

Land Use Policies and Natural Resource Management in Kenya: The Case of Nairobi River Basin

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Key words: Spatial planning, Land use policies, Natural resource; management

SUMMARY

Nairobi River Basin is a complex of several parallel rivers that flow through the City of Nairobi and empty into a larger river and flow to the Indian Ocean. The rivers are polluted with garbage, industrial liquid effluence, agro-chemicals, petro-chemicals among others. This situation has occasioned spread of water-borne diseases, loss of sustainable livelihoods, loss of biodiversity, reduced availability and access to safe potable water, and the insidious effects of toxic substances and heavy metal poisoning which affects human productivity. Past efforts to clean the rivers have not considered the integrated nature of the river basin and varied interests presented by different land uses. The river basin is characterized by a wide range of land uses including agriculture in the upper catchment, residential, commercial and industrial uses in the lower parts of the basin. The cardinal goal of ensuring sustainable use of the environmental resources is closely linked to national and regional land use policies. Land use policies address a wide range of issues including; legal, tenure, administration, institutional and special land issues. Integrated management has to consider not only the different types of land uses but also different stakeholders. There lacks a negotiated solution that explicitly takes into account the absence of a land use policy and the interests of multiple-stakeholders. Public resource allocation often requires the management of conflicting objectives of multiple policy actors at different spatial levels. Public policy evaluation and choice will usually require the harmonization of conflicting points of view in a systematic and transparent way. The paper shares the results of a research carried out on the Nairobi River Basin. The study applied a multi-attribute evaluation models based on user-weighted criteria and user-rated strategies to recommend best-compromise land use policy options for the management of the Nairobi River Basin.

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- INTRODUCTION

Land plays a crucial and central role in the economic, social-cultural and political lives of individuals and communities in Kenya. Land provides the livelihood base for the bulk of the population especially in rural areas where the main occupation is agriculture/pastoralism. In the national development blue-print, land is recognized as a critical resource in achieving the socio-economic and political development in the country.

Land in itself is a repository of a wide array of natural capital stock such as soils, forests, wetlands, minerals and wildlife among others. Natural capital-based sectors of the economy such as agriculture, forestry, tourism, mining, water and energy contribute approximately 42% of the GDP. In essence the goal of improved livelihoods and sustainable natural resource management are closely intertwined with land. Besides the direct benefits, the environment provides critical ecosystem services that are vital for quality life such as watershed protection, prevention of soil erosion, carbon sequestration and recreation among others. Sound management of natural capital is vital in ensuring adequate and continuous supply of environmental goods and services. Furthermore, proper management of the environment is critical to ensure that the negative impacts environment-related calamities such as floods and drought are minimised or even averted.

Kenya is currently experiencing high levels of natural resource degradation manifested through high rates of deforestation, soil erosion, declining soil fertility, pollution of water bodies, ineffective disposal of solid waste, violent conflicts over resources and such others. There are several factors that explain the current level of natural resource degradation such as high population growth rate, undervaluation of environmental goods and services, under funding of the natural resource sector, weak enforcement capacity, lack of land use policies and a generally weak institution framework among others. These problems are likely to pose even greater challenges in the future as the country implements the development agenda. An increase in the manufacturing activities will inevitably give rise to an increase in effluents discharged and pollution which will require more stringent and effective management to avert further deterioration of the environment. Furthermore, the increasing population in Kenya is projected to reach 52.7 million by 2025, which will be almost double the population in 1999. The increasing population will continue to put more pressure on the environment. Therefore, proper land use policies that prioritise environmental protection in the process of economic growth will become increasingly critical.

Despite the current environmental challenges, the Kenyan government has set high environmental goals. The government aims at transforming the country into a middle income economy where citizens enjoy a high quality life in a clean and secure environment.

Land uses that conflict with environmental conservation continue to pose major challenge in the country. More often than not the property right over natural resources, are poorly defined or in conflict with the socially optimal use of the resource. For the case of a river basin, there is a wide range of users of the river water varying from the farmers in the upper catchments, residential property owners, small scale enterprisers, large scale industrialists and the local authorities among others. These users have property rights over their land and in most cases the property rights over the riparian land are not well defined. The land users often use the water from the river and the riparian land in a way that degrades the river ecosystem. For example farmers in the upper catchments often over extract water from the river to carry out irrigation while the industrialists downstream often discharge effluent into the river. The pollution of the river ecosystem reduces the availability of quality water for diverse uses.

