Charting a New Path for Environmental Management and Conservation in Kenya

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Kariuki Muigua

Table of Contents

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Abstract

This paper offers some practical recommendations on how Kenya can actualise the current progressive constitutional and statutory provisions that are meant to drive the country towards achieving the sustainable development agenda as well as improving the lives of communities in a way that makes them meaning players in the game of environmental management and conservation. The paper draws from the best practices internationally and while it acknowledges the uniqueness of Kenya's socio-economic context, the recommendations are broad enough to take care of the needs of all stakeholders. They can be tailored in a way that would make them applicable and largely acceptable to communities and other stakeholders. The major argument in the discussion is pegged on the notion that solutions facing the country's sustainability problems must come from scientific as well as indigenous knowledge and practices.

1. Introduction

Environmental management encompasses all activities geared towards the protection, conservation and sustainable components of the environment.[1] While the law provides for various approaches to environmental management and governance such as the command and control, market-based approaches, incentives (taxation and subsidies), Community Based Natural Resource Management (CBNRM) and traditional resource management institutions, among others, the actualisation of these approaches requires some innovative approaches to ensure that the same are fully adopted and implemented. Such innovation is important in overcoming the shortcomings that may be associated with each of the approaches.

This paper offers a brief yet detailed discussion on some topical issues on how Kenya can adopt an integrated approach to environmental management in Kenya for sustainability. While the paper acknowledges that law is a necessary tool in effective environmental management, the paper proposes some recommendations that go beyond the law in not only achieving the environmental rights of the citizens, but also ensuring that the State's and citizenry's duties towards sustainable environmental management and conservation are achieved.

* ***PhD in Law (Nrb), FCIArb (Chartered Arbitrator), LL. B (Hons) Nrb, LL.M (Environmental Law) Nrb; Dip. In Law (KSL); FCPS (K); Dip. In Arbitration (UK); MKIM; Mediator; Consultant: Lead expert EIA/EA NEMA; BSI ISO/IEC 27001:2005 ISMS Lead Auditor/ Implementer; Advocate of the High Court of Kenya; Senior Lecturer at the University of Nairobi, School of Law; CASELAP***.

[1] Sec. 2, Environmental (Management and Coordination) Act, No. 8 of 1999, Laws of Kenya.

2. Meaningful and Active Participation of Citizens in Environmental management

The sustainable development agenda envisages not only the participation of all stakeholders in environmental and natural resources governance and management, but also ensuring that the interests of all parties are satisfactorily taken care of while at the same time balancing such interests with sustainability requirements.

The importance of the Constitution of Kenya 2010 in its provisions on the obligations of the State with respect to the environment cannot be overstretched. The Constitution envisages the participation of all stakeholders, both as rights-holders as well as duty-bearers as far as environmental matters are concerned.[2]

While these are commendable provisions, their full realisation in terms of implementation and respect by the policy and legal stakeholders remains a mirage. There are no defined mechanisms yet to ensure that the same are meaningfully implemented. There is a need for the policy and lawmakers to develop stakeholder engagement and free prior and informed consent guidelines and toolkits. Communities, with the right information and sensitization on issues affecting the environment and the nation at large, can meaningfully engage other stakeholders by way of defining their immediate needs against the national policies on environmental management and conservation.[3] The call for written submissions via the print media as is mostly the case may not always work as some of the most affected communities and groups of persons may not even have the ability to read and write let alone accessing the newspapers and other news media.[4]

This calls for more forums where the stakeholders can engage such groups of persons one on one and get their views.The Constitution of Kenya requires a collaborative approach in environmental and natural resources governance and management, within the framework of the national values and principles of governance. If this is to be achieved, then there is a need for change of tact in collecting views. The most common argument from some quarters has always been that if all interested and affected groups of persons were to be given a forum to air their

[2] Article 69, Constitution of Kenya, 2010.

[3] See UN Environment, 'Managing Forests with Community Participation in Kenya' (*UN Environment*, 13 December 2019) <http://www.unenvironment.org/news-and-stories/story/managing-forests-community-participation-kenya> accessed 6 May 2020.

