An exploration of the connection between tree cover and selected development indicators in Kenya's devolved units

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HIGHLIGHTS

- Tree cover helps to promote environmental stability and socio-economic development.
- There are limited datasets on the contribution of trees and forests to socio-economic growth at local, regional and global level.
- Successful tree cover expansion activities should acknowledge the contextual sensitivity of the wider tree planting environment.
- In Kenya, the contextual sensitivity analysis of each devolved unit should, particularlyrecognize the influence of county GDP per capita and HDI.
- Devolved units in Arid and Semi Arid Lands (ASALs) have the greatest potential for tree cover expansion and should be the focus of tree planting programmes.

SUMMARY

This study analyzes cross sectional data on the association between tree cover and selected socio-economic development indicators in Kenya's devolved units for the purpose of generating new knowledge needed for enhancing the implementation of tree cover expansion initiatives. Results substantiate that tree cover supports many productive sectors of Kenya's economy. As such, there is a moderately positive correlation between county tree cover and Gross Domestic Product (GDP) per capita and HDI (Human Development Index) (r=0.38, p=.005, one tail). These results imply the need for careful planning and understanding that county GDP per capita and HDI are the most critical socio-economic factors affecting tree cover expansion in devolved units. As such, this paper recommends various actions in order to improve tree cover in the devolved units.

Keywords: tree cover, impacts, devolved units, correlation, careful planning, development policies and aspirations

Exploration de la connexion entre le couvert forestier et des indicateurs de développement sélectionnés dans les unités décentralisées au Kenya

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Cette étude analyse les données inter sectionnelles de l'association du couvert forestier à des indicateurs de développement socio-économiques sélectionnés dans les unités décentralisées du Kenya. Le but est de fournir l'information critique nécessaire au renforcement de la mise en œuvre des projets d'expansion du couvert forestier, des politiques et des programmes. Les résultats confirment qu'il existe une corrélation modérément positive entre le couvert forestier d'un comté et le produit domestique brut (GDP) par habitant et l'index de développement humain (HDI) (r=0.38, p=.005, une queue). Ces résultats impliquent un besoin de planifier avec soin et de comprendre que le GDP du comté et le HDI sont les facteurs critiques socio-économiques principaux qui affectent l'expansion du couvert forestier dans les unités décentralisées du Kenya. Ce papier recommande diverses actions pour améliorer le couvert forestier dans les unités décentralisées.

Una exploración de la conexión entre la cobertura forestal y determinados indicadores de desarrollo en las unidades descentralizadas de Kenia

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Este estudio analiza datos transversales sobre la asociación entre la cobertura forestal y determinados indicadores de desarrollo socioeconómico en las unidades descentralizadas de Kenia con el fin de generar nuevos conocimientos necesarios para mejorar la puesta en práctica de iniciativas de incremento de la cubierta forestal. Los resultados corroboran que la cubierta forestal apoya a muchos sectores productivos de la economía de Kenia. Como tal, existe una correlación moderadamente positiva entre la cobertura forestal a nivel de condado y el Producto Interior Bruto (PIB) per cápita y el Índice de Desarrollo Humano (IDH) (r=0,38, p=0,005, una cola). Estos resultados implican la necesidad de una planificación cuidadosa y comprender que el PIB per cápita a nivel de condado y el IDH son los factores socioeconómicos más críticos que afectan el incremento de la cubierta forestal en las unidades descentralizadas. Debido a ello, el artículo recomienda varias acciones para aumentar la cobertura forestal en las unidades descentralizadas.

