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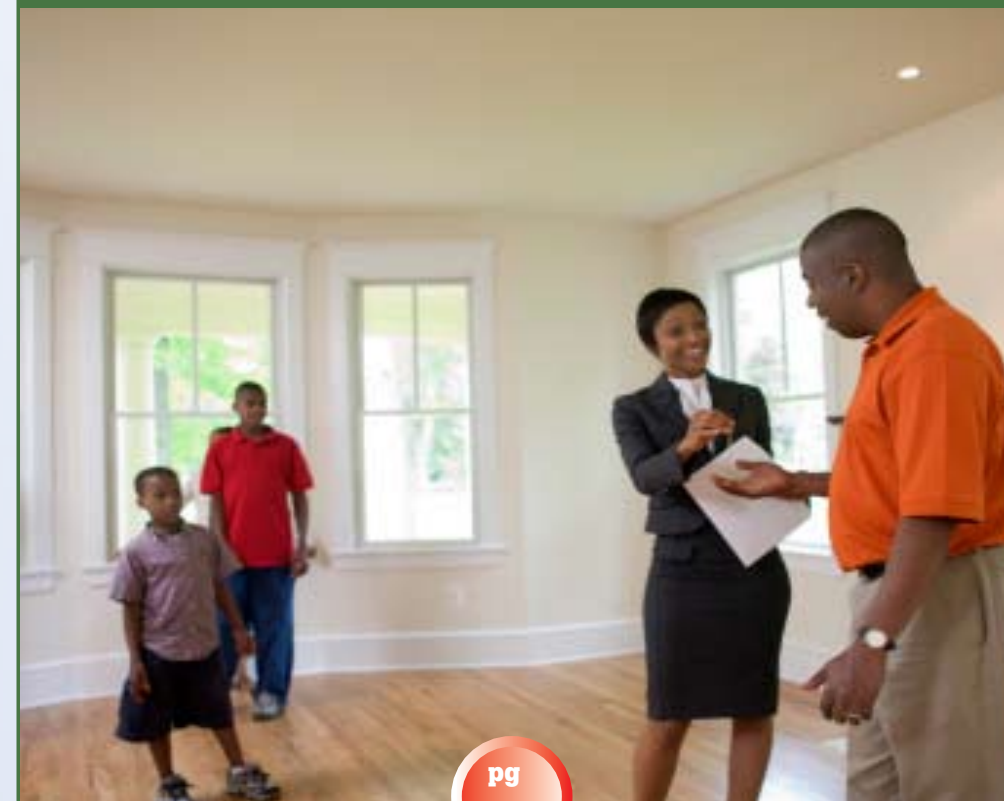
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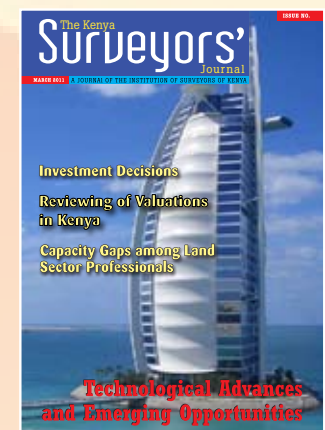
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TECHNOLOGICAL ADVANCES AND EMERGING OPPORTUNITIES FOR LAND SURVEYORS

To add meaning and flair to the symbolic progress of the Institution of Surveyors of Kenya (ISK), it is important to remember the rich history of the land surveying profession and the transformation it has undergone. The author tries to highlight some key milestones and opportunities that the profession has witnessed over the years.

The author holds a BSc. degree in Surveying from the University of Nairobi and MSc. in Resources Engineering from the University of Karlsruhe in Germany. He has practical experience in land surveying and GIS applications, particularly tunnel surveys, having worked as a surveyor on the Sondu Miriu Hydropower Project. In 2008, he graduated from a capacity building programme on policy research and analysis at the Kenya Institute for Public Policy Research and Analysis (KIPPRA). Since then, he has been employed as a researcher under the Infrastructure and Economic Services Division of KIPPRA, dealing with research on areas of sustainable infrastructure development and management.

Introducing World Development Challenges

Complexity, both in dimensions and content, has become a common feature of the numerous development challenges facing the world today. The Information Age is giving way to a new era that has been referred to as the Conceptual Age. The latter era is mainly devoted to artistic creativity and innovation. Knowledge has been regarded as the principal source of economic growth, a view asserted by economists such as Robert Solow, Nobel laureate in economics in the year 1987. Building knowledge-based economies has consequently emerged as a top goal in the development agenda of many nations across the world. Ready access to knowledge is now the main window to gaining a competitive advantage. Effective application of knowledge to solving common problems in society determines who and which institutions can achieve and sustain competitiveness and relevance in this millennium.