[4] UN Environment, 'Managing Forests with Community Participation in Kenya' (*UN Environment*, 13 December 2019) <http://www.unenvironment.org/news-and-stories/story/managing-forests-community-participation-kenya> accessed 6 May 2020.

views, then some key development infrastructure and activities would never go on.[5] However, it must be acknowledged that some of these activities, especially mining activities are likely to change the lives of these communities permanently and even affect their generations to come. A relevant example is the alleged lead poisoning in Owino Uhuru, a slum area in Mombasa city adjacent to a lead battery recycling factory, which has led to protracted court battles.[6] It is reported that leakages from the factory have significantly increased lead concentration in the slum's environment which poses environmental health risks especially to children living in the slum.[7] Further, studies have also indicated that this has contributed to soil pollution in the area.[8] Admittedly, and backed by research, the effects of lead on the environment and the people's health are bound to be long term.[9] Some writers have even rightly pointed out that the effects of lead poisoning are not usually detected in a short visit with a doctor.[10] It would therefore be not only a case of great environmental injustice but also a form of death sentence for any developer to engage in such projects that predispose a community and their future generations to lead poisoning and yet deny them a chance to participate in the approval process, in the name of their democratically elected leaders making the decision on their behalf.

It is therefore imperative that the constitutional and statutory provisions on public participation be fully implemented not just through calling for public comments on proposed projects but also ensuring that where such projects directly affect the livelihoods of a certain group of persons, the

[5] Some court cases have approved some projects based on this argument, arguing that elected leaders can give their consent on behalf of the represented communities or group of persons.

[6] Okeyo B. & Wangila A., "Lead Poisoning in Owino Uhuru Slums in Mombasa- Kenya," (Eco-Ethics International –Kenya Chapter, 2012). Available at https://www.cofek.co.ke/Lead%20Poisoning%20in%20Owino%20Uhuru%20Slums%20Mombasa.pdf [Accessed on 21/1/2020]; Zoë Schlanger, "A Kenyan mother, two disappearing Indian businessmen, and the battery factory that poisoned a village," Quartz Africa, March 18, 2018. Available at https://qz.com/africa/1231792/a-battery-recycling-plant-owned-by-indian-businessmen-caused-a-lead-poisoning-crisis-in-kenya/ [Accessed on 21/1/2020].

[7] Consumer Federation of Kenya, 'Lead Poisoning in Owino Ohuru Slums in Mombasa-Kenya' available at https://www.cofek.co.ke/Lead%20Poisoning%20in%20Owino%20Uhuru%20Slums%20Mombasa.pdf [Accessed on 6/5/2020].

[8] Caravanos, 'Conflicting Conclusions or Competing Methodologies? Documenting Soil Lead Pollution in Owino Uhuru, Kenya' Journal of Health & Pollution, Vol. 9, No. 21, March 2019.

[9] Cheng, Z., "Late attention to children's health under lead exposure: legacy of Flint water crisis?." PhD diss., University of Pittsburgh, 2018; Ravipati, E.S., Mahajan, N.N., Sharma, S., Hatware, K.V. and Patil, K., "The toxicological effects of lead and its analytical trends: an update from 2000 to 2018." *Critical reviews in analytical chemistry* (2019): 1-16; Yamauchi, Osamu. "Astrid Sigel, Helmut Sigel, Roland KO Sigel (Eds):"Lead: Its Effects on Environment and Health." Volume 17 of Metal Ions in Life Sciences." *Transition Metal Chemistry* 42, no. 6 (2017): 575-577; Assi, M.A., Hezmee, M.N.M., Haron, A.W., Sabri, M.Y.M. and Rajion, M.A., "The detrimental effects of lead on human and animal health." *Veterinary world* 9, no. 6 (2016): 660.

[10] Hanna-Attisha, M., Lanphear, B. and Landrigan, P., "Lead poisoning in the 21st century: the silent epidemic continues." (2018): 1430-1430.

affected persons are fully engaged through such forums as public *barazas* where the Government should also ensure that health officials are invited to answer any of the community's concerns on possible health effects of the proposed projects.

It is important to entrench environmental democracy which is meant to empower the general public and enable them to meaningfully participate in environmental management.[11]

3. Enhancing the Effectiveness of the Regulatory Framework on Corporations' Environmental Liability

In recognition of the important role played by corporations in the society and their contribution to the economic development, it is arguable that the potential contribution of corporations in promoting sustainable environmental and natural resources management as far as their environmental liability is concerned cannot be ignored. This is in recognition of the fact while some are directly involved in natural resources extraction and other environmental resources as sources of their raw materials, even those that are concerned with other industrial activities have wastes and discharges which, if not properly dealt with can adversely affect the environment and the lives of communities living within their locality. If the local news over the last few years is anything to go by, there has been some evidence of laxity in holding these corporations liable for environmental pollution.[12] There is a need for more stringent measures to be taken as a way of curbing the blatant pollution of water bodies and the environment in general by the industries especially those dealing with chemical discharges. The National Environment Management Authority enforcement officers should work closely with the locals and the media to not only apprehend but also hold accountable those who flout environmental rules and regulations. There may also be a need to revisit the prescribed penalties in order to curb the vice.

