliness and efficiency of farm operations; accomplishes tasks that are difficult to perform without mechanical aid; improves the quality and value of processed products; creates employment opportunities and sustainable livelihoods; provides agriculture-led industrialization and markets for rural economic growth among others.

The level of mechanisation in Kenya varies across various enterprises and value chains (AMRI Survey, 2016) with the average of about 25 percent. Land preparation has the highest level with wheat at over 95 percent. Planting operation is only mechanised in a few crops such as maize at 56 percent and wheat at 95 percent. Though labour intensive, weed control has realized only low levels of mechanization across enterprises with maize at 46 percent and tea at 14 percent. The highest application of mechanical weed control occurs in wheat at over 95 percent. Harvesting is another labour intensive operation that escalates production costs when done manually. mechanization in processing and value addition is also low across enterprises despite the existing huge potential. This is mainly due to limited awareness on technologies and high cost of machinery and equipment. Mechanization in livestock systems is mostly concentrated in hay baling, forage and feed production and stands at between 37.5 to 40.9 percent.

b. Statement of the problem

Agricultural machinery and equipment manufactured or imported into the country meet the general standards for performance and safety as guaranteed by Kenya Bureau of Standards. However, they do not undergo specific suitability testing for agricultural use in the country. The country is endowed with different ecozones and agricultural soils which require varied machinery and equipment hence the need for customisation to local conditions.

Agricultural mechanisation sub-sector receives only a small and inadequate proportion of the allocation to the agricultural sector. In addition, the public sector has inadequate capacity in provision of agricultural mechanisation services other than creating an enabling environment for private sector intervention. Moreover, there is inadequate legal framework regulating the various players in agricultural mechanization sub-sector.

c. Objectives

Objectives of strategic interventions in agriculture mechanisation are to:

(i). Create an enabling environment for development and adoption of agricultural mechanization through improved policy, legal and institutional framework.

(ii). Increase access and adoption of agricultural mechanisation through private-led service provision initiatives.

(iii). Provision and adoption of local standards and machinery testing

d.Strategic interventions

(i) Policy, legal and institutional framework

The Ministry in collaboration with stakeholders has developed a draft National Agricultural Mechanisation Policy (NAMP) 2021 that addresses challenges hampering the adoption and growth of agricultural mechanization sub-sector in Kenya. The aim of this policy is to sustainably raise the level of agricultural mechanization for increased productivity and income

of agricultural producers. This will be achieved through training, research and technology development, local manufacture and distribution, agricultural mechanization quality assurance, investments in mechanization services, extension and technology adoption and improved institutional and legal frameworks.

Further, the Ministry in conjunction with stakeholders has developed a National Agricultural Mechanization Bill 2021 that will contribute to improvement of productivity in the agricultural sector through the establishment of an Agricultural Mechanization Board and an Agricultural Mechanization Testing and Certification Centre.

(ii) Private sector-led agricultural mechanisation service provision initiative

In November, 2020 the Ministry of Agriculture, Livestock, Fisheries and Cooperatives in collaboration with stakeholders launched the Private-Led Agricultural Mechanization Initiative as a sustainable model for increased access to and adoption of agricultural machinery, equipment and services. This initiative involves both public and private sector aimed at transforming small holder farmers into successful entrepreneurs. It encompasses identification of viable farmers' producer organizations, including Cooperatives and linking them with service providers along value chains for access to necessary services such as farm inputs, machinery, aggregation, marketing, finance and credit as well as extension. The farmers under the producer organization are then incubated by Agricultural Technology Development Centres (ATDC) together with counties for a considerable period of time to gain requisite skill and build capacity to manage and operate on their own successfully.

The pilot phase of the initiative commenced in 2020 with the incubation of Bunyala Rice Farmers Cooperative Society mechanization hub in Busia County serving 713 farmers with a total acreage of 1000 ha under rice. Previously, farmers under the Cooperative employed manual labour and animal draught power in most farm operations with minimal use of farm tractors for ploughing. As such they could only manage an average yield of 15 to 20 bags of paddy rice per acre. The low yield being attributed to poor agronomical practices, high labour costs, untimely operations and grain lost in the fields during harvesting. The Cooperative has since been supported with 3 rice transplanters, 3 combine harvesters and a rice mill under this programme. Further, it received a financial credit amounting to 30 million Kenya shillings from Cooperative Bank of Kenya for marketing of farmers produce. The cooperative is also undergoing a 3 year incubation period in management and operation of their machinery by Siaya ATDC. As a result of the initiative, the yield has increased by 5 to 10 bags per acre. In addition, the Cooperative has already acquired 1 farm tractor from profits arising from implementation of the initiative. It is envisaged that at the end of the incubation period, the Cooperative would have mechanized all farm operations and milling of rice as well as develop the capacity to market all the rice produced by its members. Other pilot agricultural mechanization hubs have been planned for implementation including those for maize and potatoes in Uasin Gishu and Nakuru counties respectively.

A combine harvester provided to Bunyala Rice Farmers' Cooperative Society mechanisation hub harvests rice

e. Recommendations

The following recommendations are considered key in achievement of the goal in increasing level of agricultural mechanisation in the country.

(i) National and County Governments to identify producer organizations that amalgamate farmers' produce for market, for ease of access to finance, inputs and agricultural machinery services

(ii) National and County Governments to develop an agricultural machinery and equipment database for ease of information sharing

(iii) Agricultural equipment and machinery dealers to form and register an umbrella organization that would articulate issues affecting the industry.

f. Conclusion

The proposed policy, legal and institutional framework as well as the private-led mechanisation initiative presented above will go a long way in raising the level of agricultural mechanization from the current 25% to about 50% by 2030.

Eng. Richard Munyao Kanui is the Engineering Secretary,
State Department for Crop Development and Agricultural Research,
Ministry of Agriculture, Livestock, Fisheries and Cooperatives.

KENYA RURAL ROADS AUTHORITY

Easing access to resources and services

Hon. James Macharia,
EGH, *Cabinet Secretary, Ministry of Transport, Infrastructure, Housing, Urban Development and Public Works*

R10,000 Low Volume Sealed Roads Programme

Most of the roads in the country's network are either in earth or gravel standard. The national government was desirous in ensuring that most of the rural areas are accessible and with enhanced mobility. The government also saw the need to enhance the growth of the primary sectors of the economy and therefore adopted a programme of Roads 10,000 Low Volume Sealed Roads whose main objective was to improve 10,000Km to bitumen standards for a period of 10 years.

The concept was conceived, in Financial Year 2014/2015 when the idea of Public Private Partnership or Annuity large scale road upgrading roll out slackened and the Jubilee Government Manifesto of constructing 10,000Km of roads had to be realized. The initial contracts were awarded in January 2016.

The Programme is currently being implemented in forty-five (45) Counties as at 30th June 2021. The total length of road works procured to date is approximately 8,249.2Km at an approximate total cost of KShs. 368.7 Billion.

The implementation of the programme is in milestones basis where all certified works must comprise all components of the roads works up to the black top. There are two components of the low volume contracts

4,229.57 Km	Constructed / Upgraded Roads
5%	Potential impact on GDP

which include the upgrading works/contracts and the performance-based routine maintenance contracts. The upgrading works/contracts are implemented within the specified contract period whose expiry marks the start of defect liability period of 12months (for all projects). The second component of the contracts is the performance-based contracts where Contractors are required to maintain the road for a period of 36 months. The foregoing removed the role of maintaining the road from the Implementing Agency for the specified period. The Government has constructed/upgraded a total of 4,229.57Km of roads since the inception of programme.

It has been established in previous economic studies that with proper investment, a vibrant road infrastructure can generate up to 5% of the Gross Domestic Product (GDP). As articulated in the Road Sector Investment Plan (RSIP, 2011), for every shilling invested in roads, the country stands to gain two shillings and fifty cents in benefits.

It is therefore apparent that successful implementation of the programme will continuously contribute to the attainment of Third Medium Term Plan (2018-2022), the Big 4 Agenda and the sustainable development goals. Of great impact is the facilitation of the last mile connectivity from farm to market for farm inputs and outputs, support take-off of industrialization in the rural areas and reduction in road user charges and vehicle operating costs.

Prof. (Arch.) Paul Mwangi Maringa, CBS, *Principal Secretary, State Department for Infrastructure*

Prof. (Eng) Oyuko Mbeche, *Chairman, Board of Directors, Kenya Rural Roads Authority*

Roads sector contribution to the realization of Medium Term Plan III (2018-2022) of the Kenya Vision 2030

Medium Term Plan III (2018-2022) of the Kenya Vision 2030 focuses not only at increasing the level of investment but also enhancing the productivity of investment, as well as raising productivity in all sectors of the economy. In particular, MTP III aims at effecting structural changes towards increasing the shares of the manufacturing, industrial and exporting sectors in the economy. The Plan accords priority to development of Micro, Small and Medium Enterprises (MSME) sector of Kenya's economy and outlines measures to support the sector's growth. It accords priority to enhancing and developing foundations for economic transformation and enablers such as infrastructure, public sector reforms, science, technology and innovation and Information Communication Technology (ICT).

In the roads sector, the Government therefore seeks to provide an enabling environment for the realization of MTP III through:

i) Development, maintenance and rehabilitation of roads to ease access to resources and services thereby improving the living standards of Kenyans through reduction of road user costs, travel times and vehicle operating costs
ii) Provision of technical support to County Governments on road management
iii) Support take-off of industrialization in the rural areas.
iv) Optimization of financial, human and technological resources to provide quality infrastructure.
v) Distribution of roads development in a manner that promotes social equity.
vi) Enhancement of road safety

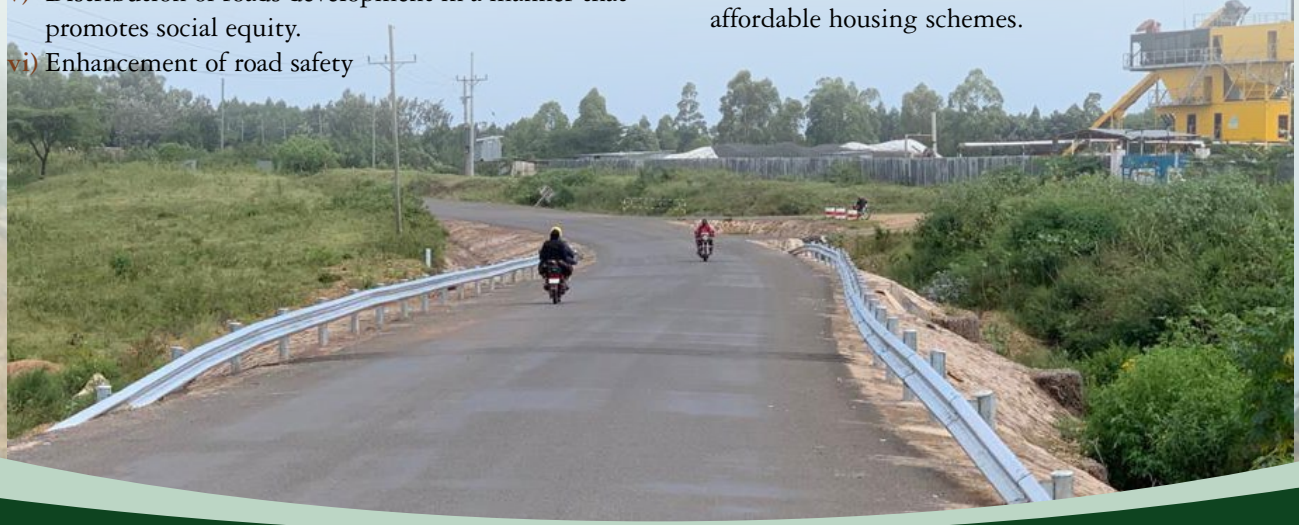
Roads Sector contribution to the Big 4 Agenda

The Government has prioritized policy objectives under "The Big 4 Agenda" that will lead to accelerated growth of the economy where it seeks to build on the progress made so far under the socioeconomic transformation. The Big 4 Agenda targets to: -

i) Focus on initiatives that guarantee food security and nutrition to all Kenyans by 2022;
ii) Support value addition and raise the manufacturing sector share of GDP to 15 percent by 2022;
iii) Provide universal health coverage thereby guaranteeing quality and affordable healthcare to all Kenyans; and
iv) Provide affordable housing to Kenyans by targeting construction of at least five hundred thousand houses by 2022.

In support of the Big 4 Agenda, the roads sector plays the following roles: -

i) Facilitate the last mile connectivity from farm to market for farm inputs and outputs.
ii) Employment creation through road construction leading to improved quality of life through food and nutritional security.
iii) Liaise with County Governments to ensure that all roads serving health facilities are accessible at all times.
iv) Opening up devolved Kenya to access raw materials for manufacturing, value addition and ease transportation of processed goods.
v) Providing access to areas designated for the affordable housing schemes.



Eng. Philemon Kandie,
Ag. Director General,
Kenya Rural Roads Authority

Roads Sector contribution to the Sustainable Development Goals

The Government of Kenya is committed to the attainment of the United Nations Sustainable Developments Goals (SDGs). There are a total of 17 SDGs which aim to enhance the quality of life of the world's citizens. Each goal has a specific target to be achieved over the next 15 years. Roads Sector contributes to the realization of the following SDGs: -

Sustainable Development Goal	Role of Roads Sector
Goal No. 1: End poverty in all its forms everywhere	• Job creation through road construction and maintenance • Facilitate access to resources and services hence spurring socioeconomic development
Goal No. 2: End hunger, achieve food security and improved nutrition and promote sustainable agriculture.	• Construct and maintain roads to enable production and distribution of food.
Goal No. 3: Ensure healthy lives and promote well-being for all at all	• Providing access to health facilities • Development and maintenance of Non-motorized facilities to enhance road safety and promote healthy lifestyles
Goal No. 4: Ensure inclusive and equitable quality education and promote life-long learning opportunities for all	• Providing access to educational facilities • Provide linkage between learning institutions and the industry
Goal No. 5: Achieve Gender Equality and Empower All Women and Girls	• Ensure that roads sector is an equal opportunity employer. • Implement fully gender mainstreaming policies for the roads sector to achieve gender parity
Goal No. 6: Water and Sanitation	• Upgrading of the rural roads to bitumen standards and construction and maintenance of drainage systems. • Rehabilitate borrow pits.
Goal No. 8: Promote Sustained, Inclusive and Sustainable Economic Growth, Full and Productive Employment and Decent Work for all.	• Promote R2000 strategy for job creation • Design and implement internship and training programs. • Full implementation of Access to Government Procurement Opportunities (AGPO).
Goal No. 9: Build Resilient Infrastructure; Promote Inclusive and Sustainable Industrialization and Foster Innovation.	• Adopt maintenance programs to sustain quality, reliable, and resilient road infrastructure. • Supporting research and innovation for cost effective building materials. • Reduce adverse impact of road construction on the environment. • Promote use of local construction materials.
Goal No. 10: Reduced inequalities	• Adopt policies that promote equal and equitable opportunities for social, political and economic inclusion. • Ensure efficient and safe mobility for people, goods, and services across the country.
Goal No. 13: Take urgent action to combat climate change and its impacts	• Undertake environmental impact assessments and audits. • Embracing innovative technologies that deal with climate change. • Restoration of vegetation cover.

Objective of the Low Volume Seal Technology

In Kenya, a substantial proportion of the road network is generally earth or gravel standard. Majority of the road network is in poor condition and mostly severed during heavy rains causing high transport costs and unreliable access. At the same time, there are increased demands for improved access and mobility from the rural communities, to support the primary growth sectors of the economy as well as improving socio-economic conditions and reducing poverty.

Roads are vital to economic development, but can be very expensive, especially if the performance of the road's pavement is not properly designed. It is therefore important that suitable methods of design and materials selection are done carefully for the wide range of road classes and conditions that the roads are expected to endure.

The Government pledged 10,000Kms of roads to open up rural areas, decongest major towns, and promote domestic and regional connectivity. The road agencies embarked on the R10000 Programme on the Low Volume Sealed Roads technology to achieve the quantum leap of delivery of the Government's developmental goal in an optimised cost effective way. The delivery of the Low Volume Sealed Roads is guided by guidelines developed by Materials Testing and Research Division based on Road Design Manual Part III: Materials and Pavement Design for New Roads, 1987 and ensures that cases of overdesign do not occur. Traditionally, specifications had been more often than not superfluous leading to very heavy and unwarranted investments. A case in point are specifications for road works in rural areas where specifications for high-design speeds were used with the resultant re-alignment of roads requiring land acquisition, resettlement action plans, relocation of utilities, among others, while specifications that allow for all weather mobility would suffice. By the LVSR technology, the cost of road construction in rural areas have been reduced by more than 60 per cent.

The Road Design Manual Part III are considered to be very successful but does not provide for pavement structures for traffic loading below 250,000 cumulative equivalent standard axles (CESA). Further, the pavement structures provided for traffic loading between 250,000 and 1,000,000 CESA are based on permissible subgrade strains for 1,000,000 CESA and are therefore mostly overdesigned. Roads with traffic below 250,000 CESA could therefore not be designed to paved standards using the manual and have had to be designed for improvement to gravel standards. However, construction of gravel roads is becoming increasingly expensive because of depletion of the existing gravel sources and high rates of gravel loss due to traffic attrition, environmental factors and poor workmanship resulting to high frequency of re-gravelling which cannot be sustained due to budgetary constraints.

It was therefore imperative to adopt a design that enables upgrading of low volume roads to sealed/paved standard to increase the pavement life to at least 15 years to lower whole life costs. The guidelines developed provides for pavement catalogues for upgrading of low volume roads to paved standards using locally available materials to the maximum extent possible.

Analysis of Seasonal Rainfall and Temperature Data for a Period of 30 Years in Kieni, Nyeri, to Establish Trends

By Eng. Dr. Jedidah W. Maina

INTRODUCTION

CLIMATE change occurs when average climatic patterns for a region shift from norm over a long time usually decades. The two climatic parameters that are mostly considered when we talk about climate change are temperature and rainfall and especially change in mean temperature.

Climate change is here with us and it needs to be addressed as it affects many economic sectors in the world. The worldwide climate change has received awareness since 1990 when IPCC first assessment report was published (IPCC, 1990). The mean global surface temperature has gone up by 0.8°C in the past 100 years and 0.6°C in the last 3 decades (Hansen, Sato, Ruedy, Lo, Lea, and Medina-Elizade, 2006) and it is mostly attributed to human activities (IPCC, 2001). Temperatures in Africa are rising and "by the end of this century they are likely to have gone up by 2°C relative to 20th century," according to the IPCC Fifth Assessment report (IPCC, 2014). Surface temperatures will continue to rise, due to climate change according to Global Circulation Models (GCM) simulations (Matzarakis & Amelung, 2008). Global models show that if nothing is done to bring down the worldwide carbon emissions, the global surface temperature is likely to exceed 2°C relative to the 1850-1900 period by the end of this century (Murphy & Tembo, 2014).

Impacts of Climate Change on Agriculture

Vulnerability of a country to changes in climate is related to its development position as shown by the contrasting impacts of climate change on divergent quarters of a country's economy (Richards, 2003). Agricultural sector is one of the economic sectors at risk from the effects of climate change (Richards, 2003). Based on observed climate trends, it was evaluated that the effects of increasing temperatures since 1981 had contributed to combined yearly losses of wheat, maize and barley yields (Lobell & Field, 2007).

According to IPCC 2014, it is anticipated that by 2050 temperate areas will undergo increased crops yields related with predicted mean temperature rise of 1-3°C, whereas water constrained tropical regions will experience a reduction in yields. In the equatorial regions, farming undertakings come about close to the thresholds of heat tolerance and moisture accessibility, suggesting that the climate change impact is probably very bleak (Zhao, Wang, Wang & Tibig, 2005).

> Inconsistent rainfall accompanied with acute dry spells are the greatest dangers facing Kenya's agricultural sector, with extreme impact on crop production (D'Alessandro & Caballero, 2015). According to the Economic Survey Report Highlight of 2014, growth in Kenya's agricultural sector dropped from 4.2% in 2012 to 2.9% in 2013, the fall was attributed to insufficient rainfall experienced in some grain growing regions (Government of Kenya, 2014).

Central Kenya is among the most productive regions agriculturally, however, notable changes in both temperature and precipitation trends have been experienced in the area. Research done in Nyeri County has shown that rainfall received in the area has been declining in every 3 to 4 years (Karienye, Mwangi, Kaguai, Waweru and Muthoni, 2012).

MATERIALS AND METHODS

Study Area

The study area was Kieni sub-county located in Nyeri, Central Kenya. The area annual rainfall is influenced by Mt. Kenya to the east and Aberdare Ranges to the west with over 4,000m and 3,000m above sea level respectively. Kieni sub-county receives yearly precipitation of 500mm (Wamicha, 1993) and is therefore classified as a semi-arid area.

Analytical Methods

Detecting trends of rainfall and temperature was done by Mann-Kendall test (Gilbert, 1987) and Sen's slope estimates Application, an Excel template by Finish meteorological institute (MAKESENS 1.0, 2002). Mann Kendal test (Mann, 1945; Kendall, 1975) is a statistical test commonly used to analyse time series data. The test is non-parametric and has a low sensitivity to inhomogeneous data. It is fit for the data series where the trend may be assumed to be monotonic with no cycle present. Depending on the total number of data values, MAKESENS performs two types of statistics. The S- statistics is used if the number of values is less than 10 while the Z- statistics is for data values equal to or greater than 10. Sen's non-parametric estimator method has been used for predicting the magnitude or true slope of various time series data and it uses a linear model for trend analysis. This is the measure of change per unit time period, in this case a year.

RESULTS

The March April May (MAM) rainfall season had positive average Mann-Kendall test value of 0.33 and positive Sen's slope average value of 0.318: an upward rainfall trend. The OND rainfall season had an average Mann-Kendall test value of -0.06 and an average Sen's slope value of 0.02. The OND average rainfall results showed a decreasing rainfall trend. The highest mean rainfall for both seasons was experienced in April with 115.2mm. The average Mann-Kendal test for MAM season was 1.09 while the average Sen's slope for the season was 0.016. The same tests for OND returned the values of 1.55 and 0.025 as the results for Mann-Kendall and Sen's slope, respectively. The MAM and OND average maximum temperature trend analysis showed an upward trend.

Discussion

The findings from this study suggest that the MAM rainfall in Kieni sub-county had marginally increased and the OND seasonal rainfall had a downward trend in the 1984-2013 period. The study findings also suggest MAM and OND temperature in the study area to have an increasing trend for the 1983-2012 period. It is projected that agriculture being among the major economic sectors which are susceptible to climate change impacts, it is important to therefore analyse rainfall and temperature trends of a region (Pearson, Nelson, Crimp & Langridge, 2011).