In order to harmonise conflicting land uses and ensure environmental sustainability it is vital to develop land use policies. Land use policies address a wide range of issues including; legal, tenure, administrative, institutional and special land issues among others. The goal of ensuring sustainable use of the environmental resources is closely linked to national and regional land use policies.

In order to address the issues that have affected the land sector, the country recently enacted a National Land Policy that recognizes land use policy as being critical in ensuring efficient use of land and land-based resources. Although it is apparent that the absence of a land use policy has contributed to the current state of environmental degradation, it is not very clear to what extent it has contributed to the problem or what form the stakeholders would like it to take. It is also not very clear what policy interventions are needed to enhance sustainable land use and land management practices that will have the greatest impact development and conservation of natural resources.

- THE NAIROBI RIVER BASIN

Nairobi river basin is a complex of several parallel streams that flow in an eastward direction and meet River Athi eventually flowing to the Indian Ocean. The Nairobi Rivers form the mid-section of an extensive tropical river system whose headwaters are located in the highlands of central Kenya. The rivers pass through the capital city and finally discharging their waters 600km away into the Indian Ocean. Figure 1 below shows the main rivers of the Nairobi river system namely; Motoine/ Ngong river, Nairobi river and the Mathare river. The Nairobi Rivers' has its source at the Ondiri swamp in Kikuyu Township where farmers living around the swamp use the water to irrigate their crops. The swamp is also a source of water for domestic use as well as for livestock. The Mathare and Gitathuru River Catchment is the upper reaches are areas of intensive tea and coffee farming that border the City. Motoine/Ngong River has its source at the Motoine swamp and Dagoretti forest. The river flows through a number of man-made dams one of which is the Nairobi Dam.

Figure1: The Main Rivers of the Nairobi River Basin



Source: Ministry of Environment and Mineral Resources, 2008

2.1 Land uses along the Rivers of the Nairobi River Basin

As noted earlier, the rivers of the basin face high levels of degradation due to an array of land uses along the basin. The catchment areas of the main rivers of the basin are either wetlands (e.g. the Ondiri swamp) or forests (e.g. the Dagoretti forest). However, the catchment areas are not maintained in a pristine state. In the upper parts of the catchment crop and livestock farming are the main land use activities. Agricultural activities are carried out by both small scale farmers and also by large scale commercial farmers. The use of agrochemicals including inorganic fertilizers as well as other types of manure in the catchment has led to nutrient loading causing excessive plant growth in some sections of the river system. Soil erosion and the associated sedimentation and siltation of the rivers have led to turbidity which impedes light penetration hence hindering primary productivity. Farming activities at the catchment level also pose a threat to biodiversity. At the Ondiri swamp for example, the papyrus and reeds in the swamp are threatened by draining of the swamp for agricultural activities as well as over-harvesting. The reduced vegetation cover around the swamp has led to the loss of habitat for birds, insects, large mammals as well as small mammals. Water abstraction within and around the swamp for irrigation may be affecting the water table and therefore the reason for the reduced water flow in the Nairobi River especially during the dry season. Livestock grazing in wetlands has also had profound effect on soil structure and vegetation regeneration. Wetlands have also been used as depositories of both solid and liquid wastes generated from settlements, factories and commercial activities.

Downstream from the river catchment, there is a shift from subsistence farming into residential property. In some instances raw sewage from residential property is discharged

directly into the rivers literally turning them into open sewers. This problem is more pronounced especially where the riparian land is under informal settlement especially in the Kibera and Mathare slums. The sections of the river that run through such areas are choking with solid and liquid waste. For instance the water quality of Motoine deteriorates sharply as it flows through Kibera into the Nairobi Dam. As river passes through the central part of the city it meanders through areas of intense commercial activities (both formal and informal). These sections of the river are characterised by high levels of pollution from solid and liquid waste discharges. There are also sections of the river that pass through various public institutions and are used for special purposes for example the Nairobi dam. The rivers also pass through areas reserved for industrial establishments. Many industries within Nairobi have a very poor waste treatment, if any, and many of them discharge their waste waters into the existing municipal sewerage system and/or directly into the rivers. Non-biodegradable waste accumulates, thus overloading the system effectively reducing its self-purification capacity.