As a way of using their corporate social responsibility (CSR) towards achieving sustainability, the corporations are also expected to contribute positively towards improving the livelihoods of the people. However, while the CSR is entirely pegged on the corporations' initiatives, the local

[11] See Muigua, K., 'Enhancing Environmental Democracy in Kenya,' *The Law Society Law Journal*, Vol. 4, No. 1, 2008.

[12] National Environment Management Authority, 'Factories Closed, Owners Arrested for Polluting the Environment' available at http://www.nema.go.ke/index.php?option=com_content&view=article&id=298:factories-closed-owners-arrested-for-polluting-environment&catid=10:news-and-events&Itemid=454 [Accessed on 4/5/2020].

content provisions that are now found within the mining and petroleum laws[13] in the country should be fully implemented in a way that ensures that any affected groups of persons have the legal backing as far as the accruing benefits are concerned.

Considering that Kenya is still at a nascent stage in exploring its extractives industry, building local capacity is critical if the full benefits of this industry are to be realised. The Government should invest in not only community empowerment but also expanding the capacity of local institutions of higher learning to offer specialized training and knowledge that is relevant for this part of the world. The stakeholders can work closely with other advanced countries in order to retain the requisite skills within the country; develop local capacities in the mining industry value chain through education, skills and technology transfer, research and development; and achieve the minimum local employment level across the entire mining industry value chain.[14]

It commendable that there are already in place legal, institutional and policy frameworks towards ensuring that there is safeguarding of the environment against the negative impact of extraction activities as well as improving the livelihoods of the communities. There is however a lot of good will that is required from the government agencies, communities as well as the private investors in order to ensure that the same works as intended.

4. Expediting the Approval of the Legislation on Benefit Sharing

While the theme of benefit sharing in natural resources and environmental goods features across most of the statutes and regulations governing the sector, it is pointing out that the single piece of legislation that is meant to provide substantive guidelines on benefit sharing has been pending for quite some time. The proposed *Benefit Sharing Bill 2018*[15] has been pending for several years due to some contentious issues as put forth by various stakeholders. There is a need to wrap up the discussion and have the Bill passed as law.

The law will come in handy considering that the State is supposed to manage these resources in trust for the people and must therefore ensure that they get to benefit from them in a bid to improve their living standards.

[13] Energy Act, No. 1 of 2019, Laws of Kenya; Mining (Employment and Training) Regulations, 2017, Legal Notice No. 82, Laws of Kenya; Mining (Use of Local Goods and Services) Regulations, 2017, Legal Notice No. 83 of 2017, Laws of Kenya; Mining Act, No. 12 of 2016, Laws of Kenya; Petroleum Act, No. 2 of 2019, Laws of Kenya.

[14] *Mining (Employment and Training) Regulations, 2017,* Regulation 3.

[15] Natural Resources (Benefit Sharing Bill), 2018 (Government Printer, Nairobi, 2018).

5. Creating Practical Platforms for use of Science and Indigenous knowledge

It is in the spirit of promoting meaningful inclusion and public participation that the theme of indigenous knowledge as a tool for promoting communities' participation features prominently in the Constitution of Kenya 2010. There is a need for the stakeholders to ensure that there is a complimentary application of the indigenous ecological knowledge alongside the scientific knowledge. The use of indigenous ecological knowledge not only make the communities own and appreciate the government's efforts in environmental management and conservation, it also enables the government to tap into the positive aspects of such community knowledge. It is common knowledge that communities have had some cultural environmental knowledge for centuries and have had a special relationship with their environment, which have made them diligently take care of it. If such practices are brought on board to form part of the government's knowledge for decision-making, it increases the chances of promoting sustainability backed by the communities. The Government's agencies charged with coming up with resilient varieties of crops should work closely with communities in order to incorporate their knowledge on the same.[16] Traditional knowledge is capable of yielding better results, technologically speaking, when placed within its environmental and social context. This is because sometimes, it has the most refined technologies, other times, it is very simple but still more appropriate, ecologically compatible and locally manageable.[17] Furthermore, local people are the custodians of traditional systems and are therefore well informed about their own situations, their resources, what works and what does not work. They are also aware of the possible impact of a change in one factor on the other parts of the production system.[18]

The incorporation of traditional knowledge in crop production will not only enhance food security but will also be useful in afforestation and reafforestation since the knowledge will greatly contribute in identifying the most ecologically suitable trees in some regions where the most common and exotic varieties of trees would not grow.