It has been reported that rainfall received in Nyeri has been decreasing every 3 to 4 years (Karienye, Mwangi, Kaguai, Waweru and Muthoni, 2012) though Nderitu, Oludhe, Ali, Omondi & Makui (2016), reported declining long rains between 1985 and 2015. From our time series trend analysis, long rains that fall between March and May were increasing while the short rains were decreasing. However, the MAM rainfall season trend upward movement could have been due to the months of April recording the highest rainfall of over 240mm which is almost halve of the area's annual rainfall of about 500mm (Wamicha, 1993).

With a projected rise in minimum surface temperatures and decrease in seasonal rainfall under climate change (Knowles, Dettinger & Cayan, 2006) local conditions, especially the amount of water present in the soil, may be reduced significantly due to loss from evaporation. The decreasing seasonal rainfall and increasing seasonal maximum temperatures in Kieni sub-county would affect the status of soil moisture and in turn plant growth (Tietjen, et al., 2017). The MAM and OND seasonal temperature trends were in upward movement suggesting increasing rate of evapotranspiration occasioning loss of soil moisture.

CONCLUSION

The MAM rainfall data analysis resulted to an upward trend which was found to increase at a rate of 0.318mm/year. The MAM maximum temperature trend analysis determined a rising trend increasing by 0.016^0C/year. The months of April had the highest mean rainfall of over 115mm as well as the highest recorded of over 240mm in a single month. Kieni sub-county's annual rainfall was 500mm suggesting that about halve of the annual rainfall was experienced in one month which could have resulted to floods which are as destructive to crops. The season's upward surge in rainfall could also have been reversed if the moisture was lost through evapotranspiration from the increasing temperature as the highest temperature was recorded in March with over 28^0C.

The OND season rainfall analysis resulted in a decreasing trend at a magnitude of 0.02mm/year while maximum temperature was found to increase at a magnitude of 0.025^0C/year. October received the highest seasonal rainfall of over 200mm while November received the highest seasonal mean at 80.5mm. Though October received the highest rainfall it recorded the highest seasonal mean temperature of 24.5^0C. The seasonal rainfall and temperature trends were both rising. OND seasonal maximum temperature increased by more than 56% as compared to the MAM temperature.

In conclusion, climate change and variability has the potential of affecting the growing of some crops due to increased temperatures and declining rainfall, reduced soil moisture and increased population of crop pests, hence the need to be considered seriously by all governments.

Eng. Dr. Jedida Maina is a lecture at the Technical University of Kenya (TUK)

Soil and Water Conservation Engineering: Principles and Practice

Eng. Prof. Elijah K Biamah

SOIL and water conservation engineering can be defined as the principles and practices that protect the productive capacity of the land from soil, water and vegetation degradation. These principles and practices involve the design and application of soil, water and vegetative structures. The major factors that trigger soil erosion and loss of land productivity include deforestation, over-grazing, mismanagement of cultivated soils, intensive cultivation and intensive urbanization.

The primary objective of conservation structures/practices should be that of developing relevant environmental, technical, socio-economic, gender and socio-cultural know-how which would not only conserve existing soil and water resources but help improve soil fertility and productivity for increased water and food security to meet the requirements of the ever increasing population.

In most countries of Africa, soil moisture conservation for crop production is a priority due to the prevailing marginal rainfall patterns. Hence conservation efforts should focus on the reduction of soil loss and surface water runoff as well as the conservation of soil moisture and nutrients using appropriate technologies. Coupled with the foregoing, changing land use patterns have led to serious environmental problems i.e. diminishing groundwater supplies, sedimentation of water retention reservoirs and deteriorating water quality of both surface and ground water.

Some key priority areas of soil and water conservation are:

(1) Soil and water management technologies like residue mulching, contour tillageand tied ridging, minimum tillage, subsoiling, crop rotation, cover cropping, rotational grazing, contour ripping and direct application of organic manure (farmyard manure) and inorganic fertilizers that improve soil fertility and productivity must be considered. The objective of any soil and water management exercise should be to improve soil structure, minimize surface sealing, crusting and compaction, increase soil water storage, improve effective use of stored water, increase infiltration, minimize soil water loss by evaporation and hence conserve moisture. Management of saline and sodic soils and wetlands is a priority in drylandfarming areas. Runoff water harvesting and conservation for increased crop production is yet another priority in marginal rainfall areas.

(2) Adapting water resource management to climate change is one of the basic drivers of change for water, alongside demographic, economic, social and technological factors. Policies, laws and finance also condition the impact of thesebasic drivers. These factors are interrelated and the outcome is evolving in a dynamic fashion. Climate change can affect water resources directly, but also indirectly through its impact on the other drivers. From the supply side, climatechange can directly affect the water cycle and, through it, the quantity and qualityof water resources available to meet human and environmental demands. Mitigation measures, including the reduction of greenhouse gas emissions, transferring clean technologies and protecting forests, are crucial to dealing withclimate change.

(3) Rainwater Harvesting and Conservation technologies. Some of the rain waterharvesting and conservation techniques are as follows:

(i) Below ground tanks

Below ground water tanks of sufficient capacity could be constructed of bricks/stones orlined with butyl rubber membranes. Where possible a well-constructed metallic roof structure of side dimensions of 5m x 20m could be put in place with a gutter and down pipe to drain rainwater into either of the tanks. The butyl rubber lined tank is much cheaper to construct. However, it must include a well reinforced metallic cover to preventlivestock, wildlife, children and mosquitoes from accessing the water directly. A hand held water bucket could be ideal for drawing the water. The water could also be treatedwith chlorine directly before use.


Digging of rectangular pits for rain water harvesting


Lining of the pits with a butyl rubber membrane to prevent seepage of harvested rain water.

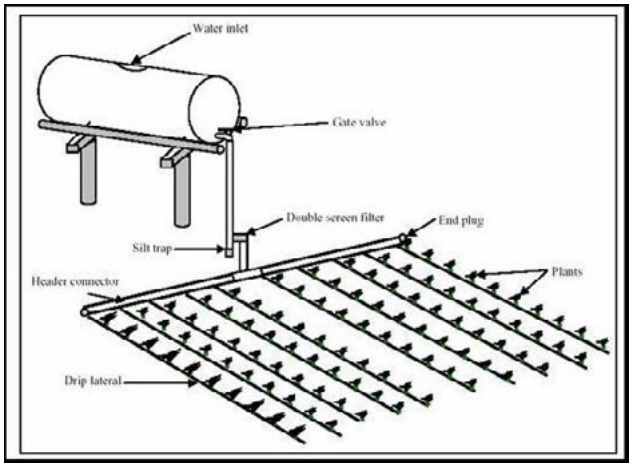
(ii) Water conservation in Earth dams.

A circular water hole that could be lined with a butyl rubber membrane to meet livestock water requirements

(4) Drip Irrigated Agriculture

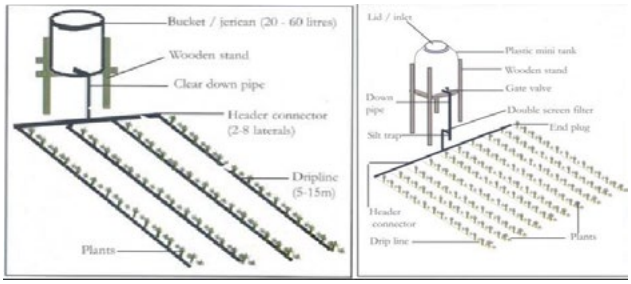
One alternative livelihood intervention is that of irrigated vegetable and horticulture production technology. Thus in Africa, there is the need to improve agricultural production through the introduction of small scale irrigated vegetable and horticulture production in households using simple gravity fed drip irrigation systems. For example, a complete simple drip irrigation kit comprising of a 20-litre container, drip lines with online emitters and other accessories. This system can apply water at the rate of 20 litres/day to 100 plants. This technology is available in some African countries where this drip irrigation system is on sale. Depending on farmers' preferences, intermediary systems with storage capacity between 20-200 litres are also available. The system can also be up-scaled beyond 200-litres even up to 5,000-litres where bigger storage facilities are available or where the system can be connected directly to a household water supply system. Thus the irrigation equipment can be used to cover between 15 m2 to 4,000m2. of land. The cost of intermediary and up-scaled systems is proportional to the size and material used.

Different sizes of a simple gravity fed drip irrigation system showing the other accessories (including the drip pipes).



Layout of a simple gravity-fed drip irrigation system

Demonstration of dream drip irrigation system to a rural community in semi-arid Kenya



Layouts of two different sizes of gravity fed drip irrigation systems

(5) Storm Water Management

There has been a growing concern in many countries of Africa for the control and mitigation of flood water damages and associated disasters. Whereas the causes of floods may be varied, there are strong linkages between land and water management in upper catchments, land use policies in flood-prone areas and the costs of flood water damages and of its prevention. This obviously places the subject of stormwater management within many national water strategies.

A promising trend towards a more positive involvement of local communities in the conservation and management of the environment and water has been observed. This participation of communities may offer a great opportunity for sustainable management of water resources.

Increasing population growth continues to set a heavy demand on land and water resources and induce trans-boundary conflicts and competing water demands because of changing needs. Environment and ecosystem degradation is becoming increasingly visible as well. Thus the emphasis should focus on the management of land and water as finite resources and on the co-ordination and integration of water, land-use, and population policies for sustainable development.

Eng. Prof. Elijah K. Biamah, Department of Environmental and Biosystems Engineering, University of Nairobi (elijahkngetich@gmail.com)

(Photo Courtesy)

Simulation of Environment of Greenhouses

By Januarius Ondiek Agullo

1. Introduction

A greenhouse is a structure with walls and roof made mostly of transparent material in which plants can be grown. A greenhouse is used to control and modify climatic factors that affect the growth of such plants. The plants are usually high value horticultural crops and the greenhouse microclimate determines their quality. Also, greenhouses enable a better control of pests, weeds and diseases that may infest plants grown within it. In Kenya, greenhouse technology is adopted widely, especially in the growing of high value horticultural crops like tomatoes, capsicum, cucumbers, jalapenos, strawberries, herbs, and spices etc.

Simulation is the imitation of the behaviour of a real world physical system or process in a computer. A mathematical model is usually used represent the behaviour of the system. A simulation model can help one gain a deeper understanding of physical system it represents and so are simulation models used to represent a greenhouse system.

A greenhouse simulation model can be steady state or dynamic in its design. A steady state model is appropriate for analyses of heating and ventilation requirements of a greenhouse. A dynamic model is good for evaluating effect of changes in design parameters. A greenhouse simulation model can thus be a useful tool in design situations or maintenance situations where optimization of physical parameters such as temperature and humidity are desired.

In developing a greenhouse simulation model development process, one can aim at come up with a static or a dynamic model. But generally, it all starts by identifying the pertinent physical parameters that could affect the microclimate of a greenhouse; using parameters identified to develop a mathematical model of the microclimate of a greenhouse; using computer to numerically solve the model developed and finally, verifying and validating the computer simulation model developed using experimental data collected from a physical model greenhouse.

Verification means that the correctness of computer the solutions of the mathematical model is checked and confirmed while validation is the comparison of the model output with that from a physical model of a greenhouse. Statistical analysis of the data should confirm whether the model accuracy is good enough.

2. Governing equations

The equations governing fluid flow within a greenhouse are based on fundamental physical conservation principle of mass, momentum and energy. At any moment in a greenhouse change in fluid mass can be considered to be zero; change of momentum of fluid mass (air) is given by force (surface and body forces) multiplied by time; and energy content of the greenhouse system must balance work done and heat supplied. These conservation principles may be expressed mathematically as integral equations or differential equations.

The integral approach considers how the total amount of a physical quantity (mass, momentum, energy, etc.) within the greenhouse is changed over an interval of time, Equation 1.

$$\text{CHANGE OF QUANTITY} = ((\text{QUANTITY IN} - \text{QUANTITY OUT}) + \text{QUANTITY CREATED}) \quad (1)$$

Equation (1) can be converted into a rate form by dividing by the time interval, Equation (2).

$$\left(\begin{matrix}\text{RATE OF CHANGE}\\ \text{inside greenhouse}\end{matrix}\right) + \left(\begin{matrix}\text{ADVECTION + DIFFUSION}\\ \text{through boundary of greenhouse}\end{matrix}\right) = \left(\begin{matrix}\text{SOURCE}\\ \text{inside greenhouse}\end{matrix}\right) \quad (2)$$

The flux (rate of transport through a greenhouse surfaces/faces) can be subdivided into: advection (movement with the flow) and diffusion (net transport by random molecular or turbulent motion)

Equation (2) is the generic equation and most physical quantities of interest in a greenhouse satisfy it, irrespective of whether the physical quantity is mass, momentum, chemical content, etc. It is referred to in literature as the generic scalar-transport equation.

Therefore, in a simulation of fluid flow in a greenhouse, we generically solve two major equations which are recasts of Equation (2): mass conservation (continuity) equation, Equation (3) and the scalar-transport (or advection-diffusion) equation, Equation (4).

$$\frac{d}{dt}(mass) + \sum_{faces}(mass\ flux) = 0 \quad (3)$$

$$\underset{\text{rate of change}}{\frac{\mathrm{d}}{\mathrm{d}t}(\text{mass} \times \phi)} + \underset{\text{advection}}{\sum_{\text{faces}}(\text{mass flux} \times \phi)} - \underset{\text{diffusion}}{\Gamma \frac{\partial \phi}{\partial n} A} = \underset{\text{source}}{S} \quad (4)$$

where t is time; ϕ is the concentration (amount per unit mass of fluid) of a given physical quantity e.g. temperature, humidity, carbon dioxide concentration etc.; r is the diffusivity and A is the area of a given surface (face) of the greenhouse.

Differential forms of the flow equations may be conservative (i.e. can be integrated directly to a form similar to Equation (1) or non-conservative. The conservative differential form of Equation (4) is as expressed in Equation (5):

$$\frac{\partial(\rho\phi)}{\partial t}+\frac{\partial}{\partial x}\left(\rho u\phi-\Gamma\frac{\partial\phi}{\partial x}\right)+\frac{\partial}{\partial y}\left(\rho v\phi-\Gamma\frac{\partial\phi}{\partial y}\right)+\frac{\partial}{\partial z}\left(\rho w\phi-\Gamma\frac{\partial\phi}{\partial z}\right)=s \quad (5)$$

where p is density of the fluid, u, v, w are the velocity component of the fluid in x,y, z directions respectively and source,s , is now given per unit volume.

Each velocity component (u, v, w) satisfies its own scalar-transport equation which is developed by replacing ϕ in Equation (4) or (5) with that specific component. The resulting partial differential equations are 3-dimensional, coupled through the pressure forces and advective fluxes and non-linear. Also, solving them requires that the velocity field be mass-consistent.

It is not possible to solve these equations analytically in there raw form. However, the equations can be simplified by reducing dimension, neglecting some fluid properties, simplifying forces or approximating some fluid properties by averaging etc. to allow for basic analytical solutions. Such reductions reduce the accuracy of the resulting mathematical model. However, it is possible to obtain approximate computer-based solutions to the equations, while maintaining most of the general properties of the equation via a methodology referred to as Computational Fluid Dynamics (CFD).

CFD may be defined as use of computers to solve fluid flow problems numerically. The CFD strategy involves discretising the flow field variables, i.e. the field variables values are approximated at finite number of nodes within the computational domain. The governing equations (integral or differential) are also approximated in terms of values at the nodes by converting them to approximate algebraic equations. The resulting system of algebraic equations is then solved to give values at the nodes. The major discretization methods include the Finite Difference Method (FDM), the Finite Volume Method (FVM) and the Finite Element Method (FEM).

The main stages of a CFD simulation are thus pre-processing, which involve formulation of the problem, i.e. governing equations and boundary conditions are identified and computational mesh is build; solving, which involve discretisation of the governing equations and finding solution to the resulting set of algebraic equations; and post-processing, which involves visualisation of the solution using graphs and plots of the solution and analysis of the results.

3. Model development: A case of 1D dynamic model

Mathematical model

In a simplified case of one 1D simulation of a greenhouse environment using the simplified form of Finite Volume Method (FVM), we take greenhouse elements of interest as cells (layers) in which a given physical quantity of interest is assumed uniform across the volume. The layers interact with each other and the thus the resulting equations representing a physical quantity of interest are coupled. We, therefore, can recast Equation (4) to represent the greenhouse system with a system of differential equations of the general form:

$$\frac{dY(t)}{dt}=f(Y(t),U(t),P(t),V(t),C,t) \quad (6)$$

where $Y(t)$, is a m-dimensional vector of state variables, $U(t)$ is a n-dimensional vector of input variables, $P(t)$ is a o-dimensional vector of disturbances, $V(t)$ is a p-dimensional vector of system variables, C is a q-dimensional vector of system constants; t is the time; f is a non-linear function based on mass and heat transfer balances.

Model assumptions

Some assumptions may be necessary when simulating a greenhouse environment using Equation (6) and assumptions made may depend on the type of the greenhouse to be simulated. In 1D simulation of a naturally ventilated greenhouse we may assume that:

- the greenhouse is divided into elements that may be the cover, internal air, vegetation, soil surface and soil layers.
- the state variable of the model maybe be taken as the internal air temperature and humidity, cover temperature, vegetation temperature, soil surface temperature, and soil layer temperatures.
- the disturbance inputs of the system may be taken as the outside air temperature and humidity, wind speed, sky temperature, deep soil temperature, outside solar radiation and the evaporation rate inside the water pools on the soil surface
- the control input of the system may be taken as natural ventilation
- the heat fluxes are one-dimensional and model only considers the vertical dimension.

Model solution

A dynamic computer simulation code can be written in any programming language to numerically solve the system of non-linear differential equations resulting from Equation (6). Any method of solving nonlinear differential equations, e.g. the fourth-order Runge-Kutta method, maybe used. For a given state variable e.g. temperature of the greenhouse elements of interest, an equation of the form:

$$\mathbf{y}'(t)=\mathbf{A}y(t)+\mathbf{u}(t) \quad (7)$$

where $y'(t)$ is the column vector of state variables, $y^k(t)$; is the independent variable, time in this case. A is the square matrix, which may be a function of or of the state variable y; $u(t)$ is a column matrix with elements, $u^k(t)$ representing inputs into the system.

3.4 Model verification and validation

Verification is confirmation that a developed greenhouse simulation model is mathematically sound and does what it is supposed to do. Validation is comparison of a simulation output with a data collected from physical greenhouse.

Figure 1 shows the output of a sample run of a greenhouse simulation model developed by the author. Simulation solves Equation (7).

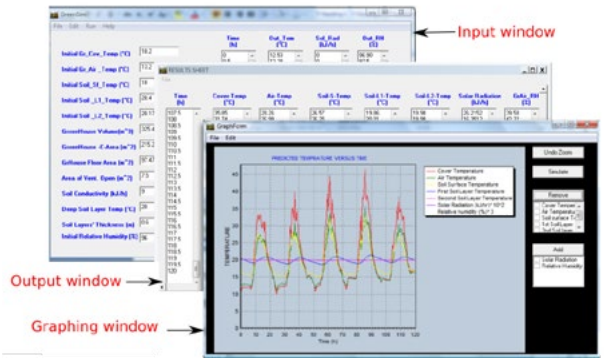


Figure 1: A sample run via Graphical user interface of the simulation tool, *Greensim*, developed by the author at University of Nairobi Department of Environmental and Biosystems Engineering. The data was used in the simulation was collected from a single-span greenhouse located at the Field Station, Kabete Campus, University of Nairobi. The external climatic parameters used in validation were global solar radiation, wind speed, ambient temperature and external relative humidity.

Model solves the energy and mass balance equations for given boundary conditions at time steps of one minute, to obtain the unknown temperatures of cover, air, vegetation, soil surface, first soil layer and second soil layer, and relative humidity of air in a greenhouse. The input is fed via a user interface. User interfaces to simulation tools are useful as they hide the technical details away from the user, thus allowing efficient use of the tool and easy interpretation of the simulation output.

The simulation output of a model as shown in Figure 1 should be compared with observed measurement from a physical green greenhouse. Figures 2 and 3 compare the out of greenhouse temperature and relative humidity predicted by the simulation model and those measured in the experimental greenhouse.

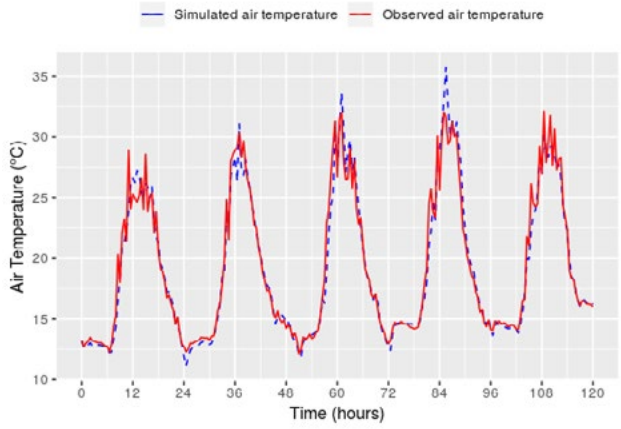


Figure 2: Simulated and observed Diurnal cycles of the greenhouse air temperature over the period of five days

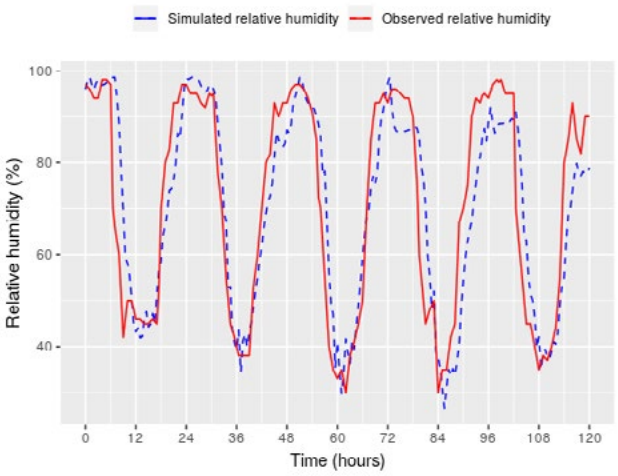


Figure 3: Simulated and observed diurnal cycles of the relative humidity of greenhouse air over a period of five days

In addition to the graphical comparisons, statistical analysis should be carried out to ensure that any similarity or difference between the observed and predicted physical quantities are not by chance. In the cases for Figures 2 and 3, good agreements were obtained between the simulated and measured values for greenhouse air temperature and relative humidity. The coefficient of determination, R2, of the measured and simulated greenhouse air temperature, and greenhouse relative humidity were 0.96 and 0.80 respectively.

Simulation tools, such as the Greensim, discussed above, can be used by greenhouse designers to predict the behaviour of yet to be prototyped greenhouses. Also, greenhouse maintainers may use such tools to predict the behaviour of installed greenhouses to enable quick interventions where and when problems are predicted.