Countries have set various goals on meeting the key sustainable development agenda of the new millennium. These targets are

reflected in the Millennium Development Goals (MDGs), Agenda 21, and national development visions. Kenya's Vision 2030 is a glaring example. Except for different degrees, every country now experiences complex problems that cut across many sectors of the economy, natural environment, governance, and society. To match the magnitude and dynamics of these challenges, countries must make and enforce effective policies and optimally apply advanced technologies.

Alert to the inevitable force of rapid urbanisation, which in the year 2008 saw half of the world population living in areas defined as urban, Kenya and other countries are now keen on integrated planning of large city regions or metropolitan areas. Generating and managing data that are linked to geographical locations, or geospatial data, are central to meeting development challenges related to land use and infrastructure planning, natural resource management, strategic location of investments, security, among others. Spatial data accuracy is at the heart of development planning in the public sector. These development challenges have far-reaching

implications for the surveying profession, in its broad meaning.

Land Surveyor: Contextual Meaning and Training in Kenya

The term surveyor is no doubt familiar in professional discourse. Despite being such a familiar word, it means vastly different things to different people depending on disciplinary approaches, or geographical and functional contexts. There is also a historical side to the diverse contexts in which a surveyor is understood from one place or situation to another. For enhanced and focused readership, this article provides a brief background by shedding more light on the identity of the land surveyor within the surveying fraternity.

A review of the systems of training used in Kenya, Nigeria, Ghana, the United Kingdom, Germany, Canada, the United States and Australia reveals a striking variety of

context-specific roles that the professional person called surveyor is trained to play in national development. The ensuing fraternity of surveyors is made up of specialties that

can be categorised into three distinct areas:

- the science and applications of earth-based measurements and mapping;
- land economics; and
- building economics.

The common feature of the various disciplinary approaches is clear; they have land, in its broad meaning, as the central theme around which revolve the philosophy and techniques used to capture, analyse and manage the data and information required for decision making. This shows how broad the profession of surveying is, and how so much can be achieved through integrated disciplinary approaches to solving land-based development problems.

Kenya has a long history of offering survey education with defined lines of specialisation in all the three areas above. The part (a) above deals mainly with mathematical and engineering aspects. These are geared

University of Nairobi) or geodetic engineer in Ghana and Germany. In several country cases, geodetic engineering is taught within the faculty of civil engineering. The generic term geomatics is nowadays used to refer to the broad discipline encompassing surveying (geodetic, cadastral, engineering and marine surveying) and including the global positioning system (GPS), mapping (photogrammetry, radargrammetry, cartography, automated mapping, facilities management and charting); remote sensing (data acquisition and application); and the creation and maintenance of spatial or geographic information systems (GIS).

Evolutionary Phases of the Land Surveying Profession

Land surveying can be traced back to practice of old forms of earth-based sciences like astronomy in navigation. The surveyor of old mainly worked within the narrow confines of land-based measurements using

planning for transportation, building and construction, environmental management, or facility location and management. The advent of space technology broadens the role of a land surveyor with a futuristic perspective. Some key opportunities for the Kenyan land surveyor have been presented below with a heavier emphasis on new and emerging issues in energy efficiency, investment choices, policy research, and natural resource management.

The modern surveyor can take pride in a broad educational background covering areas that are crucial to accurate capturing of spatial data as well as evaluating, analysing, synthesising and disseminating the resulting information in digital formats, mainly maps. The internet has opened up extensive dissemination opportunities. The advent of space technology is a further boon, giving opportunities to the surveyor to actively participate in space research. To match the demands of these new developments, current

graduates need to build upon their first degree in order to acquire advanced academic and experiential knowledge. Increased automation is also making the surveying practice less labour-intensive. Advancing knowledge is therefore critical to remaining competitive and relevant in this new era.

New Opportunities for Land Surveyors

The cross-cutting and powerful influence of science, technology and innovation (STI) has opened up vast opportunities for land surveyor to contribute immensely to solving the complex problems facing the planet. Seen in the light of technological advances, the land surveyor of the last century is no match to the modern land surveyor, both in the depth and breadth of active roles in modern global development.

The ambitious development goals of Kenya contained in Vision 2030 and the pressure to meet the Millennium Development Goals (MDGs) set the background against which the contribution of the Kenyan land surveyor

can be discussed. Planning based on land-related data and information is at the heart of this development blueprint, making the professional contribution of land surveyors vital. In order to attain the desired status of a middle-income economy, Kenya must ensure there is adequate and updated geographically referenced data to support decisions touching on all the three pillars of Vision 2030 (the social, economic, and political pillars). The following key areas will demand greater attention from the modern land surveyor.