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16 Ibid, Article 11.

17 United Nations Convention to Combat Desertification (UNCCD) (2005), 'Revitalizing Traditional Knowledge: A Compilation of Documents and Reports from 1997 – 2003', UNCCD, Bonn, Germany. 150 pp. at p. 11.

18 Ibid.

6. Entrenching Integrated Pest Management in Agricultural Production in Kenya

While pests may have major impacts on crop production, the mode of control of these pests may potentially have even a bigger impact on biodiversity. Some of the chemicals used may lead to crop poisoning, water and soil pollution and consequently, have an adverse effect on the biodiversity thriving within the soil and water. In Kenya, use of pesticides has been promoted to expand agricultural production and increase productivity.[19]

The concept of Integrated Pest Management (IPM) was born in response to the discovery of pesticide resistance as well as the environmental and health impact of pesticide overuse, and IPM has greatly evolved and expanded.[20] IPM is associated with many advantages because it optimizes the cost of production (a benefit to the farmer) and the cost of food (a benefit to the consumer) without indirect environmental costs while also providing a long-term benefit for overall food production (a benefit to the environment).[21] Integrated pest management (IPM) is an ecological approach to pest management as it discourages the use of pest control methods that have negative effects to the non-target organisms.[22]

It is estimated that "90-95% of strawberry growers in California use predatory mites to manage pest mites, an example of inundative biological control in outdoor farming."[23]

There are some positive steps that Kenya has made towards promotion and achievement of IPM. In 2018, the Ministry of Agriculture, Livestock, Fisheries and Irrigation (MoALF&I) came up with the "Integrated Pest Management Plan (IPMP) For National Agricultural and Rural Inclusive Growth Project (NARIGP)" whose main objective are objectives of IPMP are to: establish clear procedures and methodologies for IPM planning, design and implementation of micro-projects to be financed under the Project; develop monitoring and evaluation systems for the various pest management practices for subprojects under the Project; to assess the potential economic, environmental and social impacts of the pest management activities within the micro-

[19] Macharia, I.N., MithÃ, M. and Waibel, H., "Potential environmental impacts of pesticides use in the vegetable sub-sector in Kenya." *African Journal of Horticultural Science* 2 (2009).
[20] 'Integrated Pest Management: The Future of Agriculture?' (*FreshFruitPortal.com*, 5 May 2020) <https://www.freshfruitportal.com/news/2020/05/05/is-integrated-pest-management-the-future-of-agriculture/> accessed 5 May 2020.
[21] Ibid.
[22] Para. 17, *Integrated Pest Management Plan (IPMP) For National Agricultural and Rural Inclusive Growth Project (NARIGP)*, October, 2018.
[23] 'Integrated Pest Management: The Future of Agriculture?' (*FreshFruitPortal.com*, 5 May 2020) <https://www.freshfruitportal.com/news/2020/05/05/is-integrated-pest-management-the-future-of-agriculture/> accessed 5 May 2020.

projects; to mitigate against negative impacts of crop protection measures; to identify capacity needs and technical assistance for successful implementation of the IPMP; to identify IPM research areas in the Project; and to propose a budget required to implement the IPMP.[24] This document on Integrated Pest Management (IPM) is meant to provide a strategic framework for the integration of climate change mitigation measures, smart agriculture, SLM practices and technologies, environmental and pest management considerations in the planning and implementation of the activities to be implemented within the National Agricultural and Rural Growth Project (NARIGP).[25]

The Ministry of Agriculture, Livestock, Fisheries and Irrigation (MOALF&I) is designated as the principal agency responsible for overall mitigation and monitoring of the adverse impacts of the pesticides including ensuring that the IPMP is followed under the NARIGP.[26]