The lower sections of the river system before it empties to the Athi river is characterised by less intensive land use activities apart from agriculture. Several tributaries join the main river at the lower sections. The Dandora sewage treatment works also discharge treated sewage into the river in the lower sections of the river. The greenish colour in the water at this lower section is an indication the dense concentrations of blue green algae.

2.2 Stakeholders of the Nairobi river basin

There is a wide range of actors that have a stake in the utilization, management and conservation of the Nairobi river basin. The state through its various agencies such as the Ministry of Environment and Natural Resources (MENR), and the National Environment Management Authority (NEMA), the Water Resources Management Authority (WRMA), Athi Water Services Board, the City Council of Nairobi, the Nairobi Water and Sewerage Company and the various local governments are major stakeholders in the management of the river basin. There are also other stakeholders such the small subsistence farmers, the big commercial farmers, riparian private property owners, public institutions owning land besides the river, small-scale and large scale business owners, environmental conservation groups, international environmental groups, donor countries and the wider public among others. All these stakeholders have different and often conflicting objectives on the management of the river basin. These diverse group of stakeholders have to engage in some sort of negotiated trade-offs to come up with a technically feasible and economically viable compromise on how to manage the river basin.

3. METHODOLOGY

Public policy evaluation and choice usually require the harmonization of conflicting points of view in a systematic and transparent way. The formulation of a land policy for example requires the consideration of all stakeholders' views so as to ensure acceptance. Formulation of a land use policy and other regulatory decision-making problems, involves multiple criteria such as cost, benefit, environmental impact, safety, risk and other societal considerations (Linkov *et al.*, 2004). As noted by Kiker *et al.*, (2005) environmental decisions are often complex and multifaceted and involve many different stakeholders with different priorities or

objectives. The use of multi-criteria decision analysis (MCDA) methodologies in analysing environment related matters has become increasingly popular (Turner *et al.*, 1998). The increasing popularity of MCDA can be attributed, in part, to the continued existence of intangible and incommensurable environmental effects which remain outside the conventional cost-benefit analysis (CBA) domain (Prato, 2003). The methods also meet the desire, in modern public decision analysis, to be presented with a spectrum of feasible solutions rather than one 'forced' solution. It also facilitates collaborative decision-making for public goods by allowing stakeholders to compare alternatives based on their preferences for attributes rather than the traditional top-down approach to management (Joubert *et al.*, 1997).

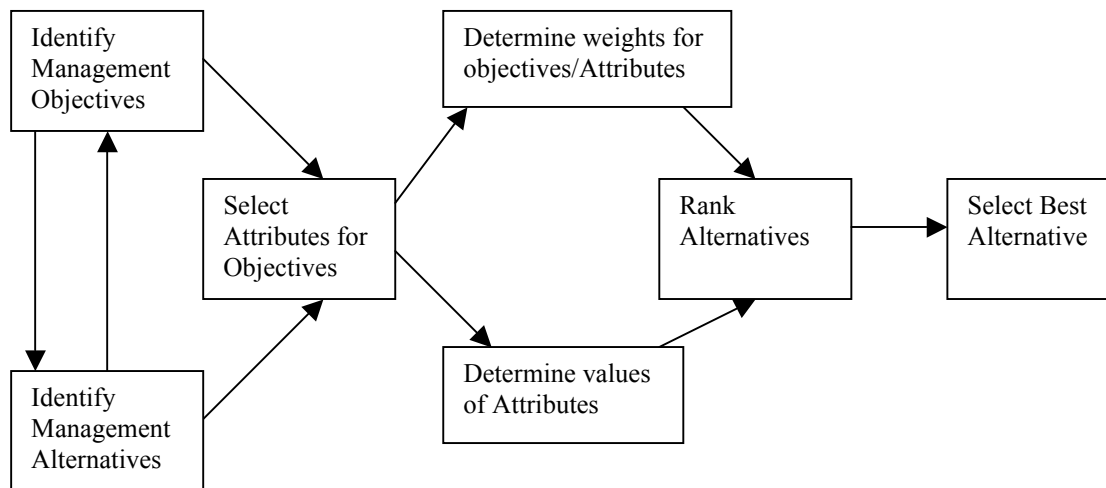
A wide range of studies have applied MCDA methodologies to analyse environmental-related issues. For instance, Prato (2003) used the multi-attribute evaluation to compare the management alternatives for the Missouri river system. Bana e Costa (2001), applied MCDA to model investment policy in the Lisbon metropolitan region. MacDonald (1996) developed a multi-attribute spatial decision support system for solid waste planning. Lahdelma *et al.*, (2002) applied a stochastic multi-criteria decision analysis in locating a waste treatment facility in South-Eastern Finland. Messner *et al.*, (2006) applied a multi-criteria decision support for the resolution of a water allocation problem in the Spree river basin in Germany.