4. Conclusion

Greenhouses are used to control and modify climatic factors that affect growth of plants. Simulation models aid in design and maintenance of greenhouses. Simulation models may be static or dynamic. The mathematical model is usually a set of non-linear differential equations that represent momentum, energy and mass balances between greenhouse elements: cover, air, vegetation, and soil etc. Computer code can be written to numerically solve the model as demonstrated by the simulation tool, Greensim, developed by the author. Any simulation model must be verified and validated to test its accuracy before being put into use. Once validated a simulation model can be used to test the effect of climatic conditions, covering materials, soil types, and greenhouse vent area, etc. on the microclimate of a greenhouse.

Januarius Ondiek Agullo is a lecturer at the Department of Environment and Biosystems Engineering, University of Nairobi

Investing In Environmental Energy Efficiency For A Greener World

By EiK Correspondent

FOLLOWING the effects of Covid-19 pandemic, focus across the globe shifted to rebuilding battered economies in the latter part of 2020 and 2021. However, while doing so, pressure remains on keeping carbon gas emissions low while promoting growth and creating jobs.

According to experts, time is now if the world is to achieve the goal of the Paris Agreement: to cap the increase in global temperature at 1.5°C. The most cost-effective and efficient path to attain these climate goals, and at the same time recover world economies, is by investing in energy efficiency.

"78% of global emissions are generated by buildings, transport and industry, and we have the energy-efficient solutions to lower them substantially, now. By doing so, we will reduce our overall need for energy and thus also the need for extra energy capacity and infrastructure in e.g. renewables," says Danfoss, a leading green energy company.

This will enable a faster rollout of renewable energy sources and creation of sustainable, green jobs, as it moves the world closer to achieving the global climate goals. "A green and sustainable restart will speed up the green transition. The solutions are ready. Now, it is about scale and speed of implementation," adds Danfoss.

Sustainable buildings for greener cities

According to the International Energy Agency (IEA), buildings account for nearly 40 per cent of global energy consumption and about a third of global greenhouse gas emissions – and have massive potential for energy savings.

Ambitious and binding annual renovation targets for different categories of buildings will ensure they increase their energy efficiency and emit less gas. At the same time, it will lead to an increase in economic activity by retaining and creating jobs.

In 2019, seven per cent of total global employment – or 220 million jobs – depended on such investments. The building sector presents an untapped opportunity to respond to the climate crisis, reiterates Danfoss.

De-carbonised future for industry

Global manufacturing industry is responsible for 25 per cent of the final energy consumption and about 20 per cent of total greenhouse-gas emissions. The Danish climate partnership for the manufacturing industry has announced an ambitious target; to become the world's first climate-neutral industry by investing heavily in energy efficiency and electrification.

> Introducing higher energy-efficiency standards for manufacturing processes will allow industries to become cleaner and more competitive, and offers massive – and largely untapped – potential.

To ensure stimulation of economic growth does not lead to increased emissions, it is essential to separate the two. And it's possible; since the 1980s, Denmark's GDP has more than doubled – while emissions have decreased.

To achieve that and more, decarbonised industry rests on a combination of increasing energy efficiency, electrification, sector integration and scaling up renewable energy.

"To drive this change, ambitious political action is required. That's why we are advocating for higher national and EU targets for energy efficiency to create pressure and incentives to act boldly," says Danfoss.

"Energy efficiency is not a strategic focus area in most industrial sectors, and investments in energy efficiency are competing with many other potential industry investments. Therefore, to unleash the potential, a strong legislative framework, incentives and funding are required."

National Irrigation Authority

From the Desk of the Chief Executive Officer

Gitonga Mugambi, Chief Executive Officer

Eighty percent (80%) of the land in Kenya is arid and semi-arid. Regardless, agriculture is still the backbone of Kenya. This tasks the National Irrigation Authority with the a huge mandate; to provide and coordinate sustainable development and management of irrigation services in Kenya hence majorly invested in engineering, agriculture and environmental sustainability. The Authority strives to ensure access to water in every irrigable acre in an effort to support sustainable food security and socioeconomic development in Kenya and for connected purposes in line with the Big 4 Agenda and Vision 2030.

The Authority has implemented several projects across the country (Kenya) in fulfilment of its mandate namely; Mwea, Lower Nzoia, Bura, Lower Kuja and Turkana irrigation development projects, Galana Kulalu Food Security Project, Expanded National Irrigation Programme, and Household Irrigation Water Storage Programme to mention but a few.
Mwea Irrigation Development Project (MIDP) consists of two packages, ICB Package 1 and ICB Package II. ICB Package I entails construction of Thiba Dam and appurtenant structures to increase the volume of irrigation water for Mwea Irrigation Scheme, which will enable the farmers, have two crops planted and harvested every year. ICB Package II entails construction works for irrigation and drainage facilities in the expansion area; Mutithi section. Thiba Dam, which targets a capacity of 15.6 million cubic metres, is currently 79% complete and set to be completed by December 2021. Upon completion, it will put an additional 10,000 acres under irrigation and introduce double cropping in Mwea Irrigation Scheme hence crop intensity.

Lower Nzoia Irrigation Project Phase I contract (Lot 1) being implemented by the Authority is currently 41.40% complete. Once complete, a net irrigation area of 10,100 acres in Lower Nzoia Irrigation Scheme Phase I within Busia and Siaya Counties will be put under irrigation.

Bura Irrigation Development Project involves conversion of the current pump fed irrigation system to a gravity fed irrigation system, which is more cost efficient hence. The project is currently 45% complete and set to completion within the set completion date.

Under the Expanded National Irrigation, the Authority has implemented 209 irrigation projects across the country putting 259,058 acres under irrigation and directly benefiting 108,275 farmers. Particularly in Turkana County, over 5,000 acres have been rehabilitated and put under irrigation in Katilu, Elelea, Morulem, Lokubae, Naipa and Nanam.

Galana Kulalu Food Security Project comprises a 10,000-acre model farm in which different irrigation systems as well as crops are tested. The Authority is using irrigation systems such as the centre-pivot which is more efficient for large scale farming. The Authority has also installed drip irrigation system which is quite water saving and efficient.

The Household Irrigation Water Storage Project was rolled out by the Government of Kenya in the financial year 2017/18 with the aim of bringing more acreage under irrigation through harnessing surface run-off resulting from rainfall received in the water pans in the arid and semi-arid counties. The project consists of construction of water storage facilities at household level ranging from 1,000m3 to 3,000 m3 in various parts of the country and community water pans of about 100,000m3. With this water storage approach, it is possible to bring up to more than 10 million acres under irrigation in Kenya up from the recorded 3 million. To date 133 community water pans with a cumulative volume of 12,897,000 cubic metres have been done benefiting 10,127 farmers and putting an additional 8,844 acres under irrigation. 21,646 water pans ranging from 1,000 to 3,000 cubic metres spread across 32 counties have been done. The water pans have a cumulative volume of 29,965,761 cubic metres, putting an additional 25,206 acres of land under irrigation and benefiting 21,646 farmers.

The Authority continues to run studies on the possible areas to be opened up to irrigation and sustainable irrigation developments. In addition, it continues to work on implementing the most efficient irrigation systems as well as educating its stakeholders on the same for purposes of sustainability of irrigation in the future.

ISO 9001: 2015 CERTIFIED

National Irrigation Authority

VISION: Water to every irrigable acre

MISSION: Provide and coordinate Sustainable Development and Management of irrigation services in Kenya

Irrigation in Lower Basin, Western Kenya

The National Irrigation Authority is implementing Lower Nzoia Irrigation Project phase 1 contract (Lot 1) located in Busia and Siaya Counties. The project which is financed by International Development Association (IDA), The Kreditanstaltfur Wiederaufbau (KfW) and the Government of Kenya (GoK) is at 41.40%. Once completed by December, 14 2022, the project will develop a net irrigation area of 4,043 ha (10,100 acres) in Lower Nzoia Irrigation Scheme phase 1 within Busia and Siaya Counties. One half of the irrigable acre (5,000 acres) will be devoted to rice farming while the other half will be devoted to high value cash crops (perennial, seasonal fruits and vegetables).

Besides, the region is also benefiting with the improvement of dykes under the Improvement of Flood Mitigation Structures (IFMS) on Lower Nzoia River contract (Lot 2) being executed by National Water Harvesting and Storage Authority (NWH&SA). This public irrigation scheme will derive its irrigation water from the Nzoia River, which flows into Lake Victoria a very short distance downstream.

The GoK considers this project as the first step in the development of irrigation in the lower basin and also plans to develop a net irrigation area of 3795 ha (9,940 acres) on the right bank of the river (referred to as Phase 2) using the same intake infrastructure.

The overall objective of the project component is to revitalize agricultural development in the sub-project area (notably, high value crops) and to increase food production and security, thereby enhancing nutrition and standards of living of the local community. The success of the project will rely on the transition from current rain-fed subsistence agriculture to commercial farming based on horticulture, while maintaining functionality of the new irrigation scheme through adequate maintenance and cost effective and efficient operation.

The project is expected to directly benefit the 12, 600 smallholder farmers with access to reliable irrigation water through increased household incomes from sustainable and productive irrigated agriculture. Additionally, agricultural production and its value will increase in absolute terms because of the extension of area under cultivation, from the current 2,464 – half of which is grazing land and 32 percent irrigated rice in Bunyala – to 4,043 hectares. The project will thus contribute to increased food security, improved nutrition, higher incomes, and generally enhanced standards of living of the beneficiary farmers.

Summary of works in Lower Nzoia Irrigation Project – Lot 1

Project Name	Construction Works of The Lower Nzoia Irrigation Project – Lot 1
Contract Number	MOWI/KWSCRP-1/020/2016-2017
Employer	Ministry of Water, Sanitation and Irrigation
Financier	International Development Association (IDA), The Kreditanstaltfur Wiederaufbau (KfW) and Government of Kenya
Implementing Agency	National Irrigation Authority
Main Contractor	Sinohydro Corporation Limited
Engineer	Tractebel Engineering in Joint Venture with GFA Consulting Group in Association with Quadrant Engineering Consultants Ltd
Original Contract Sum	Kes. 3,873,317,854.47 (USD37,275,698.72)
Commencement Date	June 12, 2018
Completion Date	December 14, 2022
Achieved (%) Progress of Works (Physical)	41.40%

National Irrigation Authority

VISION: **Water to every irrigable acre**

MISSION: **Provide and coordinate Sustainable Development and Management of irrigation services in Kenya**

Thiba Dam, Embu

Mwea Irrigation Settlement Scheme

The National Irrigation Authority(NIA) is managing the Mwea Irrigation Settlement scheme (the MIS scheme) which was first developed in the late 1950s, and have been extended and improved up to date by the Government of Kenya (GoK), and also financing from development partners such as Japan International Corporation (JICA) and World Bank. Over the years and with the increase in population, there has been a need to produce more food for the population and the area under irrigation has been on the rise hence the increase in demand for irrigation water.

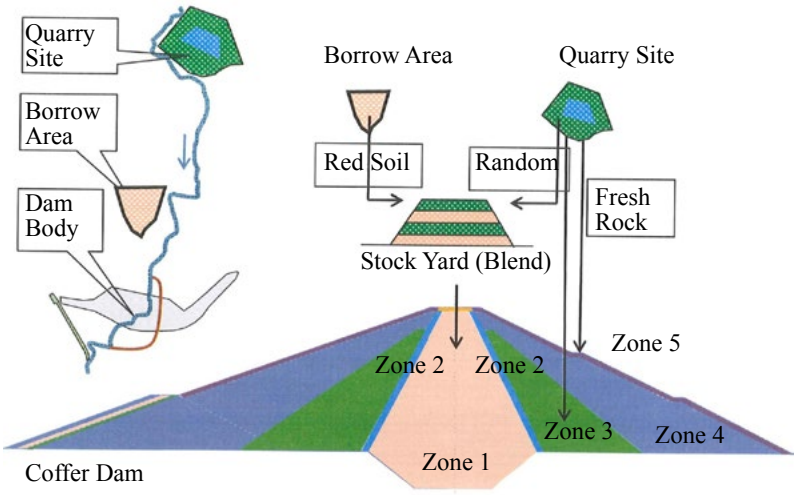
Thiba Dam Location

The Thiba dam site is located on the middle reaches of the Thiba River approximately 13.5km to the west of Embu Town, immediately downstream of the confluence of the Kaboyo and Thiba Rivers and at about 900m upstream of the bridge across the Thiba River.

Principal Features

The principal features of Thiba dam include the following:

- Dam type: Center core rockfill dam;
- Maximum height of dam wall: 40.6 m;
- Embankment volume: 1,197,300 m^3
- Mean annual flow: 184.4 million m^3;
- Total storage capacity: 15.6 million m^3;
- Effective storage cap.: 11.2 million m^3;
- Area of reservoir: 1.1 km2 (272 acres);
- Crest width of dam wall: 8.0 m;
- Crest length of dam wall: 1.1 km;
- Dam Slopes: U/S 1:2.4 and D/S 1:2.0;
- Dam release: max. 6.44 m^3/sec.



Basic concept of Zoning for the dam embankment Appurtenant Structures of the Thiba Dam

River Diversion Works

The river diversion system comprises of an inlet channel, twin diversion concrete conduits, an outlet structure with an energy dissipation mechanism, masonry lined outlet channel and an integrated coffer dam. This system is capable of safely diverting the flood discharge of 20 year return period

Spillway

The primary purpose of the Spillway is to safely release flood water which cannot be store in the reservoir to the downstream river reach. The ungated ogee crest spillway capable of safely discharging a 500 year return period flood has a side overflow which has been constructed from a viewpoint of the topographic conditions, structural stability and hydraulic safety. The Spillway capacity has also been designed to ensure no overtopping of the dam embankment will happen for a 10,000 year return flood. A stilling basin with a sub dam has been constructed as an energy dissipater to deliver discharge back to the river.

Sand trap dam

To control sediments flowing into the Thiba Dam reservoir, a Sand Trap Dam is being constructed. The proposed dam site is located immediately adjacent to the upper end of the Thiba reservoir, in which the river bed elevation is nearly equal to the full water level of the reservoir.

Intake structure and outlet works

The outlet works will be installed by using the diversion conduit which is to be provided for diverting river flow discharge during the dam construction period. The inlet structure (Submerged intake concrete tower) has been constructed at the upstream portal of the diversion conduit. The inlet of the diversion conduit will be closed with stoplogs, and after that two lanes of water channel in diversion conduit will be plugged under the dam axis. Out of two lanes, one lane with steel conduit s to be used for outlet works.

National Irrigation Authority

VISION: **Water to every irrigable acre**

MISSION: **Provide and coordinate Sustainable Development and Management of irrigation services in Kenya**

Galana Kulalu: National Irrigation Authority applying technology for National Food Security

The project is located within Kilifi and Tana River counties, in the lower reaches of the Athi and Tana River basins. It occupies 1.75million acres cutting across Galana and Kulalu Ranches. The project aims at enriching national food security through productivity optimization of the ranches. The investments targets enterprises on crop, livestock and fisheries production, as well as incorporation of sustainable utilization of other natural resources within or accessible to the area making up the Galana Kulalu ranches. Currently, the Authority is completing the remaining works on the 10,000 acres model farm to be transited for commercialization by private sector upon completion.

In the implementation and operationalization of this project, the Authority has embodied a number of technologies starting from the pumping stations, filtration systems, center pivots, sprinkler systems, chemigation, fertigation technology, minimum tillage, automated harvesting, remote monitoring of weather and water management, Aflasafe technology on reduction of aflatoxin and butt fusion technology of large diameter pipes joining. These efforts are coordinated by an able team of engineers and agronomist for the success of the project.

Pumping station

At the pumping stations, there are three types of pump units; motor driven vertical pumps (Q= 600m^3 per hour), gear driven 600m^3 per hour and centrifugal pumps (Q=540m^3 per hour). Each pump is able to irrigate 500 acres. These units are serviced and maintained periodically by the Authority`s internal capacity of mechanical engineers.

Filtration System

The automatic electric filter is a heavy duty, in line filter, which has built in automatic self-cleaning features to maintain and clean the filter screen during operation. It is designed to achieve filtration from 3500 micron to 200 micron through varying the filter screen size. The filter is available in sizes ranging from 8" to 14". The automatic self-cleaning operation is monitored by the Pressure Differential Switch (PDS) that senses the pressure drop between the inlet and the outlet of the filter. The PDS is factory preset to start the flushing cycle at 0.5 bar (7 PSI) pressure differential. When the pressure drops between the inlet and the outlet of the filter reaches the preset value, cleaning of the filtration cylinder is operated automatically. This operation consists of opening an exhaust valve located on the housing lid and starting the electric motor which revolves two stainless steel brushes on the inside of the filtration cylinder. The particles trapped on the cylinder are dislodged by the revolving brushes and flushed out through the open exhaust valve.

The cleaning operation duration is approximately 15 seconds. The service flow of the filtered water is continuous during the cleaning cycle. Water distribution is equally achieved at this point.

Centre pivots and sprinkler irrigation system

Among brands installed in this project include Valley, Zimmatic and Western Centre Pivots. Specifically, Valley Pivots, for more than 60 years has earned its reputation as the most trusted brand in the industry. From its pivot point to the last span, engineers, construct and field-test each center pivot. Valley structures are proven to stand up to the toughest loads produced by rough terrain, deep furrows and long-span machines. The Authority initially installed 20 Centre pivots, each spanning a radius of 450m, covering an area of 3,300 acres. Currently 25No. more center pivots covering an area of 5,000 acres are ongoing. These Pivots have a control mechanism that incorporate the highest quality electrical components and most advanced technology to effectively monitor and manage the fields with a capability of remote irrigation management product that uses GSM technology to monitor and manage irrigation systems.

Drip Irrigation system

The drip system gets its water from a reservoir which has a capacity of 45,000m^3. The system covers 1,800 acres. The reservoir acts as a secondary filtration system point where any excess particles settle before water is released to the drip area. This system is currently used to support production at the demonstration field at the farm.

Chemigation

This technology has been handy in reducing the cost of production in GKFSP. It is the application of soluble chemical products in water or in the irrigation line by means of appropriate equipment. It`s done in GKFSP to achieve general cleaning and maintenance by application of acids or chlorination as a method to clean droppers or nozzles. It intends to improve or increase production by Cleansing (using Fungicides, Herbicides, Nematicides) and Production (Nutritional elements known as fertigation).

Fertigation technology

Fertigation refers to the application of nutritive elements required for effective and healthy growth by means of an irrigation system for specialized application within the planted area. The application of nutritive elements must be done in a given area in order to favor the absorption by the plant, and in order to increase the yield of the applied fertilizers. This is applied through the use of a boom spray, through the center pivot. The components of this procedure are the fertigation unit, a water tank and the inlet manifold. The flow of the unit is set at 1000 litres/hr and it takes 24 hours to complete, covering 500 acres.

Minimum tillage

Soil cultivation is kept to the minimum reducing damage to the soil structure. In land preparation, the heavy disk harrow precedes the medium disk harrow.

Automated harvesting

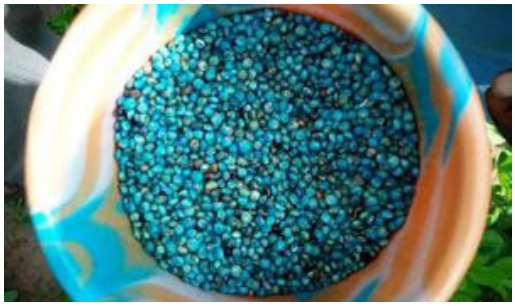
There are two (2No.) CASE combined harvesters. They work by cutting the maize, shelling the maize, and removing grains from the cob. The dried maize is dried by 2 driers, each with a capacity of 18 tons. There also four (4No.) constructed maize facilities each with a capacity of 32,000 bags each weighing 50kgs.

Remote monitoring of weather and water management

This is done by the use of satellite imagery and real time sensors which are connected to an application. This enables the agronomy team to monitor the soil temperature in the fields, do evaluation and even send notifications for efficient irrigation intervals.

Aflasafe Technology

Aflasafe is a safe natural solution to the problem of aflatoxin, home-grown in Africa with help from partners (IITA and KALRO) in Kenya. It works to stop contamination from reaching dangerous levels and keep foods like maize and groundnuts safe to eat. This product, collaboratively produced for GKFSP tackles toxic tragedy using harmless types of Aspergillus flavus. The friendly fungi are coated onto ordinary sorghum grain, which acts as a vehicle to help them get established and can easily be broadcast onto fields.



Source: https://aflasafe.com/aflasafe/what-is-aflasafe/

Butt Fusion Technology

This method is the most commonly used method of joining HDPE pipes. At GKFSP, it is one of the latest method being used for large diameter pipes between DN 500 to DN 800. No extra material is used instead the surface to be joined is heated by a heating plate. The melted surfaces are pressed and fused into each other forming a strong joint. The strength of the material is based on the fusion of atoms. Welding beads are not always removed and are usually kept as a visual reference for the welding quality.

Welding machines (heat fusion machines) have strong body frames, guide rods for the pipes, a pipe end planer, and an electric heater plate. The compressive thrust is produced hydraulically or by means of a lever or spring mechanism. To achieve a good welding result, it is better to use a proprietary heat fusion machine for better output.

National Irrigation Authority

From the Deputy General Manager,
Infrastructure And Irrigation Development Services

Eng. Charles Muasya

Kenya is an agro-based economy and agricultural production is therefore the foundation for economic growth in the Country. It has an irrigation potential of 540,000 ha and drainage/ flood protection potential of 225,000 ha. Out of these only 129,000ha of irrigation and 32,000 ha of drainage have been developed, leaving it mainly dependant on rain-fed agriculture. Solely, only 105,800ha are under agricultural production against a potential of 1.3million ha within horizon one of Kenya Vision 2030. As a result, the agricultural production has faced major challenges in relation to inadequate water supply due to unreliable rainfall patterns. This has caused limited agricultural production due to unavailability of reliable rainfall in most parts of the country.

With increased water harvesting and storage facilities, the current irrigation potential could increase to over 4 million ha. Currently, the developed irrigated land covers only 1.7% and drainage/ flood protection land covers 0.3% of total arable land. Even though not fully exploited, irrigation contributes directly between 10% and 15% of total GDP and provides the bulk of the value of all agricultural produce. Consequently, there is a need to increase water storage and harvesting structures to improve supply of irrigation water. The National Irrigation Authority has made efforts to attain sufficient food production and efficient provision of agro-based raw materials in line with the Big 4 Agenda and Kenya Vision 2030 through initiation and implementation of several irrigation infrastructure with a view to increase area under irrigation .