Notably, the targeted micro-projects will use farmer groups and associations who are the project beneficiaries to undertake monitoring for instance in observing the pests in the farms, identifying weeds, and reporting as part of the surveillance to inform what sort of control measure to adopt. The farmer groups and associations will be trained on surveillance and best management practices in pesticide application and use.[27] In addition, the Agrochemical Association of Kenya (AAK) and distributors or wholesalers of pesticides will also be used to mitigate and monitor the adverse impacts. The agro-vet distributors will be trained to provide education and awareness to farmers on judicious pesticide use and application for the benefit of the environment and human health since they have constant contact with the farmers.[28]

The Pest Control and Product Board (PCPB) and the National Environment Management Authority (NEMA) are also to be included in the implementation.[29]

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[24] Para. 23, Republic of Kenya, Ministry Of Agriculture, Livestock, Fisheries And Irrigation National Agricultural And Rural Inclusive Growth Project (NARIGP), *Integrated Pest Management Plan (IPMP) For National Agricultural and Rural Inclusive Growth Project (NARIGP)*, October, 2018. Available at http://www.kilimo.go.ke/wp-content/uploads/2019/02/NARIGP-INTERGRATED-PEST-MANAGEMENT-PLAN-IPMJANUARY-2019.pdf accessed 5 May 2020.

[25] Para. 18, *Integrated Pest Management Plan (IPMP) For National Agricultural and Rural Inclusive Growth Project (NARIGP)*, October, 2018.

[26] Para. 8, *Integrated Pest Management Plan (IPMP) For National Agricultural and Rural Inclusive Growth Project (NARIGP)*, October, 2018.

[27] Para 10, *Integrated Pest Management Plan (IPMP) For National Agricultural and Rural Inclusive Growth Project (NARIGP)*, October, 2018.

[28] Para. 11, *Integrated Pest Management Plan (IPMP) For National Agricultural and Rural Inclusive Growth Project (NARIGP)*, October, 2018.

[29] Paras. 12 & 13, *Integrated Pest Management Plan (IPMP) For National Agricultural and Rural Inclusive Growth Project (NARIGP)*, October, 2018.

The above document rightly points out that in Kenya, Integrated Pest Management is not prioritized, particularly through government policies. In addition, though many solutions to pest problems exist, farmers tend to rely on pesticides as the first choice of pest control measure, particularly in high input agriculture experienced in horticultural sector.[30]

While the above Project was a step in the right direction, the same was targeted and hence it can only be hoped that the outcome of this project will be passed on to the target farmers who will in turn be used to reach out to other farmers in order to ensure that the lessons are replicated in other farms across the country. As it is now, most large and small scale farmers continue to engage in indiscriminate use of pesticides in crop and animal production.[31] For instance, the Kenya Plant Health Inspectorate Service (Kephis) reported in its 2018 annual report that there were pesticide residues in vegetable samples collected from various outlets and markets across the country. Some of the most affected vegetables included kales (94percent of 1,139 samples), peas (76percent) and capsicum (59percent).[32] There is a need for stakeholders, including the legislators, to step in and curb the situation or at least ensure that the chemical pesticides on sale are highly regulated also and at par with the accepted international standards.[33]

It has been reported that two species of insect parasitoids, one form of biological control of pests, have been discovered in Kenya. They have found to be efficient biological control

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[30] Para. 18, *Integrated Pest Management Plan (IPMP) For National Agricultural and Rural Inclusive Growth Project (NARIGP)*, October, 2018.