This study followed multi-attribute evaluation approach as was applied by Prato (2003). Multiple attribute evaluation provides a viable way to evaluate and compare alternatives that have attributes that are not measured in monetary terms. It however requires specification of the utility function and the attribute weights unlike cost benefit analysis thus making it more complicated to undertake. On the other hand, determining attribute weights provides a proactive way to get stakeholders involved in the decision-making process. The attribute weights can be analysed using the conjoint analysis also called multi-attribute compositional models. Conjoint analysis requires research participants to make a series of trade-offs. Analysis of these trade-offs will reveal the relative importance of component attributes. The objective of conjoint analysis is to determine what combination of a limited number of attributes is most influential on respondent choice or decision making. To improve the predictive ability of this analysis, research participants should be grouped into similar segments based on objectives, values and/or other factors.

3.1 Conceptual framework

A general framework of multiple attribute evaluation is illustrated in Figure 2 below. The framework requires identifying management objectives and alternatives, attributes of the objective and weights of objectives and attributes. Alternatives are unique and specific to a given ecosystem and the management issues being addressed. In the particular case of the Nairobi river basin we conceptualized three very broad management alternative i.e. strict protection of the riparian reserves and the catchment, regulated use e.g. through extraction permits and an extreme case of open access. Weights represent the decision-makers preference for objectives or attributes.

Figure 2: General framework of multiple attribute evaluation



Source: Prato (2003)

Following Prato (2003) three broad objectives for the management of the basin are envisaged in this study; economic viability, social acceptability and ecological health. Attributes were then derived for each of these objectives for each group of stakeholders. The weights of these attributes were analyzed using the conjoint analysis approach based on the scoring exercise that was done for each group of stakeholders during data collection.

3.2 Data elicitation and analytical procedures

The methodology employed two main techniques of data collection and analysis. First, existing secondary data sources were used to generate information on past trends of land use decisions and natural resource degradation at the basin level. For this purpose, past and present digital maps and other relevant secondary data of the Nairobi river basin were used to describe changes over time. Data and information on the past trends in human population growth within the basin, changes in vegetation cover, changes in land uses, were used to carry out trend analysis.

Secondly, primary data was collected from sampled respondents among different stakeholders using a semi-structured questionnaire. The questionnaire captured the social demographic characteristics of the respondents, their perceptions of the river basin degradation, their ranking of alternative management strategies and also their ranking of different attributes of the river basin. The data from the questionnaires was analysed using two statistical softwares (SPSS and STATA). The technique of multi-attribute evaluation was applied to analyse the data collected.

- STUDY FINDINGS

4.1 Descriptive analysis of sample respondents

The study interviewed a total of 141 respondents within the basin distributed among three groups based on land use; famers (53.2%), commercial users (29.8%) and residential users (17%). The tenure status of land occupied by the respondents is summarised in the Table 1.

Table 1: Tenure status of land ownership of sample respondents

Tenure status	Frequency	Percent
Owned, titled	52	36.9
Owned, not titled	16	11.3
Rented	31	22.0
Squatter (not owned)	42	29.8
Total	141	100.00

Source: Own study, 2009

The river traverses through private land of approximately 64% of the respondents. Majority of the respondents indicated that the river passing through their land is polluted with only a minority of 12.8% indicating that the water is very clean as shown in the Table 2.