Whereas the high growth rate of the population in the country is a serious threat to food security and agro-based industrial development, it is a blessing in disguise with adequate development of irrigation infrastructure, including water harvesting and water storage facilities, in the sense; provision of labour. This is, given that the growth rate of the human population in Kenya is higher than the food production rate. In its pursuit of irrigation expansion, the Authority is also rehabilitating and expanding irrigation infrastructure in the existing irrigation projects. To this end, the Authority has expanded the area under irrigation in Mwea, Ahero, Perkerra, and Turkana irrigation schemes. It continues to put more land under irrigation with the aim of increasing the area under irrigation to enhance agricultural production for improved domestic food security. Other benefits that arise with expansion of irrigation area are generation of additional raw materials for agro-based industrial development and enhanced export of agricultural produce.

In addition to implementing irrigation projects, the Authority has been gravitating towards ensuring the projects are cost efficient and sustainable. Some of the principles and technologies it has adopted are such as designing irrigation infrastructure to distribute water through gravity as compared to pump-fed irrigation, which is more expensive, a case in study, Bura Irrigation Development Project and Lower Nzoia Irrigation Development Project.

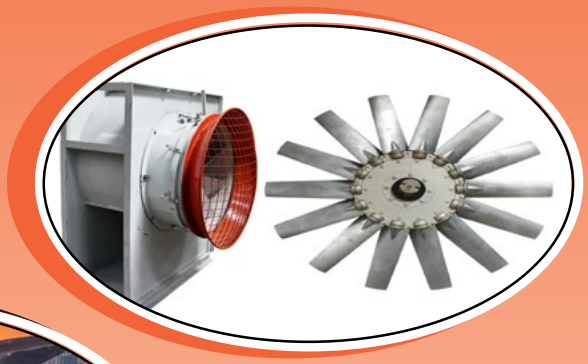
Moreover, the Authority is lining its canals in the irrigation schemes and using piping method in projects such as Galana Kulalu Food Security Project and Muringa Banana Irrigation Project for purposes of reducing siltation. This provides for a system that is more sustainable.

It is significant to exploit the huge potential for irrigation expansion to facilitate translation into higher contributions to food security and the total GDP. The growing human population in the country needs to be considered in this quest of expanding the area under irrigation to address food security. The implication herein is that food security will be enhanced through acceleration of irrigation expansion taking into consideration the rate of population growth.

ISO 9001: 2015 CERTIFIED

Physical Address
National Irrigation Authority (NIA)
Unyunyizi House, First Floor, Room 309 Lenana Road, Hurlingham, Nairobi, Kenya
Tel: +254-20-2711380/468, Fax: +254-20-2722821/2711347
E-mail: purchasing@irrigation.or.ke

CONVEYORS



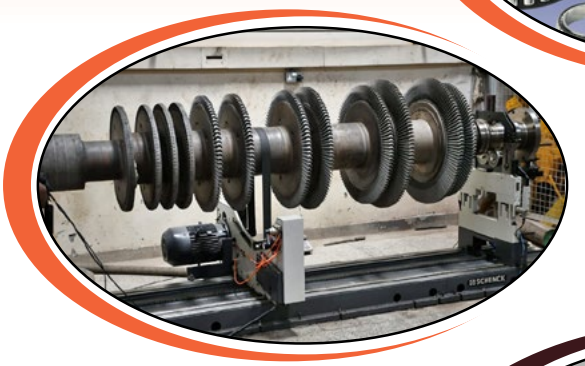
FANS

HYDRAULIC
LIFTING PLATFORM

HIGH LEVEL TANKS

MACHINING SERVICES

BEARINGS AND
CONVEYOR BELTS



BALANCING SERVICES FOR
A SUGAR COMPANY

TRACTOR TRAILERS

SHEET BENDING SERVICES

TEMEC
built on excellence

TEA MACHINERY & ENGINEERING COMPANY LTD
P.O. Box 30213 GPO 00100 Nairobi | Mobile: 0734333338 / 0743031247
Email: info@temec.co.ke / sales@temec.co.ke | **Website:** www.temec.com
Physical Address: KETEPA House, Kampala Road, Nairobi

Steel: The Perfect Construction Material

By Naitore Matumbi

THE choice of any engineering material is dependent on material properties that are sought. Such material properties maybe strength, toughness, hardness/ ductility, thermal behaviour, density, et cetera. Different material combinations are required for different applications. For instance, designing an aircraft would call for a material of high strength, toughness but low density. Performance to weight ratio should be as high as possible. Buildings, on the other hand, require a balanced measure of both ductility and toughness but accompanied with high strength, especially in earthquake-prone areas. This will allow deformations up to a certain level. For purely steel building, members ought to only be fixed on one end to reduce the structure's stiffness.

Metals in general have a special ability to allow work hardening due to the presence of moveable dislocations within the crystals. Their movement allows for the toughness and strength to change through introducing external forces causing strain. For instance, bending a wire back and forth makes it even stronger and tougher at a point.

Steel is a metal alloy of iron and carbon. The amount of carbon contained affects the strength and toughness, hence resulting in mild steel, medium steel and high carbon steel. A carbon content of up to one per cent increases the strength of iron as carbon crystals sit between iron (Fe) crystals, making it harder for dislocations to move as haphazardly as before. Higher contents will however weaken the alloy, as it becomes cast iron, which is weaker and more brittle.

Carbon content is, however, not the only determinant of these properties as the size and shape of the crystals within influence the end product too. Adjusting the size and shape through thermomechanical processing results in cold-formed, cold-rolled, hot-rolled and hot-formed products.

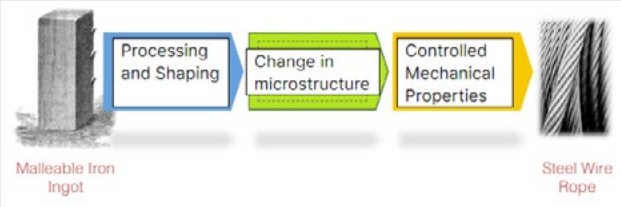


Figure 1: An instance of thermomechanical processing (Borrowed from Introduction to Steel – Tenaris University)

The aforementioned variety of steel products makes application of steel in engineering impressive. Rolled and formed mild steel products are used extensively for structural framing. High carbon steel is used in the production of high tensile wires used in tensioning structures. Mild steel, on the other hand, is used in production of steel plates and rebars. Steel may also come in different densities ranging from light gauge to heavy gauge. A slight change in processes of production results in varied material properties, hence its ability to be used to achieve a range of different requirements for different structural members.

That said, it remains important to keep the properties sought in mind when choosing the perfect construction material to sustain different load combinations.

Naitore Matumbi (B.Sc Civil Engineering) has five years experience in engineering design and supervision.

Involving Engineers at Highest Levels of Projects will Benefit the Economy

By Shem Atonio

TO optimise on development projects, Institution of Engineers of Kenya (IEK) President, Eng. Nathaniel Matalanga, recently urged government and development partners to retain services of competent and qualified engineers at all levels – as well as at the highest levels of decision making.

The IEK President also condemned disregard of competent engineers in favour of selfish competing interests in execution of projects, saying it exposes Kenya's economy to corrupt interests that result into otherwise avoidable economic losses.

His call couldn't have come at a better time. To save national resources from plunder by selfish individuals, the State and development partners must listen to competent engineering experts, locally available within IEK membership, many who are daily involved in steering fully-fledged local manufacturing and assembly initiatives.

Kenyan engineers are in charge of many technical process plants, construction projects, roads, factories and all manner of technical entities. They ensure correct equipment is procured, critical equipment are working safely and properly, and that the equipment are serviced and optimised, so that such investments can deliver value for money.

Supporting local manufacturing will open countless opportunities for citizens of this country and grow our economy. Had initiatives like the Nyayo Car been passionately funded, Kenya would today be manufacturing its own cars. It does not make sense to import a tuk tuk when our able Engineers can fabricate it here at reduced costs.

-Shem Atonio, (B.Sc Civil Engineering) is a Kenyan Telecommunications Engineering post-graduate student based in Poland


(Photo Courtesy)

Promote Sustainable Infrastructural Development as Engine of Economic Growth

By Ombima O. Byrone

IMPLEMENTATION of road infrastructure in view of indicators or components of road sustainability such as accessibility, safety, mobility, economy and resource efficiency, ecological and environmental protection is considered as one of the engines of growth in developing countries such as Kenya. In developed and developing countries, roads have historically contributed to socio-economic growth by opening up areas, creating employment opportunities, giving access to social amenities such as schools and hospitals, recreational facilities such as parks, economic centres such as markets just to mention but a few.

An adequate, safe and durable road network is therefore considered an important public asset. Kenya's Big Four agenda, which includes affordable housing, universal healthcare, food security and manufacturing, is anchored on good infrastructural development such as quality and adequate road networks. Taking these factors into account, African countries should not overlook the importance of promoting sustainable infrastructural development by taking into consideration sustainable highway design approaches in planning, design, implementation, operation and maintenance of road projects.

Factors influencing implementation of road projects include; project needs assessment, design approach, stakeholders' participation and techniques of monitoring and evaluation. The influencing factors are appreciated as being capable of augmenting or reducing user satisfaction in some, but not all situations (Linger, et al., 2013).

Road infrastructural projects are considered capital-intensive ventures based on magnitude of the projects, with the sole funding often coming from the government and development partners. A successful road infrastructural project must tackle problems that arise from economic, political, institutional, social, and environmental aspects because they affect formulation of policies in a country (Howes & Robinson, 2006).

Applying critical chain project management to road infrastructural projects can lead to elimination or reduction of uncertainties of limiting factors or constraints. In focusing on the resources required to execute each activity of a road project, it would be possible to achieve desired goals of capital-intensive road venture.

However, there has been minimal focus on critical chain management approach as a sequence of activities and resources related to a project. The effect is ignorance on 'limiting factors', which are not identified or realised prior to commencement of road project works. Road infrastructure projects in Kenya did not focus on limiting factors such as time, information technology and resource mobilisation, thereby leading to major repairs and road failures, which made it difficult for roads to achieve desired goal of socio-economic growth and prosperity (Njenga, 2014).

- Ombima O. Byrone (B.Sc Civil Engineering) is assistant Engineer, Kinyona-Gatura-Njambini (B20) Road

Use of Remote Sensing to Monitor Pollution of Rivers: A Case Study of Nairobi River

By Curios Christian Ongaya

INTRODUCTION

THE measure of the clarity of water is known as turbidity. It is the measure of how much light passage through water is reduced by suspended matter. It is a measure of reduction in amount of light passing through water by suspended matter i.e., clay, sand, silt, plankton, algae and other materials found in the stream of water. The size of these matter ranges from 0.004 mm for clay particles to 1.0 mm for sand particles. Turbidity results in the change of color of the stream of water. Turbidity detects the amount of light scattered by suspended matter. Run-off from urban areas, soil erosion at stream banks, discharges of waste water and excessive growth of algae are the major causes of turbidity.

An increase in the turbidity results in reduction in the amount of DO. This is because suspended matter absorbs more heat and cold water holds more DO compared to warm water. High levels of turbidity reduce production of oxygen in water by aquatic plants. This is as a result of light being blocked by the high amount of suspended matter present in turbid waters. Hence, hindering photosynthesis which releases oxygen as a byproduct. Suspended matter clogs fish gills. As v result fish growth rates is reduced while egg and larva development are adversely affected.

Turbidity shows the effects of run-off from logging, agricultural, construction and discharge among other activities. Turbidity increases sharply during periods of high rainfall as a result of storm water run-off causing erosion in dry periods due to earthquakes. Monitoring turbidity in developing watersheds can help in finding trends that may show a rise in soil erosion activities in the banks and channel. Turbidity is directly affected by velocity and flow of stream. Hence, measurements should be done at both the same point and flow (EPA, 2012).

MATERIALS AND METHODS

3.1 Study Area

The Nairobi River originates from Ondiri Swamp and cuts through Nairobi County discharging into Athi River. The section focused on the section between Outer Ring Road and the confluence of the Nairobi River and Ruaraka River, located in Kasarani constituency. The study area map is given below. The following are details of the section of the river indicated by the polygon feature; perimeter: 13,973.035584 Meters and area: 169,846.956248 Square Meters.

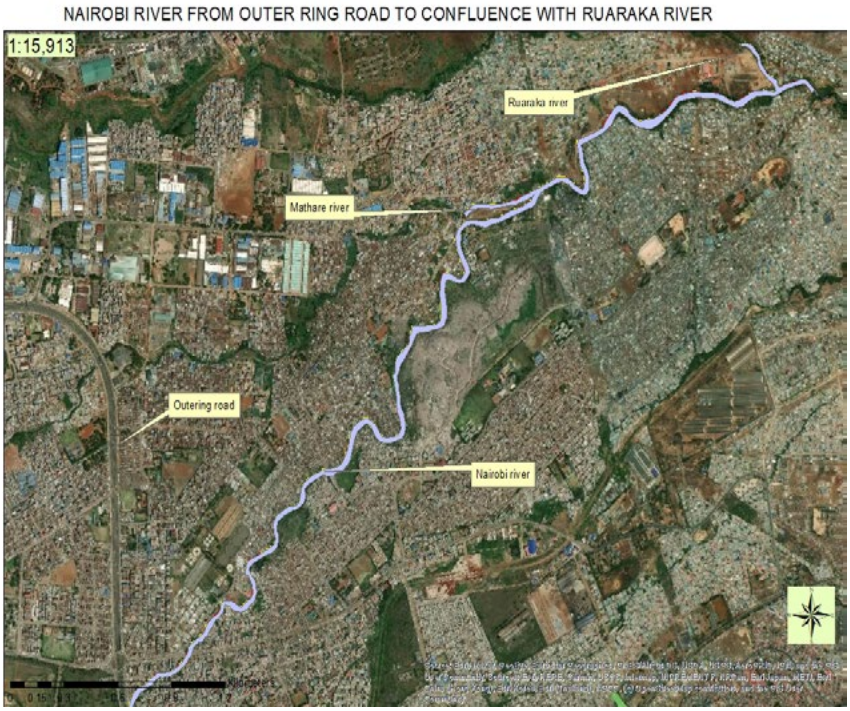


Figure 1world imagery map of Nairobi River and its tributaries

3.2 Sentinel-2 Data

The data was collected for two different dates i.e., 26th September 2017 and 16th September 2019. It was an interval of 2 years. The Sentinel-2 satellite image was obtained from the website: http://www.earthexplorer.usgs.gov/ .

3.2.1 Evaluation of Atmospheric Correction

Cloud cover was set at less than 10 %. The type of atmospheric correction used in this study was the Dark Object Subtraction (DOS) (M.ELhag, 2017).

3.2.2 Normalized Difference Turbidity Index (NDTI)

Lacaux et al (2017) developed an algorithm for estimating water turbidity for inland waters. NDTI can be computed using the following formula using remote sensing data (Lacaux, Tourre, Vignolles, Ndione, & Lafaye, 2007).

$$NDTI = ((Red - Green) / (Red + Green))$$

Where, Red band is band 4 of sentinel-2, and green band is band 3 of sentinel-2. The ArcGIS software computed the values of the standard deviation and the mean of **NDTI**. Turbidity content was classified into three classes i.e., low, moderate and high. The classification was based on the following formulae: Low was less than mean minus standard deviation. Moderate was less than standard deviation plus mean and greater than mean minus standard deviation. High was greater than moderate. The classes were assigned to the image using ArcGIS software (Shivangi Somvanshi, 2011).

RESULTS AND DISCUSSIONS

The data for the sentinel-2 satellite was obtained for 26th September 2017 and 16th September 2019. The month of September was chosen because the precipitation was below 2 inches for this month. This precipitation low for both dates hence, it was convenient for monitoring turbidity.

The amount of energy a surface reflects at specific wavelength of the sun's radiation is known as spectral reflectance. The reflectance obtained from the imagery that had been downloaded was Top of Atmosphere (TOA) reflectance. Atmospheric correction was performed in order to obtain surface reflectance. This was done so that pixels affected by atmospheric distortion can be filtered out. These distortions are due to clouds and particles found I the atmosphere (Santiago Yepez, 2017). The mode of atmospheric correction used was the Dark Object Subtraction (DOS) method. In order to perform this operation Q-GIS software, semi-automatic classification plugin which had he DOS correction method inbuilt.

From the surface reflectance obtained, spectral index i.e., NDTI was calculated. The values of the spectral indices range from -1 to 1. Values towards -1 indicate low levels of turbidity. Values towards 1 indicate high levels of turbidity. The mean and the standard deviation for the remotely sensed spectral index were obtained for the values. The following data was obtained.

NDTI 2017 values

Minimum	0.01104102004319429
Maximum	0.2342657893896103
Mean	0.08462900446068714
Standard deviation	0.03052044057462064

NDTI 2019 values

Minimum	-0.141797199845314
Maximum	0.211490124464035
Mean	0.07273611669148752
Standard deviation	0.03995682319609448

From the results it is observed that the mean turbidity of the Nairobi River decreased between the year of 2017 and 2019. The mean in 2017 was 0.08462900446068714 and 2019 was 0.07273611669148752. The year of 2017 had the highest maximum value of 0.2342657893896103. The value of turbidity in the NDTI ranges between -1 for no turbidity i.e., clear waters and 1 for high turbidity i.e., muddy water, indicating very high pollution levels.

From the established statistics, a turbidity cover map was prepared. The water quality parameter ranges of high, moderate and low were assigned to the cover map. These range values were assigned to the cover maps based on the statistical values obtained

NDTI 2017 range values

High	Greater than 0.115149445
Moderate	Less than 0.115149445but greater than low
Low	Less than or equal to 0.054108564

NDTI 2019 range values

High	Greater than 0.11269294
Moderate	Less than 0.11269294 but greater than low
Low	Less than or equal to 0.032779294

The turbidity cover maps were prepared. Each of the turbidity ranges were color coded with a different color. This was done so as to distinguish the different ranges. For the case of turbidity, the high range was assigned a red color, the medium was assigned color yellow and low range given color blue.

The following are the maps of NDTI created.

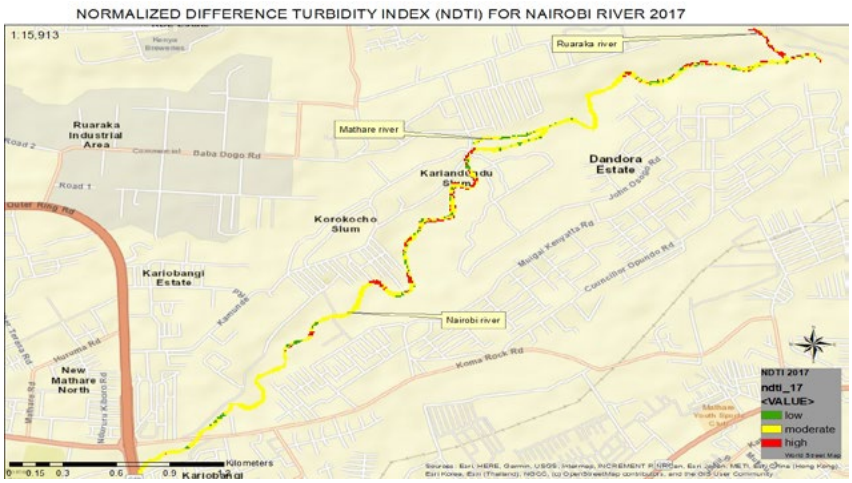


Figure 2 Map of Normalized Difference Turbidity Indices (NDTI) of Nairobi River 2017

The section of the river with a high turbidity content in 2017 as from the Normalized Difference Turbidity Indices (NDTI) cover map was located in the region around Kariandundu slum, Korokocho slum and Dandora estate (from the Dandora Municipal dumping site running towards the confluence of Nairobi River and Ruaraka river).

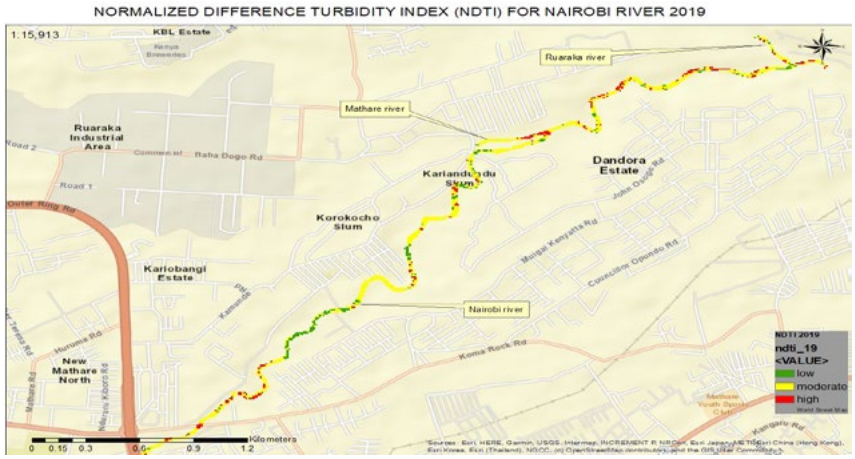


Figure 3 Map of Normalized Difference Turbidity Indices (NDTI) of Nairobi River 2019

From the map of Normalized Difference Turbidity Indices (NDTI) the section of the river in 2019 with a high turbidity content was located in the region around Kariandundu slum, Korokocho slum and Dandora estate (from the Dandora Municipal dumping site running towards the confluence of Nairobi River and Ruaraka river).

The high level of pollution in this region is as a result of the presence of the Dandora Municipal dumping site in the area contributing to pollution in the Nairobi River. The place contains domestic garbage from the Nairobi settlements. The waste contains improperly treated effluents. There is a tusker brewery that discharges waste into the Ruaraka River. The waste is organic. There is also point source pollution by sewerage. Korokocho slum and Kariandundu slum generate raw sewage which serves as a point source pollution source into the river. Run-off of human waste into the river also results in the high levels of turbidity in the river. Economical activities along the river results into clay and silt being carried into the river, this causes sedimentation increasing turbidity in the river.

CONCLUSION

This study shows that the use of remote sensing techniques is efficient in monitoring turbidity. This method has the advantage that data from inaccessible areas can be procured, study area is not distorted, very little time is taken in acquiring the data for a very large area of study, recording and reproduction of information can be done at any moment, there is potential for acquiring both qualitative and quantitative information and measurements can be taken actively and continuously enhancing a timely monitoring of pollution (Shivangi Somvanshi, 2011).

The Role of Young Engineers Beyond Covid-19 Pandemic

Eng. Michael Kamau and John Miano

THE Young Engineers Chapter of IEK (YEC) aims to facilitate the development of young engineers of the institution. The formation of the Chapter arose from the need to acknowledge the role young engineers play in building a strong association of engineers. The energy, creativity and vibrancy of this group is tapped in the various activities rolled out by the institution, and in this way, they are mentored into competent and confident engineers who are ready to serve society. They are given a platform to grow professionally and undertake programmes of their interest.