[31] 'Kenyan Farmers Grapple with High Pesticide Use - Xinhua | English.News.Cn' <http://www.xinhuanet.com/english/2019-11/10/c_138544622.htm> accessed 6 May 2020; 'ATAMBA: Pesticides Used in Kenya Do More Harm than Good' (*Business Daily*) <https://www.businessdailyafrica.com/analysis/ideas/Pesticides-used-in-Kenya-do-more-harm/4259414-5260702-bcexptz/index.html> accessed 6 May 2020; 'Kenyan Farmers Cost for Using Europe's Poisoned Agrochemicals - News' <https://www.farmers.co.ke/article/2001339810/kenyan-farmers-cost-for-using-europe-s-poisoned-agrochemicals> accessed 6 May 2020; Macharia, I.N., MithÃ, M. and Waibel, H., "Potential environmental impacts of pesticides use in the vegetable sub-sector in Kenya." *African Journal of Horticultural Science* 2 (2009); Route to Food, "Pesticides in Kenya: Why our health, environment and food security are at stake," August, 2019. Available at https://routetofood.org/wp-content/uploads/2019/08/RTFI-White-Paper-Pesticides-in-Kenya.pdf accessed 6 May 2020; 'Regulation of Harmful Pesticides in Kenya – Kenya News Agency' <https://www.kenyanews.go.ke/regulation-of-harmful-pesticides-in-kenya/> accessed 6 May 2020; Duncan M Taiti, 'Effects of the Use of Pesticides on the Health of Farmers in Molo District Kenya' (Thesis, University of Nairobi, Kenya 2010) <http://erepository.uonbi.ac.ke/handle/11295/4956> accessed 6 May 2020; https://www.the-star.co.ke/authors/johnmuchangi, 'Farmers Use Killer Chemicals to Grow Food, Study Finds' (*The Star*) <https://www.the-star.co.ke/news/2019-08-21-farmers-use-killer-chemicals-to-grow-food-study-finds/> accessed 6 May 2020.

[32] 'ATAMBA: Pesticides Used in Kenya Do More Harm than Good' (*Business Daily*) <https://www.businessdailyafrica.com/analysis/ideas/Pesticides-used-in-Kenya-do-more-harm/4259414-5260702-bcexptz/index.html> accessed 6 May 2020.

[33] Gladys Shollei, 'Kenya Should Do Away with Harmful Pesticides' (*The Standard*) <https://www.standardmedia.co.ke/article/2001349775/kenya-should-do-away-with-harmful-pesticides> accessed 6 May 2020.

agents against two major maize pests: the *Cotesia typhae* to control the maize stemborer, *Sesamia nonagrioides*, which has invaded France, and *Cotesia icipe* to control the fall armyworm, *Spodoptera frugiperda*, in Africa.[34] These are good news for the farmers and the country in general as these will contribute in avoiding and eliminating chemical control of pests due to the chemicals' adverse environmental and economic effects. With the International Centre of Insect Physiology and Ecology (ICIPE) headquartered in Nairobi, there is a need for continued research towards discovering more non-destructive but ecologically beneficial species of insects that can contribute towards biological control of pests. Farmers also need to be sensitized fully on the possibility of adopting IPM in their farming activities. Traditional ecological knowledge of the various communities in Kenya should also be further exploited in order to streamline the positive aspects of such knowledge that may have a bearing on biological control of pests.

However, even as we move towards adoption of IPM, the Government agencies should also continue working on crop species that are fairly resistant to pests yet safe for the human use and consumption, such as the BT cotton, a genetically modified organism (GMO) or genetically modified pest resistant plant cotton variety, which produces an insecticide to combat bollworm.[35] This will also contribute positively towards the gradual eradication of use of harmful pesticides in the agricultural sector and encourage the adoption of biological means of pest control.

7. Adoption of Greener Technologies in Infrastructural Development in Cities and Towns

The ever growing human population and the need for housing and other supporting amenities have often resulted in clearing of forests and other buffer zones, leading to pollution and

[34] Paul-andré Calatayud and Sevgan Subramanian, 'New Bugs, Found in Kenya, Can Help to Control Major Maize Pests' (*The Conversation*) <http://theconversation.com/new-bugs-found-in-kenya-can-help-to-control-major-maize-pests-134906> accessed 6 May 2020.

[35] 'Briefly on Farming and Agribusiness' (*Daily Nation*) <https://www.nation.co.ke/business/seedsofgold/Briefly-on-farming-and-agribusiness/2301238-5539566-l41yuq/index.html> accessed 6 May 2020; 'Kenya's Bt Cotton Approval Opens Door to Other GMO Crops' (*Alliance for Science*) <https://allianceforscience.cornell.edu/blog/2019/12/kenyas-bt-cotton-approval-opens-door-to-other-gmo-crops/> accessed 6 May 2020; See also 'Prospects Looking up for Cotton Farmers – Kenya News Agency' <https://www.kenyanews.go.ke/prospects-looking-up-for-cotton-farmers/> accessed 6 May 2020; MT KENYA STAR, 'Mwea BT Cotton to Unlock Billions - News' <https://www.farmers.co.ke/article/2001343003/mwea-bt-cotton-to-unlock-billions> accessed 6 May 2020; Muhammad Arshad, Rashad Rasool Khan and Asad Aslam and Waseem Akbar, 'Transgenic Bt Cotton: Effects on Target and Non-Target Insect Diversity' [2018] Past, Present and Future Trends in Cotton Breeding <https://www.intechopen.com/books/past-present-and-future-trends-in-cotton-breeding/transgenic-bt-cotton-effects-on-target-and-non-target-insect-diversity> accessed 6 May 2020.