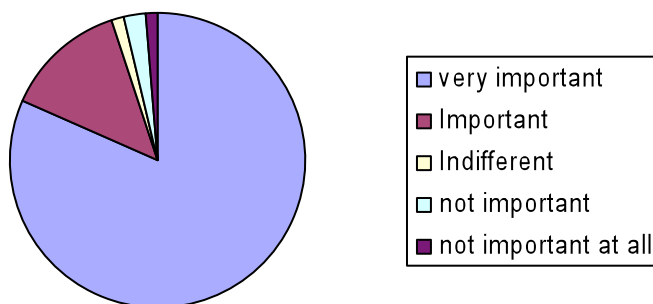
Table 2: Respondents perception of the status of the river

Status	Frequency	Percent
Very polluted	49	34.8
Polluted	41	29.1
Clean	33	23.4
Very clean	18	12.8
Total	141	100.00

Source: Own study, 2009

Most respondents indicated that the river systems was important for them as shown by the Figure 3.

Figure 3: Respondents ranking of the importance of Nairobi river



Source: Own study, 2009

3.2 Results of multiple attribute evaluation

Multiple attribute evaluation allowed the respondents to rank management alternatives and also preference for different attributes of the river. The respondent were given three broad management alternatives; total protection, regulated use and open access. Under total protection, a riparian reserve would be created and individuals would be prevented from extracting from the river either by the state or its agency. This system of management would ensure the river and the riparian reserve is maintained in a pristine form. Under total protection, the recreational values would be highly enhanced. Management under regulated use would involve establishing rules and regulations on the use of the river resources including charging of user fees. It would also prohibit uses that reduce quality of the river water. Under this approach the direct extractive uses would be enhanced while the ones that reduce the quality of the river water would be minimized. Open access is a free for all option where any individual who wishes to use the river for whatever use is free to do so without prohibition. Under this management approach all the river uses would be valued the same.

Based on the current patterns for the river use, six attributes of the river were presented to the respondents for ranking. The six attributes were summarized as follows:-

- Providing water for domestic use
- Providing water for irrigation
- Providing water for watering livestock
- Providing water for commercial use
- Recreation service
- Site for dumping waste

The respondents were asked to rank these attributes of the river in order of their importance from their use perspective. Use of a ranking procedure ensured that they all have they same standard of measurement.

The next step involved combining attribute weight in a utility function that as used to score the alternatives. This approach involved maximizing a multiple attribute utility function. The utility scores for alternatives were calculated using a linear additive utility function as follows:

$$v_i = \sum_{j=1}^m w_j r_{ij} \quad (i=1, \dots, n)$$

Where m is the number of attributes, w_j is the weight of the j^{th} attribute, $0 \leq w_j \leq 1$ and $\sum_{j=1}^m w_j = 1$, r_{ij} is the rank value of the j^{th} attribute of the i^{th} alternative.

The attribute weights for the respondents as a group are not known. The process of estimating the attribute weights for a group of individuals would involve bringing all of them together to arrive at a consensus through some form of voting. For this study, however, three attribute weighting scenarios corresponding to the three management approaches were hypothesized as summarized in Table 3.

Table 3: Weighting scenarios of management alternatives for the Nairobi river basin

Attribute	Scenario		
	1 ^a	2 ^b	3 ^c
Providing water for domestic use	0.14	0.25	0.10
Providing water for irrigation	0.14	0.25	0.10
Providing water of watering livestock	0.14	0.25	0.10
Providing water for commercial use	0.14	0.10	0.05
Recreation service	0.14	0.10	0.60
Site for dumping waste	0.14	0.05	0.05

Source: Own conceptualization, 2010

Based on the above schemes the utility scores and ranks for the three management approaches are summarized in the Table 4.

Table 4: Relative utility scores and ranks for three management scenarios for Nairobi River Basin

Scenario	Average Score	Rank	Implication
A	2.32	3	Least preferred
B	3.09	1	Best (most preferred)
C	2.54	2	2 nd best

Source: Own study, 2009.

Based on the results in Table 4, regulated use of the river is the most preferred management approach. The analytical results of the utility maximizing approach of the multiple evaluation procedure concurred with direct ranking of the management approaches by the respondents.