Specifically, the Young Engineers Chapter serves the following purposes:

i) Provide continuing education to young engineers;
ii) Promote training of young engineers;
iii) Advocate for better terms of service for young engineers;
iv) Advocate for better positioning of young engineers in society;
v) Ensure sustainability of the Institution.

> Pandemics and diseases, hunger, floods, hurricanes and other environmental problems caused by climate change are some of the calamities we have to contend with in the world today.

Alleviating the hardships brought on by these disasters and developing sustainable solutions for them require innovation, creativity and a wealth of knowledge. There is a need for new tactics such as better systems for managing the resources of nations and building of climate-ready infrastructure.

The young engineer plays a key role in tackling these challenges. He or she brings in a fresh perspective drawing from their closer interaction with peers in other scientific fields such as medicine, information technology, electronics, transport infrastructure, architecture and economic development studies. Further, their willingness to venture into commercial activities and other fields, which stimulate economic growth, ensures that the contribution of young engineers is highly valued in society.

The IEK has approximately 5,000 graduate engineers. These engineers readily offer mentorship to engineering students in the universities, and even with the pandemic they continued to do so immediately after the institutions were reopened.

In addition, they participate in mentorship of secondary school students and use such engagements to push for adoption of Science, Technology, Engineering and Mathematics (STEM) subjects among the students.

On the other hand, young engineers benefit a lot from being members of the IEK through YEC.

- The IEK continually lobbies organisations to give attachments to university students. For sure, attachment opportunities are not easy to come by.
- The IEK liaises with relevant regulatory institutions to ensure degree programmes offered by universities meet academic requirements, thus ensuring a smooth path for engineers' registration as professional engineers and also qualified admission to its membership.
- The IEK builds linkages with relevant institutions with the objective of achieving more recognition globally.
- The IEK organises functions/events for networking and discussing emerging issues; for instance, the Webinar on Digital Trends and the 27th IEK International Conference during which members discussed key infrastructure developments and different ways to cope during this period of Covid-19 pandemic.
- The institution also facilitates young engineers to publish research work, showcase their works and innovations.
- The IEK provides a discounted rate to student engineers for attending conferences, thus enabling them to network and also access much needed industry knowledge on engineering matters.
- The institution has been at the forefront in advocating for the rights and welfare of the graduate engineers through lobbying for better renumeration and terms of service. This is in line with its vision of upholding the dignity of the profession.
- Through providing guidance on the Engineers' Code of Ethics and ensuring its members uphold integrity in the delivery of engineering services to the public, the young engineer is moulded into a reliable and respectable member of society.

Eng. Michael Kamau is an IEK Council Member and chair of South Rift Branch

Engineering Smart City Environments: Lessons from Konza Technopolis


ENG. ANTHONY SANG

By Eng. Anthony Sang

WHAT would it take to build a futuristic smart city hosting 250,000 residents, all living, studying and working within one ecosystem, in close proximity of 5,000 acres?

When magnificent, modern smart cities like Beijing, Tokyo, Manhattan or Los Angeles were conceptualised, no one, not even the presiding engineers and architects, pictured they would become lasting edifices, blueprints for future smart cities.

Kenya is in the process of achieving its first engineering marvel of this kind. Designed and engineered as a smart city, the Konza Technopolis project located in Konza at the intersection of Machakos, Kajiado and Makueni counties promises more than just a built-up area of urban metropolis.

Engineering works for Phase I of the project are in high gear, happening on 400 acres of land that will host an estimated 30,000 residents upon completion. Slightly more than half of this number is catered for in the blueprint to work within Phase I alone, once the smart city urban environment is built up.

Konza has widely and correctly been touted as both a future smart city and an upcoming ICT Silicon Savanna. The rapidly developing Technopolis anchors on three major components that have often gotten overlooked: engineering, life sciences in the form of a research and development post-graduate teaching and learning university, IT-enabled services as well as a highly potential future backbone for commerce and the light manufacturing industry in Kenya.

Engineering trailblazer

Apart from its magnificent boulevards atop a 9km utility tunnel, in terms of infrastructural engineering, the Konza Technopolis will also be traversed by 40 kilometres of large-sized multi-purpose throughways, referred to as *streetscapes.*

Currently underway at the site is grading of these streetscapes, the development of the drainage facilities, a wastewater reclamation facility, water distribution and treatment, and the setting up of sewage collection and treatment plants.

Landscaping of the streetscapes is expected to follow completion of horizontal engineering works.

The Technopolis is set to host the first of its kind Kenya Advanced Institute of Science and Technology (KAIT), a fully built-up postgraduate university dealing with life sciences, research and development.

On the engineering front, the Konza Technopolis project is literally blazing the trail in construction engineering, not only in Kenya, but also in the entire East and Central Africa region. At the heart of the futuristic development is the science of engineering at its best.

To solve the problem of constant excavations when need to entrench critical infrastructure in parts of the smart city arises, Konza Technopolis engineers, stewarded by Chief Construction and Operations Management Engineer Anthony Sang, settled on a utility tunnel running under streetscapes of the smart city.

> This tunnel is the Konza City utility duct, carrying fibre cabling, power supplies and water piping around the Technopolis, and is estimated to be of **2.5m square** vertical width. The city will be interspersed by **40km** of tarmac roads.

Completion deadlines

The project aims to achieve both horizontal infrastructure in the form of streetscapes featuring roads, bus lanes, walkways, bicycle lanes, smart sewer and water treatment infrastructure, hand in hand with vertical infrastructure as the framework for the Technopolis.

The best part is that much of the horizontal infrastructural works are set for completion by February 2022, paving way for the commencement of the vertical built-up infrastructure.

"We are simulating life in one smart environment, in one smart industrial area interfacing with smart human residence, smart work, and light industrial manufacturing. Our task is to engineer a smart city that has all components of

smart living; a master-planned modern city," says Eng. Sang.

The Konza development features key components of smart urban planning: efficient mobility, waste management, enhanced technology, energy, water, security, housing development – all components that call for the best of engineering skills.

> The entire project enjoys a 10km buffer zone within the three counties of Machakos, Makueni and Kajiado, within whose proximity the smart city sits.

"The Konza project was designed based on the stitch pattern, with a green transit corridor, 20m-60m wide local roads as opposed to the normal country roads with a utility tunnel running north to south," says Eng. Sang.

Water and waste management

The Konza technopolis development envisages uninterrupted waste and water treatment and management, utilising water that has been treated for irrigation purposes, according to Eng. Sang. The city's drainage and water supply system runs for 170km; with recycled water intended for irrigation and reuse.

"Different types of waste within the smart city will be segregated, put into receptacles that exist within parcels of Phase I of the development, and at some point the waste sucked by vacuum technology to a central repository, filled-up, compacted and handled for incineration, with others heading to specific dumps where appropriate," he explains.

A 66kv electricity sub-station, located right in the middle of the Technopolis, backs up the power needs of the future smart city.

Project milestones

The development has recently registered a major milestone in the completion of the national data centre, based right inside the Technopolis. Eng. Sang underscores the importance of the data centre for the future, emphasising that the facility has recently backed up the national war against the Covid-19 pandemic as a data-hosting centre for Kenyatta National Hospital (KNH).

According to the project chief engineer, contrary to common belief that Konza is all about a future ICT hub, the Technopolis is engineered as a huge functional science ecosystem, engineered to attract opportunities in terms of future investment from a wide spectrum of industry; including residence, work, school, ICT, health and life sciences research, development and light manufacturing.

Plans are also underway to pipe into the smart city permanent water supply from Ol Turesh springs in Kajiado, as well as from Makueni's Thwake Dam, complete with standard water and waste treatment plants.

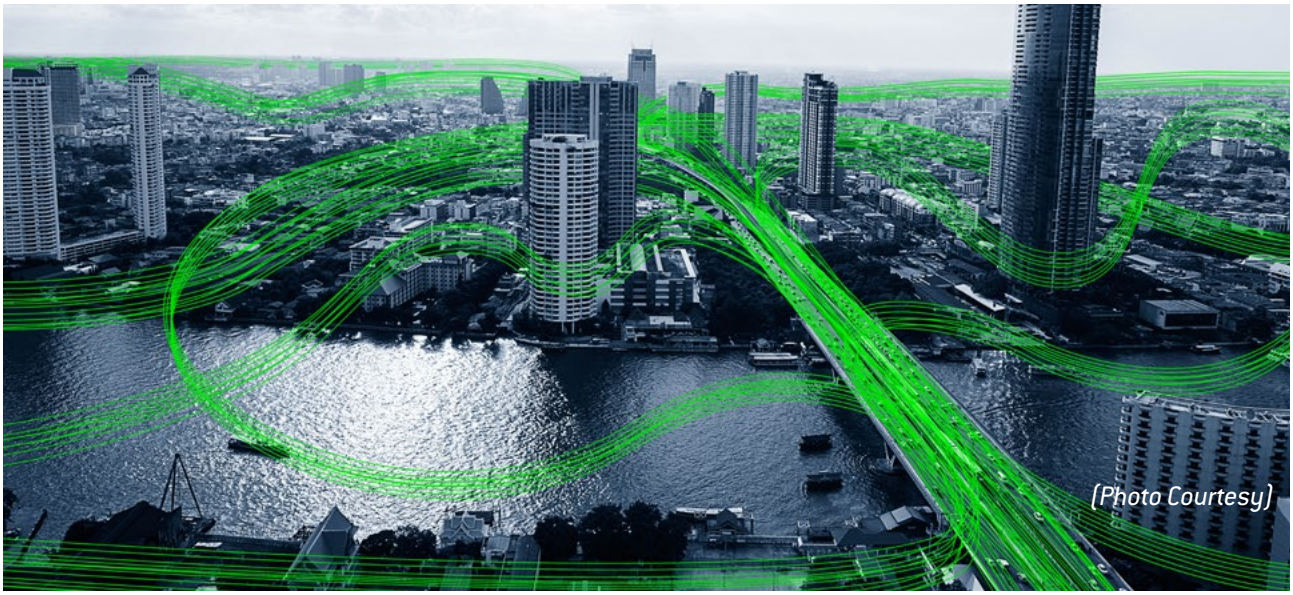
Opportunities and challenges

The smart city, Kenya's first, is coming along with plenty of design and engineering challenges, that field engineers, led by Eng. Sang, and project contractor engineers grapple with daily.

"From designs and coordinating the works of different contractors to fixing long-term challenges such as water supply and natural problems like occasional flooding, we continue to overcome setbacks," says Eng. Sang.

The Konza Technopolis project has so far provided employment opportunities for over 2,000 Kenyans currently working at the site.

Eng. Anthony Sang is Chief Engineer at Konza Technopolis



Re-Transforming Agriculture in Kenya Through the Warehouse Receipt Sytem

By Samwel Ogola

AGRICULTURE forms the backbone of the Kenyan economy, accounting for close to 30 percent of the country's Gross Domestic product and employing nearly 75 percent of the population, mostly in small-scale agriculture.

While agriculture remains a key economic driver and a key link to food security in Kenya, only 5 percent of bank lending in Kenya goes to the sector, particularly in supporting growth in agribusiness. This even as access to finance for smallholder farmers has the potential to transform agriculture in Kenya from subsistence and low-value enterprises into innovative, commercially viable, internationally competitive and modern business ventures.

However, farmers especially in the resource-poor smallholder sector, are often unattractive credit candidates for financial institutions because of the unpredictable, fragmented and unstructured nature of their agricultural activities. Further the farmers suffer from post-harvest losses of upto 30% and lack a structured market system for their produce. These challenges have contributed to the low productivity in the agriculture sector leading to the annual importation of basic food items from other countries .

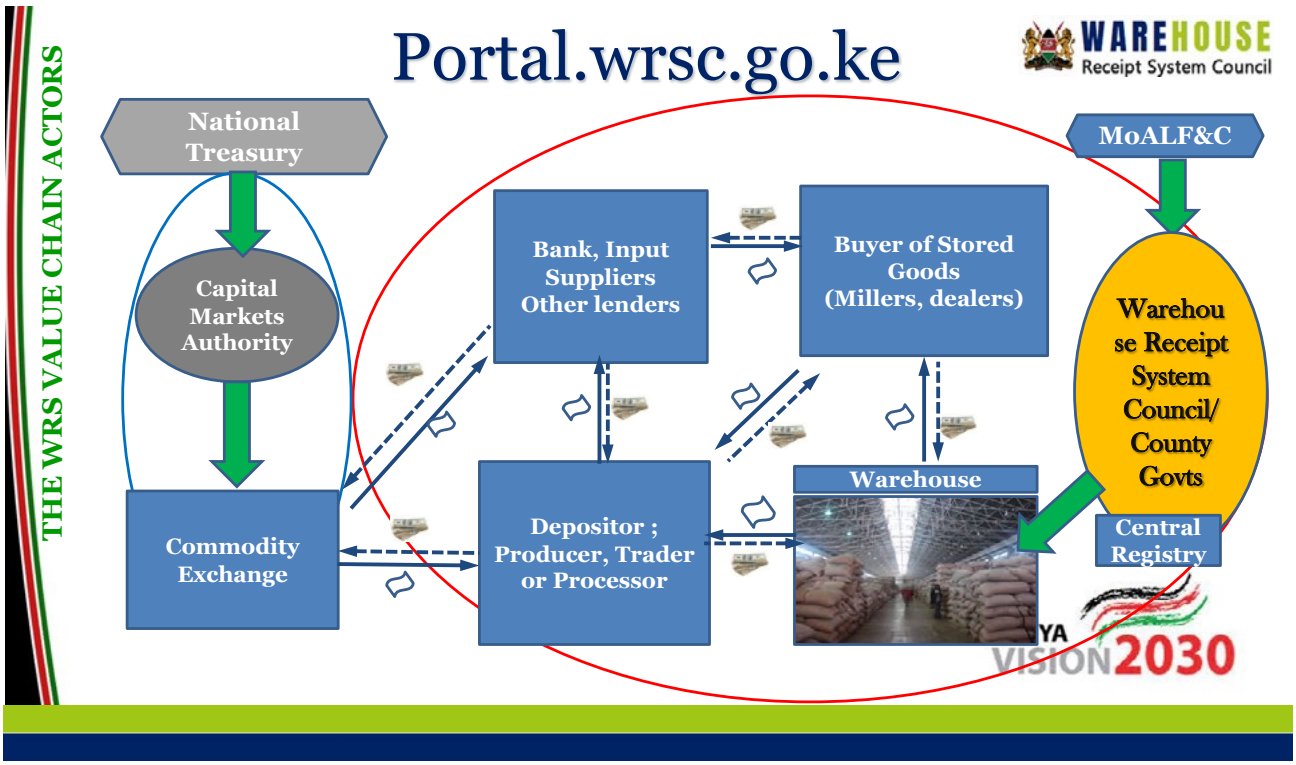
The Warehouse Receipt System (WRS) offers a solution. The System is a transformative initiative by the Government's in its efforts to structure and formalize commodity markets in Kenya as envisioned in the Agricultural Growth and Transformation Strategy, Vision 2030 and in the transformative food and nutrition security program under the President's big four agenda.

The WR system is aimed at boosting structured agricultural commodities trade and enhancing commodity prices in order to increase farmer incomes. It also aims at reducing post-storage losses through improved storage facilities with better warehousing infrastructure, distribution logistics and at the same time improving access to credit for value chain players through collateralization of the commodities within a secure and structured trading system. The main objective of these interventions is to create better opportunities for investments in the agricultural value chain system.

Warehouse Receipt for Depositors

A Warehouse Receipt System (WRS) is a process where owners of commodities (farmers or traders or dealers) deposit their commodities in certified warehouses and are issued with a document of title called a warehouse receipt. The Warehouse Receipt (WR) indicates proof of ownership. The receipt is transferable and negotiable.

The receipt allows a farmer/ depositor or trader, after harvesting; to deposit a commodity in a certified warehouse and receive a document called a warehouse receipt as 'title' that can be used as collateral for short-term credit from a participating bank or other financial institutions, thus increasing access to finance for farmers. The agricultural produce covered under this initiative are both dry and wet commodities including maize, beans, wheat, sorghum,



coffee, tea, green grams, beef, fish, potatoes, fruits and vegetables etc

Warehouse Facilities in the Receipt System

A warehouses facility is expected to boost commodities storage and handling in order to reducing post-harvest losses aggregating commodities to reduce transaction costs. The facility should also bring together buyers and sellers in a well-coordinated and rules-based manner in such a way that all parties to a transaction benefit equitably and present greater contribution to the shared socio-economic benefits.

The facilities also provide a proper environment for storing commodities. There is a challenge in Kenya for quality storage facilities including climate-controlled warehouses. To improve infrastructure for Agriculture commodities and reduce post-harvest losses, there are investment opportunities in the development of Warehouse infrastructure through utilizing existing infrastructure or putting up new warehouses. Innovations and improvement in storage techniques and technologies as well as on new models for Warehouse Infrastructure as thus encouraged.

Warehouse Receipt System Benefits

There are immense opportunities and benefits to the farmers, warehouses, professionals, financial institutions and the various government institutions in embracing the W/Receipt system. These benefits can be summarized as follows;

- WRS regulatory framework enables recognition of the receipts as documents of title which are transferable and negotiable instruments further boosting access to credit.
- With the WRS legal and regulatory framework Derisking agriculture,
- Increased bank lending for agricultural commodities.
- In the absence of a land title deed, a farmer can still access credit financing, this facility is especially beneficial to youth and women who may not own land, but can be owners of the commodity, with the receipt as proof of ownership.
- Reduction of post-harvest losses through professional storage. Small-scale farmers also stand to benefit from aggregation to sell to large traders at a better price;
- Increased value addition of agricultural commodities as the quality and quantities are assured
- Better price discovery for farmers thereby strengthening incomes as well as smoothing consumption

Opportunities for Engineers under WRC

- Design and development of value chain specific modern warehouse Infrasture
- Design and development of cold chains for wet commodities eg Fish, Beef, fruit and vegetables
- Design and development Logistics and distribution models for agricultural commodities
- Investment in value addition, packing and agro processing
- Modern agricultural drying and preservation equipment and machinery among others

Samwel Ogola is the CEO, Warehousing Reciept System Council

Proper Management of Watersheds will Ensure the Country's Sustainable Growth

By Dr. JPO Obiero

A WATERSHED refers to land areas that drain into a specific delivery point in a stream known as the watershed outlet where a gauging station is normally located. A large watershed (basin) would consist of several smaller sub-basins, which contribute runoff to different locations in the watershed that ultimately combine to a common delivery point.

Watersheds

All humans, including animals, no matter where, reside in a watershed. Watershed contains resources that include soil, water and forests, which humans depend on for their livelihoods. Water is an important resource in a watershed, which is used for purposes that include drinking, irrigated agriculture, industrial use, power generation, among others. Everyone who lives in a watershed attempts to exploit watershed resources for various purposes that include agricultural and industrial development, human settlement and as sources of fuel.

As a result of population increase, pressure has been put on forest resources, rangelands and marginal agricultural land. This has led to inappropriate cultivation practices, deforestation and overgrazing, causing sedimentation and damaging floods. Sedimentation has caused reduced life of expensively constructed engineering hydraulic structures, including dams, reservoirs and irrigation infrastructure.

Degradation

Such practices, if not carried out in controlled and sustainable manner, result in degradation of the watershed and, therefore, affect watershed "health". Degradation of watersheds may be as a result of deforestation, soil degradation, including erosion, loss of wetlands and ecosystem alteration. It is therefore important to manage the watersheds to enable its sustainable use for the benefit of the current and future generations.

Dr. JPO Obiero

Watershed management involves placing systems that ensure land resources are conserved and exploited sustainably for future generations. For watershed management to be successful, it should be a participatory process that includes all stakeholders involved in the exploitation of the watershed resources for improvement of their livelihoods. Watershed management involves conservation planning and management which, as a first step, entails the use of land according to its potential and conserving it according to its need.

> Catchment degradation has partly been as a result of using land for purposes for which it is not best suited, for example, cultivation on steep slopes that exposes the soil to erosion and hence loss of fertility and productivity. Such land could be reserved for grazing or nature conservation.

Potential for land use is partly established by agro-climatic zones whose characteristics determine the crops best suited for various regions. The use of land within its capability significantly contributes to watershed conservation and therefore its management. The use of land according to its capability will help develop watershed to its maximum possible potential, thereby protecting it from degradation, including soil erosion, and therefore maintaining fertility and productivity of the soil.

Establishment of potential for use of land and hence its capability is done through appropriate land evaluation and land use planning. This involves land suitability classification based on selected factors that are used to rate land quality for various uses. The process results into the selection of the best purpose for which the land may be put into use.

Pollution

An integrated watershed management is considered most effective if watershed conservation effort is to yield any fruit. The planning and management aim at protecting the watershed resources, especially water quality and quantity, and focus on the watershed as a whole. Pollution in a river system may be a result of runoff from various sources that include development, transportation, agriculture and forestry that originating from any location in the watershed.

Effective watershed planning and management would therefore aim at involving interested parties, and developing solutions through involvement of expertise of various organisations. A watershed plan should target an environmentally and economically healthy watershed that is intended to benefit all stakeholders and should involve all the partners in developing a statement of purpose.

On-going construction of the main canal for conveyance of water from the water intake point. (Photo Courtesy - NIA)

The main focus in integrated watershed management is water resource management. Water availability is a factor that controls the world's food production. The water resource is, however finite and the demand for it continues to rise as the years progress. Besides, it is also under threat of loss in quality arising from pollution and reduction in quantity during hydrological extremes like drought.

Sedimentation

Excess water from floods also results in accelerated erosion from degraded areas that have been subjected to such activities like deforestation, increasing sedimentation of rivers and reservoirs. Integrated Water Resources Management recognises the dependency of water users on each other within the watershed in which high demand for one use means less water for another competing use.

Integrated water resources management involves sustainable development, allocation and monitoring of the water resource use taking into consideration the social, economic and environmental objectives. Integrated Water Resources Management (IWRM) decisions on allocation and management considers together all the water users, taking into account their social and economic goals.

The management of the water resources takes into account the long-term sustainable use for future generations. IWRM aims at efficiency of water use, water conservation and management of the demand in such a manner that allows for equitable distribution of the scarce resource among users and includes recycling and reuse of the wastewater that would augment development of the new resources.

Watershed Management

In the recent past, hydrological modelling has become increasingly important in watershed management. It can be used in watershed planning for sustainable management of the watershed resources. Scenarios of proposed watershed management plans can be simulated to establish possible impact of planned land use or management practices on watershed resources, including effects on hydrologic responses, erosion and sedimentation.

This will help guide decision making by policymakers and catchment managers with regard to the best combination of land use or management practices that would support development while protecting resources from deterioration in quality and quantity. Modelling has also been used to model the impact climate change has on the water resources and development of adaptation measures for the management of equitable use of the scarce water resources.