Urban planning

Rapid urbanisation is among the most pressing challenges facing the world today. By the end of 2008, it was estimated that half of the world's population lived in urban areas. A sound spatial framework is crucial to guiding urban development and ensuring that facilities are located favourably to serve the needs of resident populations in space and time. Web-based systems that combine internet technology with GIS to capture, process and display information in real time are resourceful in active community involvement and capacity building. Realisation of Kenya Vision 2030 demands sound physical planning that can boost efficiency in systems and services related to transport, housing, communication, and location of utilities and investments. Sound spatial data must therefore be the bedrock of metropolitan planning and a key anchor to the economic, social and governance pillars of Kenya Vision 2030.

A look at Nairobi reveals the disharmony that characterises the location of facilities, resulting in long distances from residential sites to social amenities. To come up with an accurate spatial framework, the land surveyor's input is needed in determining geographical positions of important sites

and mapping them for planning purposes. Analysing, updating and disseminating such surveyed data and information are made even easier by modern GIS technology. Developed countries demonstrate the great benefits of having a sound spatial planning framework for their cities with possibilities for easing congestion in settlements and transportation networks, investment decisions based on proximity and human activities, waste management decisions, and so on.

In the area of telematics (combination of telecommunication and informatics), the land surveyor applies Global Positioning System (GPS) technology integrated with computers and mobile communications technology to facilitate automotive navigation systems. Practical applications of telematics can be seen in vehicle tracking and fleet management. Intelligent transportation systems (ITS) continue to boost safety and urban service delivery in advanced economies. Such systems do rely on the input of accurate spatial data that can only be obtained through precise survey techniques.

The new paradigm of utilising idle and/or contaminated sites (referred to as brownfields) is gaining approval in urban planning to help minimise interference with fresh land outside the inner city (greenfields). Viewed from this perspective, it becomes evident that metropolitan planning visions cannot be realised without optimal input of land surveying techniques. Space economy, a key requirement in land development, has been a success factor in transport and housing development for many exemplary cases such as Singapore, Germany, and Switzerland.

Engineering surveying techniques provide control for the design and development of man-made structures. The increased demand

for high quality and safe housing in urban areas can only be met when engineering surveys are carried out adequately to ensure high standards of implementation and maintenance of built structures, including monitoring of deformations.

Countries that manage sound national network-based spatial data infrastructure have become competitive in promoting the use of updated geographical information in support of political, economic, social and personal development by all citizens. This has contributed to more vibrant economies with benefits of time saving and access to knowledge in making investment decisions. Economics is about competition for scarce resources, and ready access to crucial geographical information gives the power to gain competitive advantage in economic ventures. Land-parce- based information can richly inform planning and investment decisions, with one best-practice example being the Full Circle Community Mapping and Planning Project (CMAP) of Chicago Metropolitan Agency for Planning, USA. Here, using web-based technologies, communities through mobile mapping can participate in their neighbourhood development and articulate their concerns better in the public planning process.

Environmental and energy resource management

Environmental sustainability is central to development issues in the world today. Greening has become the buzzword of the moment, a term used for environmentally friendly interventions in the built environment, energy sector and industrial processes (hence green technologies). The US Green Building Council is a premier in promoting green building technologies aimed at reducing long-term operation costs, energy consumption