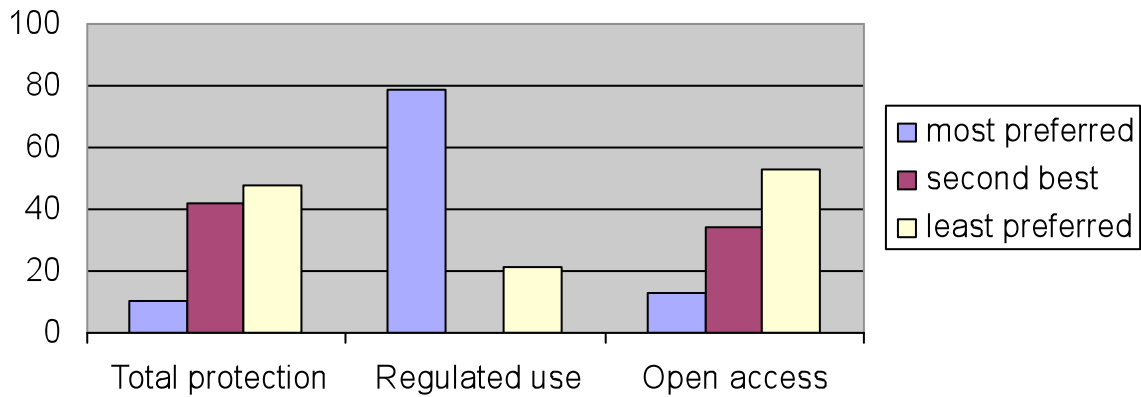
Across all the different management approaches regulated use was the most preferred type of river management as shown in the Figure 4 with over 75% of the respondents preferring.

Figure 4: Respondents ranking of the preferred management approach

^a This is the neutral scenario where all attributes carry the same weight. This scenario is representative of the open access management approach.

^b Pro-use direct extractive use (domestic/agriculture). This scenario represents the regulated use management approach.

^c The scenario here is the pro-recreation use. It represents the total protection approach.



Source: Own study, 2009

- CONCLUSIONS

The results of the study strongly support the regulated use of the river basin. This finding provides some insights to policy makers and others who are involved in the management of the river basin. It indicates that overall, all the stakeholders taken together and taking into account their different preferences and river use priorities would like to have a regulated system of management. In order to set up an effective regulated use system, there is need to pool all the relevant information on river basin including the bio-physical characteristics of the river, the land tenure arrangement on the different parts of the basin, numbers and profiles of different users . Such information will play an important role in guiding the formulation and effective implementation of landuse policies that would ensure the natural resources are managed in a sustainable manner.

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BIOGRAPHICAL NOTES

Dr. Paul M. Guthiga is currently a research fellow with Environment for Development (EfD) initiative in Kenya hosted at the Kenya Institute for Public Policy Research and Analysis. Before joining EfD, he held a post-doc position at the center for development research (ZEF), Germany. He holds a PhD in Agricultural Economics from the University of Bonn, Germany.

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His areas of research interest include; natural resource governance, economics of biodiversity conservation, environmental valuation, and economics of climate change. Dr. Guthiga has published his research several international peer reviewed journals.

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BIOGRAPHICAL NOTES

Mr Mwenda MAKATHIMO holds a Masters Degree in valuation and property management in addition to B.A. (Land Economics) Hons.

He is a full member of the Institution of Surveyors of Kenya (MISK), and is currently serving as its chairman. He is also a member of the International Facilities Management Association (IFMA) African Real Estate Society (AFRES) besides being a Registered Practising Estate Agent. Makathimo is both a Registered and Practising Valuer.

Mr. Makathimo is a trained and widely experienced Land Economist, Valuer and Administrator. He has over 12 years experience in issues relating to assets and property valuation, land policy, land management and administration, investments appraisal and facilities management.

He is also a director at Vidmerck Limited, a real estate consultancy firm based in Nairobi, Kenya and has been a lecturer at the University of Nairobi, department of Real Estate and Construction Management. He was recently appointed as a commissioner in the Interim Independent Boundaries Review Commission of Kenya.

He has served as a member of the Nairobi City Valuation Court and has been a Valuation and Property Management Examiner with the Institution of Surveyors of Kenya. He also served the institution as Hon. Treasurer. He has participated as a resource person in many forums organized by the Institution of Surveyors of Kenya, CASLE, FIG, UNHabitat and Government of Kenya amongst others.

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