To support integrated water resources management objective of equitable water use, watershed modelling has been applied in development of water allocation plans to harmonise the competing water uses in a watershed. Watershed modelling is used in performing degradation hazard assessment, including erosion hazard assessment. This is used to identify degradation hotspots to facilitate targeted interventions.

Dr. JPO Obiero is a lecturer at the Department of Environmental and Biosystems Engineering, University of Nairobi

TEMEC
built on excellence

Tea industry is one of the pillars of our Kenyan economy. We therefore at Tea machinery and Engineering Company Ltd have a stake in driving the industry to its full potential by offering innovative, high quality engineering products and services at competitive prices, and in a timely manner.

ABOUT US

Tea Machinery and Engineering Company (TEMEC) Ltd is a wholly owned subsidiary of KTDA (H) Ltd located at Kampala road of Enterprise road in industrial area Nairobi.

We are a manufacturing company involved in fabrication, installation, repair and maintenance of processing machinery and equipment majorly in the tea industry.

Our customers are processing companies and those who require engineering services.

Our Products and services.

Our products include (but not limited to):

1. TEA PROCESSING MACHINERY

- Withering troughs (including installation of radiators and fans).
- Continuous withering machines
- Continuous Fermentation Units (CFU)
- Driers
- ID fans, Cyclone, axial and humidifier fans
- Presorter
- Tea packers
- Final sorter (Vibro screen sorters)
- Vibrating packer complete with Forming boxes
- Lifting Platform
- Winnowers
- Bulking and storage bins.
- Hoppers
- Conveyors
- Vertical bucket elevators.

2. SUPPORT SERVICE- FABRICATION & INSTALLATION

- Leaf Carriers, Tippers and Truck Bodies.
- Drier Cyclones and boiler Chimneys.
- Tractor trailers (Tipping and Non-tipping).
- High level Tanks.(steel pressed Tanks)
- Fuel Tanks
- Condensate Service tanks for Boilers
- Log splitters
- Steam to Air Heat Exchangers/Radiators.
- Ball breakers
- Boiler air pre-heater systems

3. INSTRUMENTATION

- Thermographs
- Digital thermometers
- Dial gauge thermometers

4. SPARE PARTS AND CONSUMABLES

- CTC Segments
- Spare parts for CTCs, Rotor vanes, Milling/Grooving machines and CFUs.
- Conveyor Belts- PVC and Cotton Belts (All sizes).
- CFU perforated belts.
- Geared Motors, Magnets, FB Drier parts.
- Vibro screen final Sorters spares (for Pennwalt-Sharples) e.g Screen meshes, motors, bearings and discharge domes.
- Pennwalt vibro sorter.

5. AGENCY

- Timken Bearings
- Isuzu, Mitsubishi and Toyota Vehicle spare parts.
- Lubricants

6. WORKSHOP AND MAINTENANCE SERVICES;

- Steam systems-fittings, piping, condensate tanks, lagging and cladding.
- Machining of parts such as Gears, Shafts, Pulleys and Moulds.
- Rolling, cutting and bending of Sheet metals.
- 2D/3D CAD design and drawing.
- Maintenance services of processing machinery-Both Electrical and mechanical.
- Belt Vulcanization (At our workshop and customer's site.)
- Balancing of Fans and Ball breakers.
- Mounting and tensioning of Final Sorter – Vibro Screen Meshes.
- PVC/Cotton canvas belt vulcanization.

OUR RESOURCES

TEMEC delivers high quality products and services by utilizing it resources which include:

1a. A modern Workshop, equipped with;

- A rolling machine.
- Pressing, Bending, Drilling, Cutting and Milling machines.
- Lathe machines.
- Plasma cutting machines.
- Welding Machines(Resistance, TIG and MIG)
- Grinding Machines(Cylindrical Grinding, Internal and External)
- Belt Vulcanization machines.
- Dynamic Balancing.
- Flange Rolling.
- Gear cutting
- Vibro screen mesh tensioning
- PVC/Cotton canvas belt vulcanization
- Computer Aided Design and drafting

1b. A team of highly qualified and competent staff that includes mechanical engineers, electrical engineers, drafts man, certified welders and machinists.

Our contacts
Mobile: 0734333338/0743031247
Eng. Cherutich - 0713779833 | Mary – 0725712750

Email: sales@temec.co.ke / info@temec.co.ke
Website: www.temec.co.ke
Physical Address: TEMEC House, Kampala Road, Industrial Area, Nairobi

Is Electricity the Best Energy Source for a Clean Future?

By Carol Koech

ELECTRICITY is a wonder of our time, but the concept behind it, the flow of electrical power or charge, is not – electricity has been known about and experimented on by scientists since the early 17th century. Today, electricity is the basis for how we live. But electricity can be much more than this – it is the most energy efficient source we have, and also the best vector for decarbonisation.

The biggest challenge facing the world today is climate change. Without immediate action, the earth is expected to be 4.1°C – 4.8°C warmer by the end of the century. Despite some progress, we are still far from being on track to avoid this scenario. Destruction of life and livelihoods is occurring with increasing frequency due to the growing prevalence of extreme weather events: floods, cold snaps, heat waves, and storms.

With limited time to tackle global warming, we need to prioritise the actions and solutions that can have the greatest impact in the shortest amount of time, while still enabling economies to recover and thrive. And electricity offers the fastest, safest, most cost-effective way to decarbonise our societies through the convergence of electric and digital, bringing into play the term that we like to refer to as Electricity ***4.0.*** While digital connectivity, software and artificial intelligence can be described as the fulcrum that will support our transition towards Industry 4.0, ***if we are to build a sustainable future we must focus on a clean and new electric world.***

Innovation today relies heavily on both electric and digital. From gadgets that make our lives better, to digital home-working, to e-mobility. Energy is responsible for over 80 per cent of the world's carbon emissions. The reality is that our latest tech innovations are still largely powered by the 20th century 'fuel'. Over 80 per cent of the world's energy demand is met by fossil fuels and is distributed through outdated systems that are passive and disconnected.

As energy plays such a vital role in the climate crisis, we need to upgrade each stage of the value chain; from generation (with cleaner energy production), to distribution (with more microgrids closer to points of consumption and more access to energy), to usage (with metering and smart technology to empower users with visibility and efficiency). The technology already exists. The solution is to collectively deploy Electricity 4.0 at scale and with speed.

Digital and electric sustainability tech ticks the all-important boxes of efficiency, safety, measurable outcomes and the speed at which such solutions can be scaled and deployed. Most importantly, it allows us to bring consumers, small and large businesses along on the journey giving them more choice and control when it comes to the sustainability of their homes, offices and entire cities.

We are going to have to deal with the consequences of climate change for years, even decades to come. Digitisation can help industry become greener and cleaner. You can change what you measure, and digitisation is key to be able to measure energy and resource consumption. The most sustainable companies are using the data they collect from their infrastructure to continually improve their efficiency and reduce their carbon footprints. Sustainability is a virtuous circle and the more companies optimise their operations, the better they are prepared for the next unforeseen scenario.

> Going forward, electricity demand is expected to double by **2040,** and the good news is that we expect to see six times more electricity coming from renewables in that same time frame … from six per cent today to **40 per cent** in the next **20 years**.

As we manage the transition to cleaner energy sources in the future, we should focus on the acceleration of renewables. This shift to renewables will also help people around the world to access energy, whether that be in developed or developing countries. Renewables provide energy in a much more decentralised way, at any scale and in closer proximity to their point of use; therefore, meaning fewer losses in transmission.

While electricity powered by renewables and enabled through digital technology cannot solve 100 per cent of the climate challenge, it can get us a significant way there. Let us focus on the technologies and energy sources we know work now, are readily available and safe to deploy. We cannot afford to wait for miracles in the race against climate change.

Carol Koech is Country President, Schneider Electric East Africa

Tea Oxidation: Why Value Addition is Crucial for Physicochemical Characteristics of Tea

By Joshua Charana

RECENT findings indicate that tea oxidation is the main driver of desirable characteristics of tea for consumers. Oxidation of tea is a process that comes immediately after withered green leaf is cut, in the cut, tear and curl (CTC) process.

> The CTC process exposes plant cell for oxygen absorption and browning; therefore, a comprehensive cut of withered leaf enhances better coloration of dhool during oxidation process. Here, the cut leaf (greenish) is collected and spread over a perforated, wide membrane with adjustable speed control and time. The length and width vary from one manufacturer to the other, while speed or time can be controlled by the operator.

The perforated conveyor is hereby referred to as continuous fermentation unit (CFU). During operation, it is filled with cut tea (*dhool*) to a certain depth and conveyed while oxygen-aerated with controlled humidification. Evidence supporting this view has been largely drawn from buyers' reports, professional tea tasters and management of tea making.

However, there is a wide gap on how buyers' desirable characteristics can be achieved by tea makers. I have considered this section of tea processing because I believe this is where about 86 per cent of this gap can be answered.

The most common desirable tea physicochemical characteristics by professional tea tasters, which are identified during cupping, include colour, taste, flavour, smell, astringency and texture. All these are sensed by use of tongue, eyes and nose. No

Joshua Charana

problem has been recognised during cupping, the only underlying problem is how to get these desirable characteristics and those that are enhanced by the CFU/oxidation unit. This is the highlight of this article.

In filling *dhool* on the CFU, the feeding conveyor is set on hold to accumulate enough *dhool* to build the desired depth. This depth is critical to generate heat necessary for the oxidation process, and thus enable enzymatic action. Heat generation and controlling along the process is responsible for colour development.

Forks are placed immediately after *dhool* is spread in the CFU to aerate it, and minimise chances of enzyme denaturing due to high heat generation. The aeration process supplies the *dhool* with oxygen-rich air because tea catechins (polyphenols in the leaf) absorb significant quantity of air during this stage of oxidation.

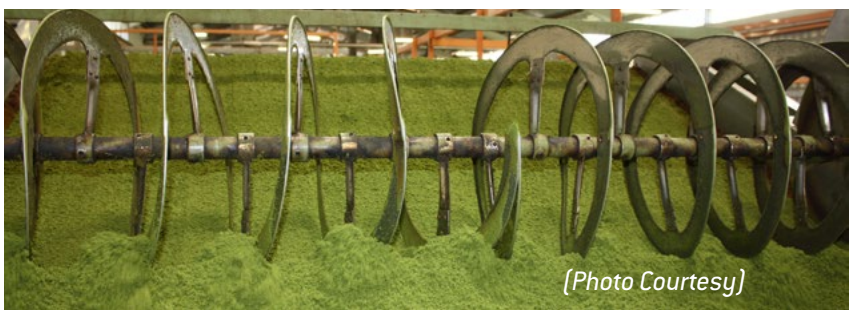
Oxygenation of polyphenols triggers chemical reactions that yield the flavour component. Excess heat leads to over-oxidation, thus, *dhool* may end up becoming dullish.

Plate up-turners are operated to turn *dhool* upside down for uniformity of character development. Also, to minimise heat evaporation from the CFU, an atomised flow of water is spread over and above each stage of CFU. This process is called humidification and is only applied when the wet and dry thermometer temperature difference exceeds 20C.

In some advanced system, this process is automated via Arduino circuits. Here, the sensor monitors air dryness and regulates humidity level. A ball breaker is a system that also controls build-up of heat and is placed at the point where the temperature approaches maximum level. Variation of its speed, direction of rotation and number of rods along the segment have a greater effect on the physicochemical characteristics of tea made.

The CFU has air supply modules with control valves. Since colour is the main desirable characteristic, the air supply along the CFU is incremental in every stage. This operation leads to a very bright colour of *dhool* exiting the CFU to drying. In the second stage, the CFU speed is increased and thus the *dhool* depth is shortened than in the first stage.

Here, the average temperature levels are reduced than in the first stage and the red brownish colour is obtained. When all these operations are practiced the *dhool* exiting the CFU has a balanced theaflavins and thearubigins, which in conclusion consist of all desirable physicochemical characteristics.



(Photo Courtesy)

NCA, EBK and BORAQS Join Forces to Combat Collapse of Buildings

(Photo Courtesy)

EBK Chief Executive Officer, Eng. Margaret Ogai, NCA Executive Director, Eng. Maurice Aketch, and BoRAQS Executive Officer Mwongera Rukaria address a press conference on the collapse of a building in Ruiru, Kaimbu County in October 2021.

By EiK Correspondent

IN the early morning of October 17, 2021, a nine-storey building under construction in Membley area, Ruiru, Kiambu County, collapsed.

Following the incident, the Engineers Board of Kenya (EBK), the National Construction Authority (NCA) and the Board of Registration of Architects and Quantity Surveyors (BoRAQS) will work with the Kiambu County Commissioner and the county government to conduct investigations into the collapsed building.

On the day of the incident, a multi-agency team visited the site and reported no casualties. Two guards who were on the premises at the time of collapse were rescued. The collapse also affected an adjacent nine-storey building, which is fully occupied. The team evacuated the tenants for their safety.

"Investigations by multi-agency teams will include, among others, assessment of structural designs of all ongoing projects. We want to start with Kiambu County because of the rate of public developments going on there and will gradually roll out to the rest of the country," said Eng Maurice Aketch, NCA Executive Director.

Eng Aketch said the developers of the building had made an application for registration in the NCA portal on January 10, 2021 but the same had not been approved, pending a clarification on documentation sought from the developers.

The state agencies said they will collectively engage all county governments in the near future to stem the tendency of unscrupulous developers flouting safety rules and regulations.

Once the investigations are completed, the multi-agency team will share full reports as well as actions taken against the developers and any other person(s) found to be culpable, and recommendations on the way forward with regards to alleviating the collapse of buildings. The investigation will include a structural design assessment of all ongoing projects within Kiambu County in collaboration.

Aketch urged developers to engage only licensed professionals (engineers and architects) to design and supervise their projects. Developers can confirm the status of their engineers and architects by logging in to the EBK and BoRAQs websites, respectively.

Developers are further urged to ensure their projects are registered with NCA and that their contractors are in good standing with the Authority, which can be verified on www.nca.go.ke.

Strategies to Drive Enterprise Profitability through Integrated Power Management and Process Automation

THERE continues to be enormous pressure on energy intensive industries to reduce existing capital project costs, operating expenses, energy consumption, and to accelerate their environmental sustainability targets. Electrical power management and process automation have long been designed and operated independently throughout a plant's lifecycle. Historically this separation made sense, but IoT and digitalization have enabled a level of connectivity to manage these two domains differently in the future. Now is the perfect time to reassess and redefine the approach to capital and operational investments. By doing this, there is the potential to become more agile, stronger and to work smarter.

Profitable Efficiency and Sustainability Through Integration

To boost efficiencies and cut costs, players across various industries especially those in the oil, gas, and petrochemical companies have begun to consolidate their automation and electrical operations. In combination with new and enhanced digital capabilities, this approach presents an opportunity to rethink the synergies of converged operations on a grand scale, one where costs can be significantly trimmed, and productivity increased.

This article summarizes "Eight Strategies to Drive Enterprise Profitability through Integrated Power Management and Process Automation." The integration of power and process is a catalyst for operational resilience and improved sustainability across the lifecycle of the plant. This integrated, digitalized approach drives Electrical, Instrumentation and Control (EI&C) CAPEX reductions up to 20% and OPEX efficiencies, including decreased downtime up to 15%, in addition to improving bottom line profitability by 3% points.

End users see energy procurement cost reductions of 2-5% and carbon footprint reductions of 7 – 12% when implementing these strategies. It offers a comprehensive view of asset performance management, energy management, and the value chain from design through construction, commissioning, operations, and maintenance.

When undergoing such an integration effort, implementing the right strategies can improve operational resilience for better anticipation, prevention, recovery from, and adaptability to market dynamics and events. This plant-wide data collection, reliable control & command exchange between systems, operators & control room will empower the workforce with clear and verified decision-making.

Eight value-added integration strategies

Field experience shows that the following eight strategies can help organizations achieve these power and process automation integration benefits:

1. Unified engineering and asset information

The integration of power and process asset information should be built into asset models from the design phase and maintained through the plant's lifecycle to avoid disconnects that reduce engineering efficiency and raise OPEX. Unified engineering creates an asset digital twin of the plant that matures at every operational stage and merges engineering asset information for industrial manufacturing processes, power systems, and equipment. This allows enhanced engineering efficiency, reduced construction costs and faster project delivery timelines through automation of project documentation, thereby reducing errors and improving workflow efficiencies.

2. System design optimization

Despite a strong interdependence, uncertainties in process electrical demand encourage power system over-design. Integrating the two aligns equipment with expected power demands, resulting in more efficient power systems that can reduce EI&C CAPEX by up to 20%. OPEX, emissions, and maintenance costs are also reduced through more efficient designs.

3. Unified simulation

Using a digital twin asset to predict power, process, and business performance creates a behavioral model for the life of the plant. Used for engineering, commissioning, asset condition monitoring, and real-time optimization, it enables operator training, unit performance evaluations, asset operation monitoring, and real-time optimization to increase energy and process efficiency and overall business performance.

4. Unified project execution

Siloes of design and construction tasks of the Main Automation Contractor and Main Electrical Contractor often adds expense, time and risk to projects. By creating a converged job description, like Main Automation and Electrical Partner (MAEP), better coordination and integration of systems is possible. The full MAEP process unifies project management to reduce uncertainties and mitigate risk. If properly executed, such a strategy can achieve an overall EI&C CAPEX reduction of up to 20% and

(Photo Courtesy)

scheduling improvements of up to 25% for EI&C scope.

5. Unified Power and Process Systems

Though process and electrical systems interact, their management through separate Distributed Control System (DCS) and Electrical Management and Control System (EMCS) can limit operational visibility. Integrating the systems into one control architecture alerts operators to conditions that may compromise the electrical distribution network before a process is started and identifies how measures such as intelligent fast load shedding can impact a process. In addition to reducing costs through optimizing cabinet footprints and cabling use, operations and maintenance efficiency can be improved by understanding process and electrical system interactions.

6. Integrated Asset Performance Management

A holistic view of major plant operating assets and their status (rotating, electrical, automation, and process equipment) is vital to improving overall facility performance. Linking root causes to seemingly disconnected events is difficult without advanced diagnostic monitoring of plant assets. An integrated asset performance management system for both power and process data provides an asset-centric view of total operations, enabling issues involving multiple equipment classes to be analyzed and resolved. Wide-ranging savings are possible through increased production uptime, extended equipment life, a streamlined procurement process and enhanced labor productivity.

7. Process Energy Optimization and Sustainability

Energy is second only to raw materials in terms of major industrial plant expense. Therefore, understanding the interaction between process and energy usage is essential to improving financial performance. Big data analytics engines, predictive digital twins, and real-time accounting capabilities are key tools for providing effective management of energy and process interactions. Carbon footprint reductions of about 10% are typical for mid- to large-scale plants, along with a further 2% to 5% reduction of energy purchase costs through an effective contract strategy and implementation.

8. Value Chain Optimization and Agility

Understanding current operating status, prevailing market conditions and opportunities, plus facility power and process equipment capabilities are all key factors in making the right decisions. Having easy access to such information allows plant operators to optimize feedstock selection, determine which products to make, facilitate buy versus sell options, and reveal which operating conditions maximize economic benefits while maintaining appropriate reliability and safety levels. Implementing an application architecture that supports streamlined, automated workflows, unites real time asset information, and enables enterprise visualization is vital achieving these results. This approach is key to quickly implementing the best business and operating decisions.

Conclusion

Uniting power and process management and leveraging digital capabilities reduces complexity, lowers the number of system components required for operations, and streamlines project execution while building collaboration between process and power teams. CAPEX and OPEX are improved, and digital transformation goals are achieved. This then enables dramatic improvements in business and organizational processes to flourish.

To learn more, you can access the entire white paper here. https://rb.gy/bfiyef

About Schneider Electric and AVEVA

Schneider Electric and AVEVA enable you to maximize value from your industrial, data center and infrastructure assets. Our longstanding partnership, combined with our integrated digital transformation solutions bring together energy management and automation tools with leading-edge industrial software that spans engineering, operations and maintenance. With a shared culture of innovation and proven history of delivery, we work together to realize your vision to increase profitability, minimize risk and drive higher sustainability, empowering your people through our connected capabilities. Now you can optimize engineering, operations, and maintenance performance across your entire organization, realizing efficiency and cost savings rapidly. Working together, we help you turn opportunity into business value.

Navigating Engineering Career as a Woman

Eng. Christine Omina Mutayi, (Bsc. Civil Engineering)

By Christine Omina Mutayi

BEING a woman in today's competitive job market can be a challenge, particularly if you are hoping to start your career in a male-dominated field such as science, technology, engineering and mathematics (STEM). In such fields, women are not only the minority in employment but are also more likely to face gender discrimination.

There are still people who view women in male-dominated career fields as oddities or as having improperly earned their positions. However, a woman has to take specific steps to not only successfully navigate these fields and their subsequent challenges but also experience more satisfaction and purpose in her job. In order for you to minimise these challenges that you may face as a woman starting career in these fields:

1. Display confidence

Don't hesitate, be confident! People who carry themselves with confidence, no matter which gender, typically get noticed more. Be careful, there is a fine line between confidence and cockiness.

2. Learn from successful male counterparts

Have confidence, speak up and watch and mirror our successful male counterparts. As a woman who has searched for jobs and worked in male-dominated fields such as site agent (with contractors at county level under road maintenance), intern (State Department of Infrastructure) and currently a trainer at Sigalagala National Polytechnic (Building and Civil Engineering Department), I say, "Go for it!" I still keep in touch with every one of my male managers from all these companies and have learnt a lot about how our diverse approaches end with better results.

3. You have to want it

It is not much fun being the only woman in the room. Men's behaviour often changes when they are with packs of other guys, and sports talk or aggressive competition may be the order of the day. However, engineering career is incredibly prestigious and lucrative. Decide in advance if you can stomach the culture and if you can, go for it!

4. Gender – schmender!

Do not grow anxious about the gender balance in this field. Your gender will neither help you nor hurt you if do not possess the baseline qualifications. As a woman, you need to be aware not only of your own growth but also of those around you. Ask for company-wide benchmarks, for knowledge is power.

5. Find your voice . . . and use it

Assertiveness is a quality that can suffer in women, especially in a male-dominated atmosphere. Too often, whether in job interviews or boardrooms, women who clearly state what they want are considered blunt or unfeminine. Find your voice and share your thoughts and desires within the workplace. Advocate for yourself by knowing what you want and how to ask for it, negotiation is an essential skill that will serve you well in your career. Always remember that someone else will take an opportunity to speak if you don't.