affecting the efforts towards tackling climate change. However, some architects and engineers have been coming up with innovative ways to mitigate the loss.[36] The have been advocating for adoption of green technology as a tool to solve these problems with an orientation towards sustainable development at all levels.[37]

Green technology is considered to be very effective tool in modern urban planning which incorporates of all aspects of planning such as infrastructure and industry, energy, telecommunications, transportation and other vital areas in cities. These technologies are environment friendly inventions that often involve - energy efficiency, recycling, safety and health concerns, renewable resources, and more.[38] Green technologies include several forms of technology that help to minimize negative effects on the environment and create new ways to achieve sustainable development.[39]

The technology is used to make production processes more efficient, finding solutions to various "threats" that may affect the ability of cities to compete, such as the use of soil and urban transport, waste management in the city, quality of air, cultural heritage of cities, urban information systems, sustainable energy, agriculture, and new building materials applied to urban development and sustainable water management.[40]

The various aspects of green technology can be incorporated into the spatial planning process to help find new ways to achieve sustainable development by reducing the negative impacts of various economic and human activities on the environment and ecosystems and guiding development towards adoption of green and eco-friendly ways of life in cities and urban areas through such means as promoting green transport to enhance access to services and help reduce pollution levels and health inequities of the city's population; the use of treated wastewater in public water and green gardens help to reduce overall water consumption. Cities should look at circular development models that recycle water and waste and produce energy in them, so that sewage can be used.[41]

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[36] Chai-Lee Goi, 'The Impact of Technological Innovation on Building a Sustainable City' (2017) 3 International Journal of Quality Innovation 6.

[37] Laffta, S. and Al-rawi, A., "Green technologies in sustainable urban planning." In *MATEC Web of Conferences*, vol. 162, p. 05029. EDP Sciences, 2018.

[38] Ibid.

[39] Ibid.

[40] Ibid, p. 05029.

[41] Ibid; See also Bai, M., Zhou, S., Zhao, M. and Yu, J., "Water use efficiency improvement against a backdrop of expanding city agglomeration in developing countries—A case study on industrial and agricultural water use in the Bohai Bay Region of China." *Water* 9, no. 2 (2017): 89.

While originally, "green" infrastructure was identified with parkland, forests, wetlands, greenbelts, or floodways in and around cities that provided improved quality of life or "ecosystem services" such as water filtration and flood control, now, green infrastructure is more often related to environmental or sustainability goals that cities are trying to achieve through a mix of natural approaches: "green" infrastructure and technological practices include green, blue, and white roofs; hard and soft permeable surfaces; green alleys and streets; urban forestry; green open spaces such as parks and wetlands; and adapting buildings to better cope with floods and coastal storm surges.[42] Applications of these green infrastructure approaches range in scale from individual buildings, lots, and neighborhoods to entire cities and metro regions.[43]

It is noteworthy that many cities and towns across the world have embraced the idea of green technologies in infrastructural developments.[44] The benefits of developing Eco-cities and Eco-Townships; which among other things, are largely green and eco-friendly include: efficient land-use, habitat preservation and restoration, effective transport management and energy efficiency, efficient use of resources, emissions and pollution control and enhanced quality of life for the occupants.[45]

It is important that towns and cities in Kenya start not only embracing this idea but also implementing the same in larger scales, considering that the real estate in Kenya has been on upward trajectory in the last few years and the effect has been adverse on the environment.*

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[42] Foster, J., Lowe, A. and Winkelman, S., "The value of green infrastructure for urban climate adaptation." *Center for Clean Air Policy* 750, no. 1 (2011): 1-52, at p.3; Goi, C.L., "The impact of technological innovation on building a sustainable city." *International Journal of Quality Innovation* 3, no. 1 (2017): 6.

[43] Ibid.