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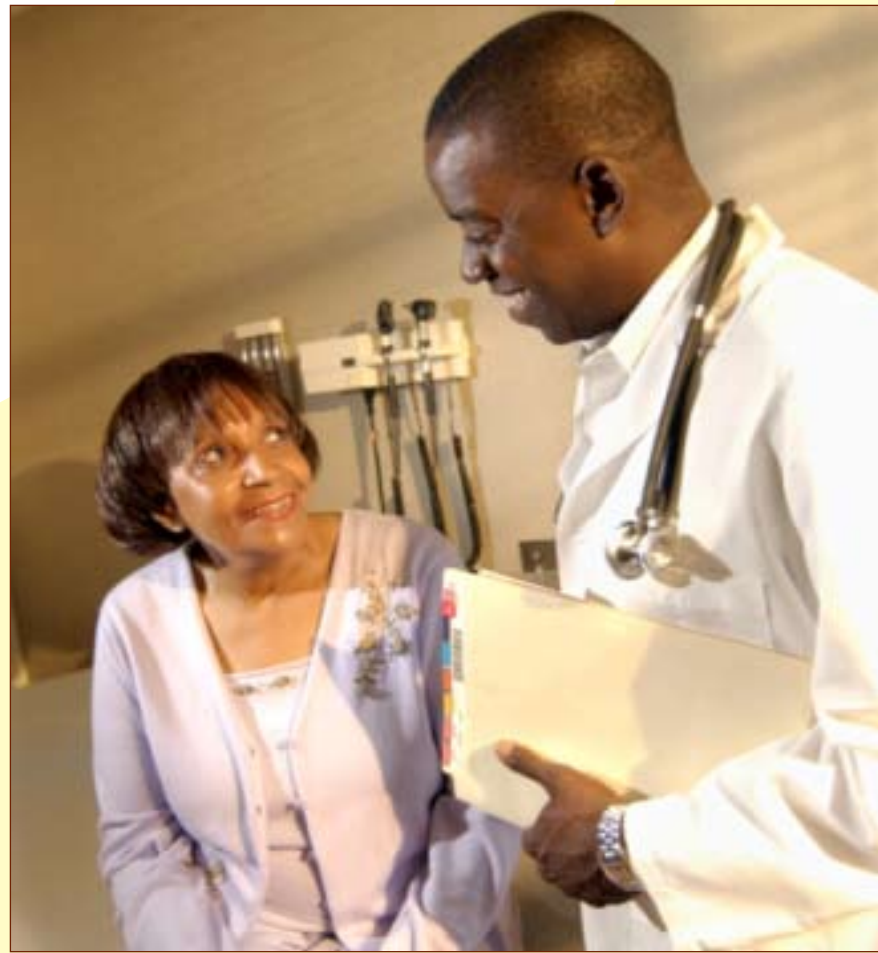
towards representing the shape and size of the Earth and its gravity field in an accurate co-ordinate system to guide accurate measurements on the Earth. Due to this particular orientation, this specialist area has always been a core and compulsory subject for the typical Kenyan land surveyor, who, in essence, must also study mapping and positioning techniques in space as well as on the land and sea.

In this era of technological advancement, the imperative to manage geographically referenced data and information using modern systems like GIS has become a natural addition to the land surveyor's common duty of spatial measurements. Consequently, names considered more representative of the profession have been coined for the professional, otherwise for long known as a land surveyor. These names include geomatic(s) engineer (for instance, at Kenya's Jomo Kenyatta University of Agriculture and Technology, in Canada and Australia), geospatial engineer (at the

rudimentary equipment such as chains. There has since been considerable improvement in survey instrumentation, with modern digital equipment capable of handling multiple data capture and processing tasks fast and efficiently, whether on land, sea, or in space. The ultra-modern information and communication technologies have changed the face of the profession completely. It is no longer out of place to find graduates of land surveying actively engaged in diverse, non-traditional areas such as public policy, emergency, public safety and security services, applied metrology, strategic business solutions, intelligent transportation systems, environmental monitoring, among others.

Given the present state of Kenya's development and her development goals, the Kenyan land surveyor has huge and diverse opportunities to make significant impact on national development. This is true considering that most of the challenges to be overcome have a spatial dimension, whether in sound





and polluting emissions. Proper management of water resources and conservation of critical ecosystems such as forests can be improved using information from catchment delineation and mapping of buffer zones. To enhance modelling of changes in the levels of large water bodies, adequate bathymetric mapping is required, and this calls for application of hydrographic surveying techniques. Optimal location of environmental infrastructure to facilitate waste management solutions also requires a surveyor's expert guidance.

Nature conservation is a big boost to tourism, which is a top foreign exchange earner for Kenya. Mapping of wildlife migration routes and tracking endangered species are avenues where survey applications are crucial, especially given the advanced functionalities availed by modern remote sensing and GPS techniques. Coastal resource mapping is gaining increasing importance, as more and more people are projected to live within one kilometre of the coastline (about 7 per cent of Kenya's population is now living within 25 km of the coastline). Social justice as a pillar of sustainable development requires that tourism benefits local communities, hence the new concepts in ecotourism aimed at benefiting the communities adjacent

to conservation areas while raising their awareness on managing such sensitive ecosystems. It is the duty of a surveyor to provide reliable spatial measurements and data to support management and policies touching on such valued ecosystems.

Agricultural productivity can be improved by reducing over-reliance on rain-fed production, which is already threatened by climate change. Survey and mapping is necessary for developing irrigation systems that can boost agricultural production all year round. Land use suitability analysis using GIS is a highly useful approach to raising productivity.