6. Create a solid peer support system

Reach out to other women in your company or industry and form relationships. Find sustainable and supportive support systems in professional development associations, such as the Association for Women in Science and STEM. These organisations can help you to connect with women in similar careers and work environments. You can gain aspirations from other women in STEM fields like software development, building and construction, electrical engineering, manufacturing, information technology, etc., and make valuable connections that may help you advance your career.

7. Team up with a mentor or role model

It is important to get someone who will encourage you and help you in sustaining workplace equality and diversity. See and learn from a successful woman in upper management who is a proof that success and career progression can be achieved alongside motherhood and raising a family. Team up with other women in the career field. They can share with you their stories and experiences in Engineering fields and how they have coped with challenges and achieved success. Having a role model reminds you that you can indeed have it all should you want it.

8. Believe in yourself

Finally, believe in yourself and trust in God. Yes, you can make it. Reach out to peers and mentors for support and pay it forward by helping the career women entering your career field after you. In this way, women can successfully manage and enjoy careers in traditionally male-dominated fields. Together we can make it. **Yes, we can!**

Eng Christine Omina Mutayi, (Bsc. Civil Engineering) is IEK Kakamega County Representative

My Experience with the FAEO Students Writing Contest

Eng. Grace Kagondu awards the 3rd prize winner Shueb Mohammed in October 2021.

By Shueb Sheikh Mohammed

I first got wind of the upcoming essay competition through the WhatsApp group chat for the Bsc. Petroleum Engineering class, which I am part of.

The writing competition titled 'The Value of Water' was organised by the Federation of African Engineering Organisation (FAEO), through the Women In Engineering (WIE) standing technical committee, in celebration of the World Water Day on March 22, 2021.

The competition was for female students in senior science secondary schools and all students in universities.

It was the first time I was hearing about FAEO and after digging deep about it, I concluded the competition was a must participate for me. "This competition is aimed at ensuring that the students acquire the necessary skills and experience required for contemporary writing," read the poster.

Apart from presenting an opportunity to horn my writing skills, the contest also meant an opportunity to test and benchmark against the assessment metrics set forth by the panel of judges. The seven metrics used were; originality, relevance, analytical skills, structure, adherence to topic, grammar and overall impression.

> TThe competition was open to students from all African countries that are national members of FAEO. Each country was asked to nominate five participants for the senior category – university students and five for the junior category (senior high school). In total 22 students applied for the senior category and 19 for the junior category. Overall, 41 students from 10 African countries were nominated to participate in the contest.

It was the first competition of its kind that the organisation had managed to pull together since its founding in 1972.

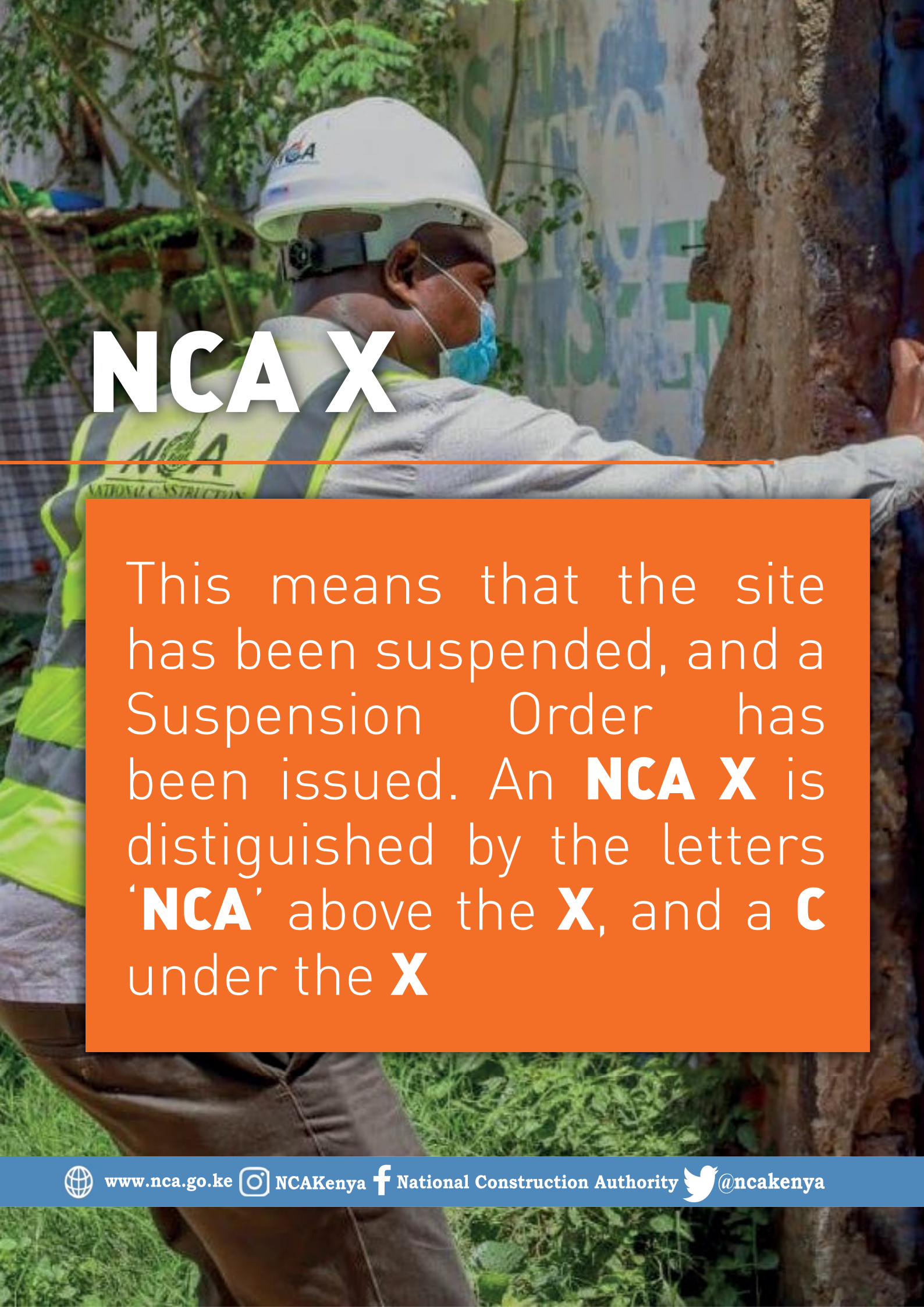
For me, it was a trial experience; an opportunity to dip my legs in the waters and see the outcome. I hoped to reap the potential rewards if I won, otherwise I would take the whole thing as a learning experience. The kick-off ceremony was held virtually via Zoom on March 23 and the actual essay writing contest happened virtually, as well, on April 29.

The writing was done real time on a piece of paper and, yes, the whole event was being recorded. The experience felt old school but indeed boosted the credibility of the essays, as no room was given for cheating. Every so often, the invigilator would caution that the recorded video would be replayed and anybody suspected of cheating would have their results cancelled. This instilled discipline among the competitors. To further boost transparency, it was required of every participant to be alone in the room, else they would be disqualified if any human presence/shadow was noticed on the camera.

The panel of judges who assessed our essays consisted of three lecturers from Kenya, Nigeria and Ghana. After what seemed an eternity, word finally came from FAEO that the award ceremony would be held on July 28, 2021. During the ceremony, which was graced by top officials of the organisation and sponsors of the contest, the speakers took turns reviewing the competition, appreciating the assessors as well as the sponsors, and announced the winners and their awards. Finally, a group photograph was taken for posting in the organization's official website.

As it turned out, the winners for both categories were female: the top girl in the senior category came from Zambia while from the junior category came from Zimbabwe. I was third position in the senior category from Kenya.

FAEO awarded laptops to the best three in the senior category and the best two in the junior category. I was delighted to be handed my award at the IEK offices on October 28. I hope to attend the formal award ceremony to be held on November 12 during the 28th IEK Conference in Mombasa. My appreciation to FAEO and IEK is profound. I am preparing to submit my application to be a student member of IEK.



NCA X

This means that the site has been suspended, and a Suspension Order has been issued. An **NCA X** is distiguished by the letters '**NCA**' above the **X**, and a **C** under the **X**

+254 709 126 102/172/173 info@nca.go.ke

NATIONAL CONSTRUCTION AUTHORITY

Eng. David Mwadali
Managing Director

Numerical Machining Complex Limited

'Facilitating & Promoting Industrialization'

NMC Mandate

Our mandate is the commercial production of steel, engineering design and development of machinery and components.

Vision

To be the pacesetter in innovation for industrialization in Kenya

Mission

To catalyze industrialization in Kenya by leveraging national resources and modern manufacturing technologies through stakeholders collaboration for sustainable development

About NMC

Numerical Machining Complex (NMC) is a public company incorporated on 4th January 1994 and is under the Ministry of Industry, Trade and Enterprise Development. NMC is owned by Kenya Railways having (KR) 51% and Kenya Shipyards Limited (KSL) 49% shares in trust of the Government.

NMC is well equipped with modern facilities and highly skilled staff for design and manufacture of machinery and components. The facilities are for the design work, machining, fabrication, foundry works, heat treatment and a metallurgical laboratory.

Due to the company's extensive experience in Kenya's manufacturing industry, NMC was appointed as a reseller and trainer of Autodesk manufacturing software These products are used by professionals in 2D and 3D design for the Manufacturing industry.

NMC is ISO 9001: 2015 certified which confirms our commitment to good practices that ensure consistent delivery of services in line with globally recognized standards. The company is committed to delivery of quality products and services at all times.

NMC has a wide market to include; energy, automotive, mining, tea, sugar, SME's, TVETS, construction among others.

NMC's Contribution to The Big 4 Agenda

NMC is equipped with machinery and equipment that enables the manufacture of various products that supports the Government Big 4 Agenda and also enhances the Buy Kenya Build Kenya initiative. NMC is equipped with modern facilities namely; Computer Numerically Controlled (CNC) machines, foundry plant, heat treatment facility and metallurgical laboratory. The equipment are for machining, fabrication, castings, profile cutting, heat treatment, material analysis (mass spectrometer) among others.

CNC Gear Shaping Machine

NMC has developed and offers various products and services in line with the Government's Big 4 Agenda namely;

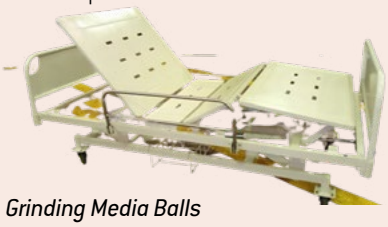
- 3 Crank hospital beds
- Cement Grinding media balls
- Water pumps
- Brick making machines
- Power Transmission Fittings
- Automotive parts
- Assorted Industrial Spares
- Product design services and training
- Metallurgical laboratory services

Tiba Bed

NMC has designed and manufactured a 3 crank functional hospital bed branded as 'Tiba Bed' for use in the healthcare sector and have been certified by KEBS.

Benefits of Tiba Bed

- Locally manufactured
- Availability of spares
- Competitive Price
- Suitable for use in any category of hospitals



Grinding Media Balls

NMC has designed and manufactured high quality grinding media balls for the cement and mining industry. The balls are made in different sizes, technical specifications and in various alloy steel compositions to cater for diverse grinding and milling applications. Currently, this product is imported and therefore NMC would like to bridge the gap by manufacturing the product locally. The challenge the companies are facing while importing the products is time and therefore would appreciate and willing to have a local supplier who can meet the quality and reduce the timelines.

Grinding Media Balls

Water Pumps

The NMC driven water pump otherwise known as *Mavuno Water Pump* is of centrifugal design which uses a rotating impeller to draw water into the pump and pressurize the discharge flow. It converts energy of the prime mover e.g. electric motor or engine into velocity and

then into pressure head. Mavuno water pumps have been purchased by several customers.

Typical applications of Mavuno water pump

- Domestic water supply
- Crop irrigation
- Industrial services
- Construction industry

Brick Making Machines

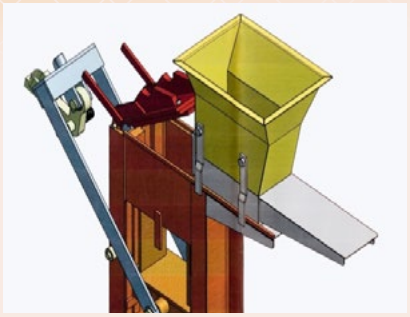
Brick making contributes to the building industry by supplying affordable and cost effective building material using locally available raw materials. Stabilized soil bricks technology offers a cost effective, environmentally sound masonry system

NMC has designed and developed different types of brick making machines namely; automated (Tofas) machines, manual and semi-hydraulic.

Automated (Tofas) brick making machine

Advantages of NMC brick making machine

- High quality and durable machine
- Easy to maintain
- Accurately machined mould
- Produce uniform blocks of great strength.
- Bricks can be made on site so transportation cost is minimized
- Bricks are environmentally friendly
- The bricks have an appealing aesthetic with an elegant profile and uniform size that doesn't require plastering.



NMC Manual brick making machines

Power Transmission Fittings

In order to achieve the large agenda in industrializing the country and increase the local manufactured content, NMC has ventured into manufacture of quality power transmission fittings that were otherwise previously imported. These include galvanized clamps, fuse bars, angles, cross arms, terminal meter sealing plates etc. This is done through precision machining, fabrication and galvanizing processes. NMC has collaborated with stake holders like KPLC in order to achieve the quality of the process.

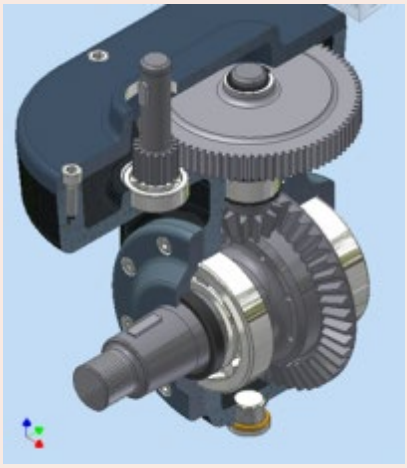
Automotive parts

NMC has been in the manufacture of assorted auto parts tailor made to customer specification. This is a big opportunity to increase the local content for locally assembled vehicles

Assorted Industrial spares

In order to support the local industry. NM Manufactures various parts and spares customized and to customer standard. These include various types of gears, shafts, splines, housings, assorted pump parts, fans etc. these are made in a state of art CNC manufacturing facility to precision and modern foundry facility.

Product design services and training



NMC offers resale and training on Autodesk manufacturing collection software including AutoCAD, AutoCAD Mechanical, AutoCAD Electrical, Inventor Professional, Fusion 360 as well as CNC programming and Machining. We also offer customized training on foundry & CNC operations and metallurgy. NMC has experienced staff who offer training and use the software and facility on a day to day basis. This is therefore mad practical and industry oriented.

Metallurgical laboratory services

NMC offer various test services in both destructive and non-destructive testing of material. Our metallurgical laboratory is equipped for carrying out various tests including Mass spectrometry, Hardness testing, Ultrasonic testing, magnetic particle testing and dye penetrant tests for cracks detection.

Other services offered at NMC include:

- Fabrication and Machining services
- Foundry Services
- Galvanizing Services
- Heat Treatment Services

NUMERICAL MACHINING COMPLEX LIMITED

Numerical Machining Complex (NMC) Ltd. is an ISO 9001:2015 certified Company established in 1994 that designs and manufacture high quality industrial machinery and components.

OUR RANGE OF PRODUCTS / SERVICES

2. TRANSMISSION UNITS

Design & manufacture of:

- Spur/helical gears
- Straight, spiral and hypoid bevel gears
- Worm wheels and shafts
- Splines
- Sprockets

1. FOUNDRY SERVICES

- Ferrous castings – Cast iron, SG iron and carbon steel.
- Non-ferrous castings – Bronze, Brass, Copper and Aluminium.

3. GENERAL MACHINING & FABRICATION

- Ferrous castings – Cast iron, SG iron and carbon steel.
- Non-ferrous castings – Bronze, Brass, Copper and Aluminium.

7. HEAT TREATMENT

- Hardening & tempering
- Gas Nitriding
- Gas Carburizing

6. NMC TIBA BED

4. SPECTROMETRY & HARDNESS TESTING SERVICES

5. SALE & TRAINING IN AUTODESK DESIGN SOFTWARE

- AutoCAD for general application
- Inventor 3D design software
- Training in design software


TRANSMISSION PARTS


STEEL FITTINGS


WARM WHEEL & SHAFT ASSEMBLY


BRAKE BLOCKS

ENGINEERING DESIGN SOFTWARE

FOR BUSINESS ENQUIRIES CONTACT: Sales & Marketing Department, Numerical Machining Complex
Email: sales@nmc.go.ke, Tel: 020-2241701/Cell:+254 716 43 11 14

President Uhuru Kenyatta opens the National Geospatial Data Centre. (Photo Courtesy)

Digital Land Transaction Platform to Curb Fraud, says President Kenyatta

By EiK Correspondent

ON April 27, 2021, President Uhuru Kenyatta launched the National Land Information Management System (NLIMS), a digital land resource management platform.

The platform aptly named Ardhisasa is designed to enhance the security of land records, speed up land transactions and curb fraud.

The President said the digital platform will relieve innocent Kenyans from exploitation by cartels, middlemen and fraudsters.

"Missing files, perennial fraud, corruption and illegal land transactions will be a thing of the past when this programme is eventually rolled out throughout the country," he said during the launch at the National Geospatial Data Centre in Nairobi.

At the click of a button, users will now be able to search and carry out various land transactions, drastically reducing human interactions, delays and other inconveniences previously experienced at manual land registries.

Ardhisasa platform is a Kenyan innovation built after three years of painstaking work by a multiagency team of young Kenyans. Citizens and investors will now be able to access Government services and information on land from the comfort of their homes or offices, using mobile phones or computers.

The phased rollout saw introduction of a wholly digital registry in Nairobi, with another 20 counties being on-boarded to the digital system by the end of the year.

"The digitalisation of land services will be rolled out to the rest of the country in a phased and gradual manner as we incorporate feedback from users. We project to cover the entire country by the end of 2022," he added.

While the digitalisation of services in Nairobi is complete, there are aspects that require alignment with the law to facilitate digital transactions. These include sectional properties – or apartments – and other sectional units that are in the process of being brought under the Sectional Properties Act 2020. This is in addition to many titles that need to be regularised before landowners can enjoy the benefits of these far-reaching reforms.

"Ardhisasa platform will assist court processes and investigative agencies like the EACC, Directorate of Criminal Investigations and the DPP to curb fraud in the lands sector," President Kenyatta said.

The landmark project is part of an array of programmes the government is undertaking to consolidate geospatial data that will provide an interface between critical but inter-related government services such as the National Addressing System, Business Registration Services, the Registrar of Persons, the National Land Commission, Kenya Revenue Authority and professional actors in the land sector.

> The platform will increase revenue generation due to proper valuation and payment of land rents as well as improve urban planning and infrastructure development.

said Faridah Karoney, Cabinet Secretary, Ministry of Lands and Physical Planning.

The President emphasised that digitalisation of land administration was part of the government's broad policy of ensuring seamless synergy and cohesion between sectors that are crucial to the overall economic development of the country.

"Land is a critical enabler of all the pillars of my Big Four development agenda namely; universal healthcare, affordable housing, food security and manufacturing," he said.

He observed that the continued geospatial survey and mapping of national resources would facilitate quality physical planning, spur increased revenue collection and promote environmental conservation by use of detailed and accurate maps.

Students voices

Let's plan for non-motorised transport

Pavements are engineered structures that are important in our everyday life, commerce, and trade. Mobility is undergoing constant change in terms of volume and spatial patterns. Non-Motorised Transport (NMT) is defined as any vehicle driven by human or animal power. This includes walking, use of wheelchairs, wheelbarrows and carts, animal-drawn carriages, bicycles, skateboards, strollers and human-drawn carts. NMT is an important element in creating increased public health benefits through recreational use and physical activity, improvements to local air quality through reduction of automobile use, enhanced quality of life through increased alternative transportation opportunities, increased property value near NMT infrastructure, and increased economic activity through spending at local businesses. Research suggests that more than 48 per cent of Nairobi's population use NMT (cycling or walking) to access their workplace, businesses and general movement. However, this core mobility infrastructure that creates access to the city for the majority and is also used to carry goods necessary for small businesses is overlooked in the current transportation planning. A study needs to be done on the NMT infrastructure condition with regards to the safety, availability and comfort at public transport points, residential areas, schools, and activity or economic centres in the country. The infrastructures of interest include sidewalks, pedestrian crossing zones, cycling lanes, footbridges and the overall pavement condition. Data to be collected includes traffic volume counts, pedestrian flow rates, number of bicycles, animal and human drawn carriages, strollers, and people on wheelchairs. In conclusion, improved, well-integrated, and networked pathways for NMT users yield several benefits.

Jerry Okoth - Graduate Engineer

Monitoring of sponge city measures by hydrologic modeling

Sustainable development is one that meets the needs of the present generation without compromising the ability of future generations to meet their needs. Water Resources Management aims at the sustainable use of resources. Urbanisation has, however, created numerous environmental as well as developmental challenges. Due to rapid urbanisation and climate change, there is an increase in floods, droughts, over-exploitation of groundwater, excessive surface runoff, and surface and groundwater pollution. This has given rise to various approaches by which to best manage water resources sustainably.

Sponge city is a concept that draws from practices promoting natural and semi-natural measures in managing urban stormwater and wastewater. Sponge city promotes sustainable urban development and water management through flood control, water conservation, water quality improvement, and natural ecosystem protection. It envisions a city with a water system that operates like a sponge to absorb, store, infiltrate and purify rainwater and release it for reuse when needed. Similar to low impact development and green infrastructure, sponge city practices affect urban flood control as well as rainwater harvesting, water quality improvement, natural water discharge and ecological restoration. The sponge city intervention measures include structural and non-structural measures.

Non-structural measures are adopted during the design stage to mitigate the effects of conventional land development by ensuring most of the natural ecosystem is left undisturbed. These measures include reduction of the impervious surface required to achieve the desired building programme, limitation of the site disturbance and clustering and concentrating development and planning the site to achieve the program within less space. Structural measures are incorporated within the design, altering the conventional designs to act in a way that mimics the natural ecosystem. They include bioretention systems, permeable pavements, water capture-reuse systems, and vegetated roof systems.

Maxwel Kizito,
University of Nairobi

ENGINEER, RISE AND LEAD

Upon graduation, there is a big excitement in the mind of a young engineer. Their dream, desire and drive are to have a great impact in a big organisation, to be involved in high-level technical discussions and significant decision making. For many Kenyan engineering graduates, these anticipations will soon hit rock bottom as the hunt for a fitting placement grows continually frustrating. "Should I start a business?" many wonder, "But how will I compete with the other established institutions?" These thoughts cross the engineer's mind, but they find the courage to toil on.