INTRODUCTION

Kenya is increasing tree cover expansion activities in the quest for more inclusive socio-economic development and environmental stability. Even though correlation studies on the association between tree cover expansion and economic development are limited, the existing literature shows that trees and forests contribute an estimated USD 365 million (ca. 3.2 to 3.6% of the GDP) annually to Kenya's national economy (FAO 2015, 2016, UNEP 2012 and UNEP website 2020). However, the highlighted economic estimations are an undervaluation of the forest sector's contribution given the diverse subsistence, safety net and the gap-filling role played by trees in the process of development and the exclusion of non-market goods and services in national accounting processes (Wambugu *et al.* 2018). Nonetheless, it is speculated that these positive contributions may have contributed to raising Kenya's ranking to a lower-middle-income country (World Bank 2020). Consequently, trees are recognised and protected by key policy instruments as important elements in the green infrastructure. The Constitution of Kenya of 2010 and the blueprint Vision 2030 demands that country attains and maintains a 10% tree cover of the land area (MENR 2016). In order to catalyze management actions towards this policy objective, key forest policy documents have been formulated, including development of the Draft Forest Policy, 2020, and enactment of the Forest Conservation and Management Act, 2016. These policy modifications have improved the country's tree and forest cover. In the year 2015, tree and forest resources covered an estimated 7.2% of the land area in the country (MENR 2016). Other sources, such as MENR (2018), have placed the forest cover at 7.4%, consisting of a closed canopy forest cover (ca. 2%), compared to the African continent average of 9.3% and the global average cover of 31%. Tree and forest cover expansion activities are likely to increase exponentially on community, private, and public lands as the government shifts focus on implementing an ambitious country-wide strategy for achieving and maintaining 10% tree cover by planting ca. 2 billion tree seedlings by the year 2022, at the cost of Kenya Shillings (KES.) 48 billion (MENR 2019).

However, since the operationalization of a new constitutional order which established 47 semi-autonomous devolved units (counties) and one national government in 2010, the relationship between tree cover and key socio-economic development indicators in devolved units remain unknown. As such, there is limited information on the best way that tree cover expansion activities could be integrated or improved for greater ecological integrity and sustainable development. This study addresses this challenge by exploring the available county tree cover statistics. In order to holistically address the problem, two research questions were asked: (1) How is the distribution of tree cover across devolved units related with key socio-economic development indicators such as Gross Domestic Product (GDP) per capita and Human Development Index (HDI)? (ii) In view of the correlation between tree cover and key socio-economic indicators, how can tree cover expansion be enhanced in devolved units for sustainable development? To answer these questions, this study reviews literature on the link between socio-economic development and tree cover expansion programmes, then applies lessons learnt to the Kenyan context in order to provide the recommendations of this paper. The aim of this paper is to truly link tree cover management activities to transformative socio-economic development in Kenya's devolved units. Unlike prior general studies carried out focussing on forest cover's linkage to national development such as MENR (2016), this study focuses on tree cover expansion in Kenya's 47 devolved units. The 47 counties in Kenya have been chosen for this study in view of the recent governance and policy reforms occasioned by the 2010 constitution and the emerging body of knowledge that suggests that these units have become centers of growth (KIPPRA 2016). It will thus be interesting to evaluate the key socio-economic indicators that should guide the choice of the most appropriate devolved units for tree cover expansion in the country.

In Kenya, tree cover expansion activities involve the planting of both exotic and indigenous tree species on the private, community, and public lands for multiple benefits. The success of tree planting programmes is determined by various parameters such as survival count, expressed as a percentage, and the area covered by trees per hectare are commonly used to describe tree cover and planting success in Kenya (KFS 2010).

Tree cover and socio-economic development

Based on existing literature, there is no universally accepted definition of a tree. However, in this paper, a 'tree' in the Kenyan context means a woody perennial plant of at least 2 m in height with one or several stems, having a definite crown (KFS 2021). This definition also includes bamboos, palms, fruit trees, but excludes non-perennial non-woody species such as banana and tall shrubs or climbers. Consequently, tree cover refers to an area on the ground covered by a tree crown. Forest cover is a derivative of tree cover (KFS 2021).

Tree cover expansion is widely acknowledged as one of the feasible ways of promoting ecological integrity and socio-economic development (Holl and Brancalion 2020). Tree cover generates a wide range of environmental goods and services that boost national socio-economic growth (Kauppi *et al.* 2018). Even though there are varying definitions of ecosystem goods and services, in this paper, ecosystem goods and services will be defined according to definition by the Millennium Ecosystem Assessment Report of 2005. The report identifies four functional lines for classifying ecosystem goods and services. They include; (1) provisioning services, (2) regulating services, (3) supportive or supporting services, and (4) cultural services (Assessment 2005). Conventionally, the ecosystem goods and services are measured in monetary terms which may include, the amount of income generation, the value of producing goods from forests, and the sector's role in the country-wide economy, energy supplies, and international trade (Ewers 2006, Assessment 2005, Baral *et al.* 2016, Kauppi *et al.* 2018, Corona *et al.* 2016, McGuire 2012). These econometric valuations represent a major undervaluation of these forest goods (McGuire 2012). However, our understanding of the economic effects of tree cover and