[44] Bertie Russell, 'This Small German Town Took Back the Power – and Went Fully Renewable' (*The Conversation*) <http://theconversation.com/this-small-german-town-took-back-the-power-and-went-fully-renewable-126294> accessed 10 May 2020; 'Small Towns May Hold the Key to India's Future of Sustainability' (*Times of India Blog*, 10 June 2019) <https://timesofindia.indiatimes.com/blogs/voices/small-towns-may-hold-the-key-to-indias-future-of-sustainability/> accessed 10 May 2020; 'Three Ways Cities Can Take the Lead on Climate Change — Quartz' <https://qz.com/1750042/three-ways-cities-can-take-the-lead-on-climate-change/> accessed 10 May 2020; 'The Case for ... Making Low-Tech "dumb" Cities Instead of "Smart" Ones | Cities | The Guardian' <https://www.theguardian.com/cities/2020/jan/15/the-case-for-making-low-tech-dumb-cities-instead-of-smart-ones> accessed 10 May 2020; 'To Fix Our Infrastructure, Washington Needs to Start from Scratch' <https://www.brookings.edu/research/to-fix-our-infrastructure-washington-needs-to-start-from-scratch/> accessed 10 May 2020; 'Truly Sustainable Cities Are All about Balance' <https://www.sustainability-times.com/in-depth/truly-sustainable-cities-are-all-about-balance/> accessed 10 May 2020; 'A 100 Percent Clean Future - Center for American Progress' <https://www.americanprogress.org/issues/green/reports/2019/10/10/475605/100-percent-clean-future/> accessed 10 May 2020.

[45] 'Eco-Innovations in Designing Eco-Cities and Eco-Towns' <https://www.thesmartcityjournal.com/en/articles/1042-eco-innovations-eco-cities-eco-towns> accessed 10 May 2020.

The county and national governments should work closely with private investors and professionals such as engineers, architects and urban planners to incorporate green technologies into urban planning and management.[46]

8. Conclusion

An integrated approach to environmental and natural resources management in Kenya with practical application of diverse knowledge from science and traditional ecological knowledge would go a long way in ensuring that the various approaches to resource management are not only applied efficiently but also that the various aspects of the environment such as the flora and fauna are well taken care of.

The law, if applied alone will not be effective in addressing such challenges as pollution, environmental degradation, food insecurity, natural resource based conflicts and other social ills all of which pose some threats to environmental sustainability. For hundreds of years, local communities have acknowledged and indeed observed the ecological approaches to conservation. However, rising levels of poverty and the ever shrinking parcels of land due to the commercialization of land in the country have often made them lean more towards anthropocentricity at the expense of sustainability. However, all hope is not lost as the government agencies can work closely with them to address the challenges through integrated approaches to poverty alleviation, agriculture, animal husbandry, and generally the realisation of the sustainable development agenda. This is the only way that will ensure that anthropocentric approaches coupled with ecocentric approaches are adopted in order to strike a balance in safeguarding environmental, social and economic interests of the country.

This is the only way that the global *2030 Agenda for Sustainable Development*[47] which is a plan of action for people, planet and prosperity, will be achieved.

[46] 'Invest in Technologies That Convert Waste into Energy and Fuel, CS Macharia Challenges Counties – Kenya News Agency' <https://www.kenyanews.go.ke/invest-in-technologies-that-convert-waste-into-energy-and-fuel-cs-macharia-challenges-counties/> accessed 10 May 2020; See also Hermelin, B. and Andersson, I., "How green growth is adopted by local policy–a comparative study of ten second-rank cities in Sweden." *Scottish Geographical Journal* 134, no. 3-4 (2018): 184-202; Hammer, S.et al.(2011), "Cities and Green Growth: A Conceptual Framework", OECDRegional Development Working Papers2011/08, OECD Publishing.http://dx.doi.org/10.1787/5kg0tflmzx34-en; cf. Zuniga-Teran, A.A., Staddon, C., de Vito, L., Gerlak, A.K., Ward, S., Schoeman, Y., Hart, A. and Booth, G., "Challenges of mainstreaming green infrastructure in built environment professions." *Journal of Environmental Planning and Management* 63, no. 4 (2020): 710-732.

Charting a new path for Environmental Management and Conservation in Kenya is absolutely necessary. We have to explore new paradigms in order to achieve the goal of effectively managing the environment for the present and future generations.

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[47] *Transforming our world: the 2030 Agenda for Sustainable Development*, Resolution adopted by the General Assembly on 25 September 2015, [without reference to a Main Committee (A/70/L.1)], Seventieth session, Agenda items 15 and 116, 21 October 2015.

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