Finally, they find placement in an institution offering engineering services. However, the engineer finds him/herself flanked by other professionals in the fields of procurement, business analysis, finance, logistics, warehousing, human resource, and legal, among others. This is to enable the engineer focus on the engineering problem definition and ensure successful solution delivery on time, in expected quality, and within cost.

The culture of working in silos is outdated and cannot sustain us into the new age. An engineer is the project lead as long as the project is offering an engineering solution, whether officially recognised or not. No one cares more for the project than the engineer, and the CEO. The only way our projects succeed and the profession grows is if engineers, in whatever level of employment, plan, do, check and act as the organisation's chief executive officer. Gather cross functional information and rally for integration from processes execution through process execution. Dr. Maxwell would say, "Everything rises and falls on leadership". Engineer, rise and lead.

Nyagaka Charles, PMP®, GEng;
Adrian Kenya Ltd.

The Role of KeNHA in Highway Engineering in Kenya

The growth and sustainability of any economy largely depends on the development and maintenance of physical infrastructure. One of the key infrastructure components is roads. Roads are essential in the transportation of goods and services from one place to another within an economy. When roads are good and well maintained, they facilitate fast transportation of goods and services, consequently accelerating the growth of an economy (Wang, et al. 2018).

Engineering in Kenya has shown tremendous progress since independence. Specifically, civil engineering has shown the development of quality civil infrastructure that has boosted the growth of the Kenyan economy over the past few decades (Rutto, 2015). The Kenya National Highways Authority (KeNHA) oversees the development and management of national and international trunk roads, and major highways within the country.

The primary duties of the authority are technical in nature and hence require professionals with the technical skills to perform them – engineers. The key personnel in the authority starting from the Director General to staff under training in various capacities are mainly engineers, and more specifically civil engineers (Wanzala, 2021). Most of the highway engineering activities, including the design of roads, supervision of highway construction projects, administrative duties related to the development and management of national highways, among many others, are done by the civil engineers who form the larger part of the staff of the organisation. It is therefore worth noting that, as the country moves ahead to transform and make even better the engineering sector, KeNHA plays a key role in ensuring engineering in Kenya is relevant.

Clinton Maroria Rosana

DEDAN KIMATHI UNIVERSITY OF TECHNOLOGY

Better Life through Technology

APPLICATIONS ONGOING

The University welcomes applications for admission into the following accredited programme;

Post Graduate Diploma in Technical and Vocational Education

- Are you a graduate in an engineering or technology field?
- Do you aspire to be a professional trainer in the TVET sector?
- Do you wish to be registered as a TVET trainer?
- DeKUT's Post Graduate Diploma in Technical and Vocational Education Programme is designed for you.

Aims of the Programme

The Post Graduate Diploma in Technical and Vocational Education (PGD-TVE) programme aims at providing prospective trainers with pedagogical skills and strategies that will enable them to train using Competency-Based Education and Training approaches.

Target Clients

Individuals with a Bachelor of Science in Engineering and/or Bachelor of Technology degree.

The University also welcomes application to the following accredited postgraduate programs;

SCHOOL OF ENGINEERING
PhD Mechanical Engineering
Master of Science in Telecommunication Engineering
Master of Science in Machine Tools Designs & Manufacturing
Master of Science in Advanced Manufacturing & Automation Engineering
Master of Science in Industrial Engineering and Management
Master of Science in Civil Engineering
Master of Science in Mechanical Engineering
Post Graduate Diploma in Technical and Vocational Education Training
INSTITUTE OF GEOMATICS, GIS & REMOTE SENSING (IGGReS)
PhD in Geomatics & Geospatial Information Science
Master of Science in Geospatial Information Systems and Remote Sensing
GEOTHERMAL ENERGY TRAINING AND RESEARCH INSTITUTE (GETRI)
Master of Science in Geothermal Energy Technology
Post Graduate Diploma in Geothermal Energy Technology

SCHOOL OF COMPUTER SCIENCE AND INFORMATION TECHNOLOGY
PhD Computer Science
Master of Science in Computer Science
SCHOOL OF SCIENCE
Master of Science in Chemistry
Master of Science in Leather Technology
Master of Science in Industrial Mathematics
INSTITUTE OF FOOD BIORESOURCE TECHNOLOGY
PhD in Food Science and Technology
Master of Science in Food Science Technology
INSTITUTE OF TOURISM HOSPITALITY MANAGEMENT
Master of Science in Sustainable Tourism and Hospitality Management
INSTITUTE OF CRIMINOLOGY, FORENSICS AND SECURITY STUDIES (ICFoSS)
Master of Science in Forensics and Security Management
SCHOOL OF BUSINESS MANAGEMENT AND ECONOMICS
PhD in Business Administration & Management
Master of Science in Economics
Master in Business Administration
Master of Science in Supply Chain Management

You can apply online through our website https://admissions.dkut.ac.ke/

DEDAN KIMATHI UNIVERSITY OF TECHNOLOGY
PRIVATE BAG – 10143, DEDAN KIMATHI
TELEPHONE: 061-2050000 Ext. 1149, 0727088807
E-mail: pro@dkut.ac.ke; website: www.dkut.ac.ke

IEK MEMBERSHIP REPORT

The IEK membership committee meets every month to consider applications for membership of the various classes received at the secretariat. The IEK council at its 481st meeting resolved to waive for 60 days the entrance and annual subscription fee for applicants to the class of Graduate member which led to high number of Graduate Member applications. In the month of October the number of new applicants accepted by the council in the various classes of membership was 672 broken down as follows;

	MEMBERSHIP CLASS	NUMBER
1	FELLOW	3
2	CORPORATE	19
3	GRADUATE	644
4	GRADUATE ENGINEERING TECHNICIAN	1
5	GRADUATE ENGINEERING TECHNOLOGIST	0
6	STUDENT	5
	TOTAL	**672**

Gender Data

Gender	No.	Percentage
Male	549	81.70%
Female	123	18.30%
TOTAL	**672**	**100%**

In the same period we had three (3) members who transferred from the class Corporate to Fellow class and nineteen (19) who transferred from Graduate to Corporate class.

		485 APPROVAL

	FELLOW	
	NAME	REG. NO
1	Jude Ian Wayne Loveday	M.1435
2	George Omolo Odawa	M.1899
3	Eliud Wanyonyi Bone	M.3652

	CORPORATE	
	NAME	REG. NO
1	Amollo Otieno Kenneth	M.7146
2	Kipkorir Ngeny	M.6739
3	Sammy Karanja Kamau	M.8507
4	Simon Musyoki Kimanzi	M.6938
5	Harriet Avuna Amugongo	M.6894
6	Sheilla Jendeka Akaranga	M.6560
7	Nickson Bukachi Ongeri	M.7922
8	Stanley Munene Karanja	M.5742
9	Edwin Kiprono Rutto	M.8778
10	Alfred Vincent Wanjohi Gakuo	M.7517
11	Carol Awuor Ofafa	M.8459
12	Kelvin Otieno Odhiambo	M.8553
13	Lawrence Odhiambo Oduor	M.3198
14	Wycliff Mitunda Bokea	M.8590
15	Nashon Onyango Tambo	M.7448
16	Joanne Nyaguthi Mahugu	M.6788
17	Jacob Gachomba Njenga	M.9367
18	Tom Ngure Mburu	M.6545
19	Alex Macharia Muhuni	M.7327

The council is calling upon its members to apply for transfer of class from Corporate to Fellow and Graduate to Corporate. Members can check requirements eligibility and how to apply on our website using the following link: **https://iekenya.org/web/register_as_member**

The IEK condoles with family and friends of our members who have passed away in the recent past. May their souls rest in peace.

"Death is not extinguishing the light . It is putting out the lamp because the dawn has come."

University of Eldoret

flame of knowledge and innovation

Come Study with us

Academic Programmes

SCHOOL OF AGRICULTURE AND BIOTECHNOLOGY

UNDERGRADUATE PROGRAMMES

1. Bachelor of Science in Agriculture
   a) Major in Crop Science
   b) Major in Agricultural Economics
   c) Major in Animal Science
   d) Major in Horticulture
2. BSc in Apparel and Fashion Design
3. BSc in Food Science and Nutrition

MASTERS PROGRAMMES

1. MSc Agricultural Economics
2. MSc Agriculture Extension Education
3. MSc Agronomy
4. MSc Animal Production
5. MSc Apparel and Fashion Design
6. MSc Dairy Production
7. MSc Meat Production
8. MSc Community Nutrition
9. MSc Plant Protection
10. MSc Soil Science
11. MSc Plant Breeding and Biotechnology
12. MSc Animal Nutrition
13. MSc Horticulture
14. MSc Seed Science and Technology
15. MSc Gender and Agriculture

DOCTORATE PROGRAMMES

1. PhD - Agricultural Economics
2. PhD - Agricultural Entomology
3. PhD - Crop Eco-Physiology
4. PhD - Agricultural Extension Education
5. PhD - Plant Pathology
6. PhD - Seed Science
7. PhD - Soil Science
8. PhD - Weed Science
9. PhD - Plant Breeding
10. PhD - Horticulture

DIPLOMA PROGRAMMES

1. Diploma in Agricultural Economics
2. Diploma in Agriculture Extension Education
3. Diploma in Food Science Nutrition
4. Diploma in Agriculture
5. Diploma in Sustainable Agriculture
6. Diploma in Animal Production and Management
7. Diploma in Community and Nutrition
8. Diploma in Horticulture
9. Diploma in Community Development

POSTGRADUATE DIPLOMA PROGRAMMES

1. Postgraduate Diploma in Seed Science and Technology

SCHOOL OF BUSINESS AND MANAGEMENT SCIENCES

UNDERGRADUATE PROGRAMMES

1. Bachelor of Commerce
   a) Accounting Option
   b) Finance and Banking Option
   c) Risk and Insurance Management Option
   d) Marketing Management Option
   e) Purchasing and Supplies Option
   f) Human Resource Management Option
   g) Business Management Option
   h) Project Planning Option
   i) Entrepreneurship Option
2. Bachelor of Hotel and Hospitality Management
3. Bachelor of Tourism Management

MASTERS PROGRAMMES

1. Masters in Business Management (Accounting, Finance & Banking, HRM, Purchasing, Marketing, Strategic Management)
2. Masters in Hospitality Management
3. Masters in Tourism Management

DIPLOMA PROGRAMMES

1. Diploma in Business Management
2. Diploma in Hotel and Restaurant Management
3. Diploma in Project Planning and Management
4. Diploma in Tourism Management
5. Diploma in Travel & Tour Operations Management
6. Diploma in Human Resource Management

KASNEB COURSES

1. Accounting Technician Diploma (ATD)
2. Diploma in Credit Management (DCM)

SCHOOL OF ECONOMICS

UNDERGRADUATE PROGRAMME

1. Bachelor of Arts (Economics)

MASTERS PROGRAMME

1. Master of Arts (Economics)

DIPLOMA PROGRAMME

1. Diploma in Economics

SHORT COURSES

1. Certificate in Applied Econometrics and Data Analysis
2. Certificate in Applied Economic Modeling
3. Certificate in Economic Development
4. Certificate in Public Policy Economics

SCHOOL OF EDUCATION

UNDERGRADUATE PROGRAMMES

1. Bachelor of Education Science
2. Bachelor of Education (Home Science and Technology)
3. Bachelor of Education Arts
4. Bachelor of Education in Special Needs (Secondary School Option)
5. Bachelor of Education in Technology Education
6. Bachelor of Education (Physical Education & Recreation)
7. Bachelor of Education (Agricultural Education Science)

University of Eldoret Town Campus January/May 2022 intake ongoing.
Apply Now! visit: www.uoeld.ac.ke/next-intake

MASTERS PROGRAMMES

1. MEd Technology Education (ELT/BCT/MECH/AUTO/COMP/TVET)
2. MEd Science Education- Physics, Chemistry, Maths, Biology, Agriculture
3. MEd Educational Technology
4. MEd Educational Technology- (Subject Specialisation)
5. MEd Educational Psychology
6. MEd Educational Administration and Management
7. MEd Economics of Education
8. MEd Educational Planning
9. MED Educational Foundations (Sociology of Education, Comparative Education, History of Education, Philosophy of Education)
10. MEd Curriculum Studies
11. MEd Early Childhood Development and Primary Education
12. MEd Home Science & Technology

POSTGRADUATE DIPLOMA PROGRAMME

1. Postgraduate Diploma in Education (PGDE)

DOCTORATE PROGRAMMES

1. PhD Educational Technology (various subject specialisations eg. Kiswahili, English, Mathematics, Home Science)
2. PhD Educational Psychology
3. PhD Educational Administration and Management
4. PhD Curriculum Studies
5. PhD Technology Education- (ELT/BCT/MECH/AUTO/COMP/TVET)
6. PhD Early Childhood & Primary Education
7. PhD Science Education
8. PhD Educational Planning

DIPLOMA PROGRAMME

1. Diploma in Education Arts

SCHOOL OF ENGINEERING

UNDERGRADUATE PROGRAMMES

1. Bachelor of Engineering in Mechanical and Production Engineering
2. Bachelor of Engineering in Civil and Structural Engineering
3. Bachelor of Engineering in Agricultural and Biosystems Engineering

MASTERS PROGRAMME

1. MSc Agricultural and Biosystems Engineering (Soil & Water, Power & Machinery, Process Engineering)

SCHOOL OF ENVIRONMENTAL STUDIES

UNDERGRADUATE PROGRAMMES

1. Bachelor of Environmental Science
   a) Hydrology Option
   b) Environmental Biology & Health Option
2. Bachelor of Environmental Planning and Management

MASTERS PROGRAMMES

1. MSc in Environmental Studies (Environmental Biology)
2. MSc in Environmental Studies (Environmental Health)
3. MSc in Environmental Studies (Environmental Earth Science)
4. MSc in Environmental Studies (Human Ecology)
5. MSc in Environmental Studies (Environmental Economics)
6. MSc in Environmental Studies (Environmental Planning and Management)
7. MSc in Environmental Studies (Environmental Information Systems)
8. MSc. in Environmental Studies (Environmental Law)

DOCTORATE PROGRAMMES

1. PhD in Environmental Studies (Environmental Biology)
2. PhD in Environmental Studies (Environmental Health)
3. PhD in Environmental Studies (Environmental Earth Science)
4. PhD in Environmental Studies (Human Ecology)
5. PhD in Environmental Studies (Environmental Law)
6. PhD in Environmental Studies (Environmental Economics)
7. PhD in Environmental Studies (Environmental Planning and Management)
8. PhD in Environmental Studies (Environmental Information Systems)

DIPLOMA PROGRAMMES

1. Diploma in Environmental Disaster Management and Mitigation
2. Diploma in NGO and Environmental Project Management

SCHOOL OF HUMAN RESOURCE DEVELOPMENT

DIPLOMA PROGRAMMES

1. Diploma in Development Studies
2. Diploma in Public Relations

SCHOOL OF NATURAL RESOURCE MANAGEMENT

UNDERGRADUATE PROGRAMMES

1. Bachelor of Science in Fisheries and Aquatic Sciences
2. Bachelor of Science in Forest Resources and Utilization
   a) Forestry
   b) Agroforestry
   c) Forest Products Technologies
3. Bachelor of Science in Natural Resource Management
4. Bachelor of Science in Wildlife Conservation and Management

MASTERS PROGRAMMES

1. MSc in Fisheries and Aquatic Sciences (Aquaculture, Fisheries Management, Aquatic Sciences)
2. MSc in Wildlife Management
3. MSc in Forestry (Forest Economics & Management, Tropical Forest Biology & Silviculture, Tropical Forest Soils & Hydrology)
4. MSc in Agroforestry
5. MSc in Wood Science and Industrial Processes (Wood Composites, Wood Bio-deterioration, Wood Preservation, Pulp & Paper Science, Saw Milling, Bio-Energy)
6. MSc in Protected Area Management

DOCTORATE PROGRAMMES

1. PhD in Fisheries (Aquaculture Management, Fisheries Management, Aquatic Sciences)
2. PhD in Forestry (Forest Economics & Management, Tropical Forest Biology & Silviculture, Tropical Forest Soils & Hydrology)
3. PhD in Forestry (Agroforestry)

SCHOOL OF SCIENCE

UNDERGRADUATE PROGRAMMES

1. Bachelor of Science
   a) Botany
   b) Zoology
   c) Chemistry
   d) Physics
   e) Mathematics/Applied Mathematics/Statistics
2. Bachelor of Science in Microbiology
3. Bachelor of Science in Biotechnology and Biosafety
4. Bachelor of Science in Analytical Chemistry with Computing
5. Bachelor of Science in Biochemistry
6. Bachelor of Science in Actuarial Science
7. Bachelor of Science in Applied Statistics with Computing
8. Bachelor of Science in Information Technology
9. Bachelor of Science in Computer Science

MASTERS PROGRAMMES

1. MSc in Chemistry (Analytical, Organic, Inorganic, Physical)
2. MSc in Mathematics (Biostatistics, Pure and Applied mathematics)
3. MSc in Zoology (Animal Ecology, Entomology, Parasitology, Animal Physiology)
4. MSc in Physics (Theoretical physics, Electronics, Materials Science, Renewable Energy)
5. MSc in Botany (Plant Taxonomy, Plant Ecology, Genetics, Plant Physiology, Plant Pathology, Phycology)
6. MSc in Microbiology
7. MSc in Mycology
8. MSc in Biochemistry

DOCTORATE PROGRAMMES

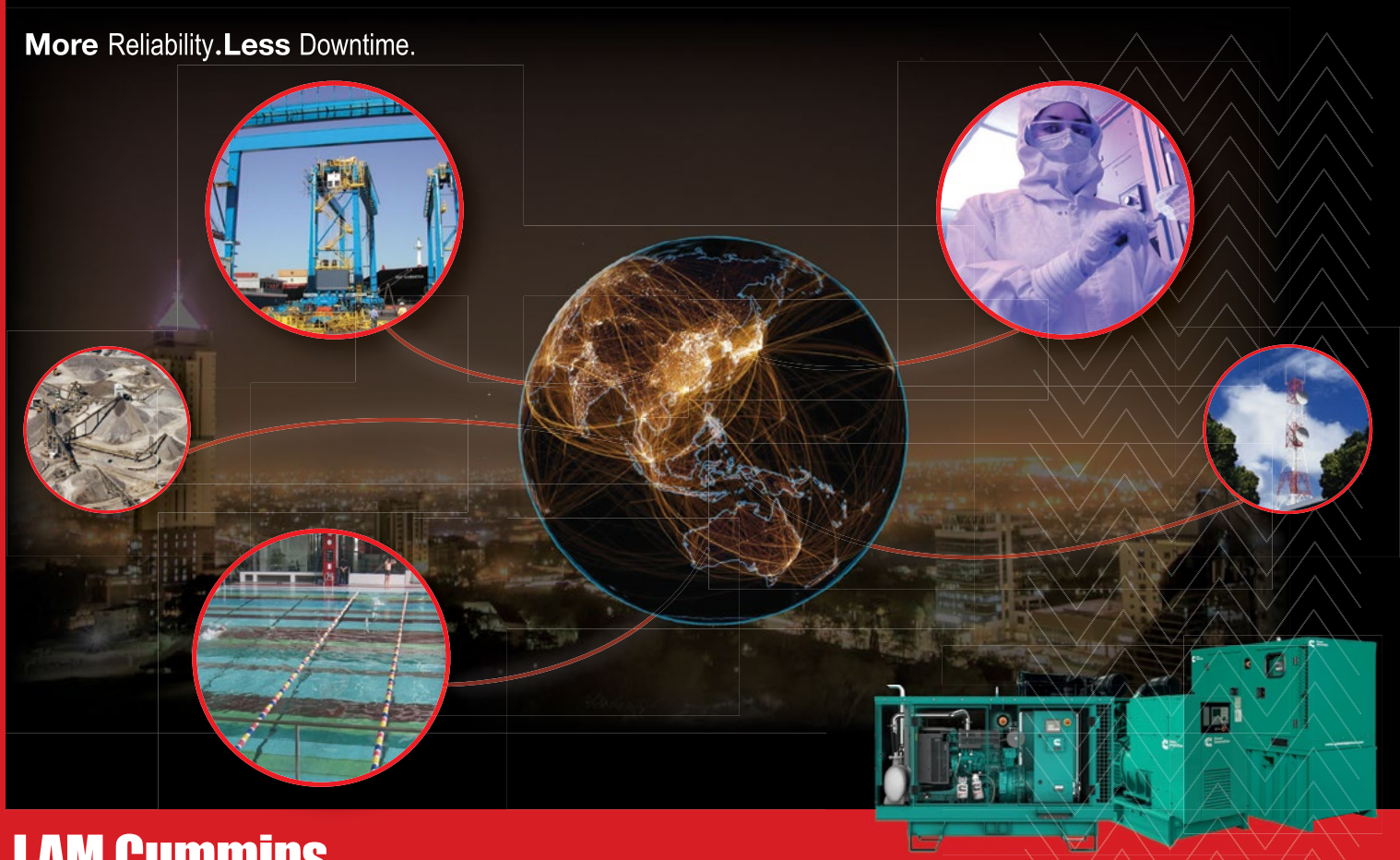
1. PhD in Chemistry (Analytical, Organic, Inorganic, Physical)
2. PhD in Mathematics (Applied Mathematics, Biostatistics)
3. PhD in Zoology (Animal Ecology, Entomology, Parasitology, Animal Physiology)
4. PhD Physics (Theoretical physics, Nuclear Physics, Electronics, Renewable Energy)
5. PhD in Botany (Plant Taxonomy, Plant Ecology, Genetics, Plant Physiology, Plant Pathology)

DIPLOMA PROGRAMME

1. Diploma in Computer Science
2. Diploma in Information Communication Technology (DICT)

P. O. Box 1125-30100 Eldoret, Kenya. Tel: +254 788 232 004, +254 740 354 966.
: www.uoeld.ac.ke :@UniversityofEldoret :UoE_Main
:University of Eldoret :University of Eldoret

More Reliability.**Less** Downtime.



I AM Cummins
A Global Power Leader

Available from 110-3000KVA

ALWAYS INNOVATING

EVERY PART GENUINE.

- **Support: 2 year warranty. 24 hours, 7 days a week.**
- **Tools: Equipped workshop, engine rebuild centre and onshelf parts.**
- **Power of one: Generators, switch gears, controls and networks.**
- **Synchronization / paralleling Systems.**

Nairobi: 0722 - 209876 - Lusaka Rd Kisumu: 0722 - 509935 - Obote Rd

Mombasa: 0722 - 209875 - Mbaraki Rd Nakuru: 0728 - 606179 - Nakuru Eldoret Highway

Kenya . Uganda . Tanzania . Burundi . Ethiopia . Eritrea . Djibouti . Seychelles . South Sudan

for more information : info@cargen.com | www.cummninscargen.com