forests is further challenged by an emerging body of knowledge that suggests that economic contribution and economic impact are conceptually different. Whereas economic impact analysis is primarily used to determine the net impacts created by a firm's/industry's entry to/exit from an existing regional economy, economic contribution analysis is used to track the gross effects linked with a sector, policy, or event in a current provincial economy. Hence, the authors emphasize that economic contribution (not impact) analysis should be used to report annual activities from prevailing sectors related to the tree and forest industry (Watson *et al*. 2007, Agrawal *et al*. 2013).

Globally, it is estimated that the current 4.06 billion hectares of trees and forests provide over 86 million green jobs and support the livelihood of an estimated 880 million people (FAO 2020). Other studies estimate that trees and forests provide both direct, secondary and induced effects. Directly, trees and forests engage over 18.21 million people and support more than 45 million jobs in 2019. In addition, Li *et al*. (2019) found that globally trees and forests directly contributed $539 billion, and a total of $1,298 billion, to global GDP in 2011. In this paper, the authors observe that Li *et al*. (2019) are explicit when describing forest contribution to socio-economic development compared to other studies that fail to specify the methods used to forecast this contribution. For instance, the Food and Agriculture Organization of the United Nations (FAO) has reported that the forest industry contributes more than USD $450 billion into national incomes – comprising nearly 1% of global GDP in 2007 – and provides official employment to 0.4% of the world's employment force (Li *et al*. 2019). In this study, the authors note that with the widely acknowledged lack of global datasets on the contribution of trees and forests to economic growth, the attempts by FAO represent a good effort at determining the forestry sector's economic impact on socio-economic development. However, more analysis is required to disaggregate these figures into direct, indirect, and induced effects in order to improve the comprehensibility and the replication of similar studies in the scientific community. Overall, tree cover expansion has varying socio-economic effects and appears to portray many patterns in its contribution to societal livelihoods, economic growth, and national economies. It will thus be interesting to probe tree cover expansion in Kenya's devolved units and to identify the current patterns and relationships with selected socio-economic variables.

Traditionally, the objectives of tree cover expansion in many developing countries have been wood production for revenue generation, erosion prevention and improved water flows. However, objectives are now shifting towards multi-objective socio-economic benefits where socio-economic impacts of tree growing are evaluated using variables such as GDP per Capita and other human development variables such as the Human Development Index (HDI) (Le *et al*. 2012). However, studies reveal that the socio-economic success of tree cover expansion programs should be evaluated based on how it affects local livelihoods, the steadiness of market prices of commodities, and resident empowerment and training opportunities (de Jong *et al.* 2006, Jones *et al.* 2004, Peterson *et al.* 1998, Kanowski *et al*. 2009).

There are recent examples where forest managers and policy makers have upscaled efforts to expand tree cover by launching initiatives to plant hundreds of millions of trees (Holl and Brancalion 2020). For example, the Ethiopian government has recorded planted 350 million trees in one day (Holl and Brancalion 2020). In addition, there are many multilateral environmental agreements that are calling for increased tree planting activities. Many countries have pledged significant commitments and support to Forest and Landscape Restoration (FLR) by 2030 under various agreements such as the Glasgow Declaration of 2021, the Bonn Challenge, the New York Declaration on Forests, the Aichi Target 15 of the Convention on Biological Diversity (CBD) and Sustainable Development Goals (SDGs), particularly SDG 15 on Life on Land, which aims to achieve land degradation neutrality by 2030. These ambitious tree cover expansion aspirations are informed by recent studies which suggest there is an interaction between a country's tree cover expansion and socio-economic development such that countries with a higher Gross Domestic Product (GDP) per capita have a higher likelihood of increasing tree cover than those with lower income per capita (Ewers 2006, Naidoo 2004, Baral *et al*. 2016, Kauppi *et al*. 2018). Evidence from analysis of satellite images indicates that keeping all factors related to climate and terrain differences constant, countries with a higher GDP per capita tend to have significantly lower forest cover within the group of low-income economies unlike countries with higher levels of income (Cuaresma *et al*. 2017). Moreover, studies indicate that many socio-economic factors affect tree and forest cover expansion negatively in countries with low levels of human development index (HDI), but their impacts become positive in countries with higher levels of HDI. Among others, the key socio-economic factors which influence tree cover changes include, the rate of rural population, adult literacy rate, and GDP per capita (Jha *et al*. 2006). These findings provide strong evidence for the environmental Kuznets curve for deforestation and tree and forest cover changes as reported by Ewers (2006) and provide good grounding for similar studies in the case of Kenya's devolved units.