With the growing visibility of energy as an essential driver to economic development, energy efficiency has gained prominence. International talk is vibrant with issues of environmental responsibility, ecological footprints for estimating the extent of human demand on the planet based on areas of productive land and water needed to support a given lifestyle, and green energy (referring to renewable like solar, wind, hydropower and geothermal energy). The land surveyor's training in field astronomy is important in determining parameters like declination of the sun, which can be programmed to make

maximum use of insolation, especially in temperate regions. Solar energy optimisation relies on accurate determination of a tracking mode that can maximise insolation. Surveying techniques provide the crucial measurements of altitude, azimuth and declination needed for automatic tracking. Kenya's main source of electricity is still hydropower. Hydropower structures, such as the over 6 km long tunnel of Sondu/Miriu Hydropower Project, must be set out accurately using land surveying methods to meet design specifications and achieve intended goals.

Public health and safety and security

Geological risk assessments have been improved using remote sensing techniques such as radar systems (radargrammetry). Surveyors nowadays delve into the interdisciplinary fields of image processing for security intelligence, digital and close-range photogrammetry for medical research, precise positioning and missile guidance for the military, and monitoring of deformation in facility management. Any country has every reason to take public safety and security seriously. This is reflected in Kenya Vision 2030 and Nairobi Metro 2030 Strategy, in the global agenda like the Millennium Declaration of 2000 together with the poverty related MDGs, and in Agenda 21. Highway safety is also important here, and it is a routine task for surveyors to ensure that geometric design aspects for highway safety are attained.

Political governance

In political governance, equitable resource distribution is crucial. Using mapping techniques which display true representations of proportional areas can facilitate decisions on equitable resource distribution. Boundary disputes are not uncommon, and the technical input of a land surveyor is necessary for guiding decisions in such belligerent political situations. Boundary revision is becoming more imperative because of the need to reflect the rapid spatial and demographic changes over time that should inform effective political governance. Land surveying applications are crucial in these aspects.

Research and development

The demands of today's challenges have special implications for capacity building and disciplinary approaches. Developments through the 20th century to the present

have continued to dissolve the boundaries that existed between traditional specialties. Modern scientific research must not be confined to natural sciences, but has to include social and behavioural sciences for effective solutions. Many researchers now appreciate the strengths of multidisciplinary approaches in solving complex problems in real life.

Better understanding of the geometry of the earth and its gravity field is helpful in studying changes in the environment. Research on the finer physical details of the planet and related aspects of the universe is still far from optimal. Space technology offers unprecedented opportunities for studying environmental changes such as declining forest and water resources. This places the role of the land surveyor within the broader global development agenda that take into consideration changes in our environment. Modelling future changes in population, water demand, land use, energy demand, and land cover changes require accurate spatial analysis.

Business and industry have much to gain from research involving location-based intelligence solutions and precision measurements (industrial metrology). The insurance industry is a good example of where objective application of accurate spatial data can lead to major breakthroughs. For instance, there are opportunities for establishing an objective basis of insurance against agricultural risks by capturing and interpreting geospatial data on rainfall index

and vegetation greenness index (Normalised Difference Vegetation Index NDVI).

Concluding remarks

Land remains a central factor of production and a highly valued fixed asset that draws much interest from investors and financial institutions. The land-based professions have a central role to play in ensuring efficient and sustainable land-based developments, as well as managing physical assets. From this article, it is self-evident that land surveyors play a central role in planning, designing, implementing and managing the data and structured information essential to the infrastructure and facilities that help improve efficiency, safety and quality of life.

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In summary, the opportunities for the Kenyan land surveyor are increasingly becoming evident and critical to addressing the modern challenges facing the country. The land surveying profession as it once was has been modified by technology so that the trade of the modern land surveyor is not limited to traditional specialties. The major strength of this profession is in the fact that developments on the planet will forever require the knowledge of positional relationships on the earth or in space to a reasonable degree of accuracy.

It is no longer uncommon in Kenya to find graduates of engineering and technology courses actively employed in sectors like insurance, auditing, banking, and similar financial and commercial sectors. It is important to note that the role played by surveyors will be appreciated better through a more visible impact on modern industry and commerce. The visibility of surveyors can be enhanced by encouraging their participation in diverse sectors of the economy. The current graduates of surveying courses need to internalise the reality that their training in surveying is not a limitation to practice within the narrow confines of land management issues, but rather a wide window of opportunity to make extensive technical contributions that can guide crucial decisions in areas of key public interest such as safety and security, environmental sustainability, emergency preparedness, suitability analysis of land use and investment locations, and socio-economic policy research.