With this knowledge in the absence of careful planning that determines the most critical variable that affect the success of tree cover expansion, tree cover enhancement could overshadow other important development actions or, worst, still cause unintended negative socio-economic consequences. Traditionally, tree cover improvement has always been associated with positive benefits related to the provision of ecosystem goods and services (Holl and Brancalion 2020). However, with the changing contextual matrices, especially socio-economic circumstances, there is a growing body of knowledge that suggests tree cover enhancement could result in catastrophic consequences depending on how, when, and where tree and forest cover is expanded (Holl and Brancalion 2020). For instance, existing literature suggests that whereas tree cover improvement enhances biodiversity conservation

and climate resilience, tree planting in historic savannah may damage natural environments by altering species diversity which may in turn compromise ecological integrity (Holl and Brancalion 2020). Equally, tree cover expansion that is imposed on local communities may result in unintended socio-economic consequences such as loss of livelihoods if proper planning is not carried out. Many top-down tree cover expansion projects, programmes and policies fail because of their short-term nature, which focuses heavy expenditures on the number of seedlings planted rather than those trees that survive to maturity and the key socio-economic impacts of tree cover expansion. As such, the established trees may fail to be nurtured as local communities and other stakeholders retaliate by using the land for other gainful purposes, leading to re-clearing of tree cover immediately after planting (Holl and Brancalion 2020).

While it has been established that countries with a high GDP per capita and low remaining forest or tree cover are more likely to experience increased tree cover expansion, the association between tree cover expansion and socio-economic development is more complex. In this paper, the authors also speculate that other development variables such as HDI and population density would yield similar results and hence the need for this study. Reviewed literature shows there could be a relationship between tree and forest cover, people's livelihoods, and the global economy. However, there are varied patterns across the globe attributable to differences in socio-economic factors, especially HDI and GDP per capita. Hence, to the study was established to explore the status of tree cover expansion in devolved units with this background.

Tree cover and socio-economic development in Kenya

Kenya is a unitary state with a multi-party-political system with two levels of government, namely, national and county governments (counties/ devolved units), and each of these tiers have defined mandates and functions in accordance with the constitution (Kenya's NDC 2020). Kenya's 2019 census reports a population of 47 million, which is projected to reach 60 million people by the year 2030 (Kenya's NDC 2020). Around 84% of the land is arid and semi-arid, leaving 16% to support over 80% of the population. The economy is dependent on climate-sensitive sectors, namely, rainfed agriculture, tourism, wildlife, and water, whose vulnerability is exacerbated by climate change. Drought and floods are the main climate hazards negatively affecting lives and livelihood. In 2011, drought caused over US$ 11 billion in damage. In 2018, floods displaced more than 230,000 people, including 150,000 children closing over 700 schools, drowned over 20,000 heads of livestock, destroyed over 8,500 hectares of crops in addition to wiping out key infrastructure. Between 2014 and 2018, drought-affected 23 counties, caused starvation amongst approximately 3.4 million people, and left over 500,000 people without access to water (Kenya's NDC 2020).

Kenya has four major forest types and eight sub-types. Dryland forests represent the majority of the state's forest cover (45.4% of the total forest area), followed by montane forests at 32.9%. Trees and forests provide many environmental goods and services that support the livelihoods of many people (UNDP 2019, Chisika *et al.* 2020, Cheboiywo 2016). More than 10% of households living within 5 km of forest reserves depend on them for subsistence resources (UNDP 2019, Chisika *et al.* 2020, Cheboiywo 2016). Cheboiywo (2016) placed forests' contribution to Kenya's economy at 3.6% of GDP. This represents an undervaluation given a recent assessment that analyzed the contribution of three forest ecosystems namely, Mau Forest Complex, Cherangany Hills, and Mt. Elgon ecosystems which established the Total Economic Value (TEV) of the three water tower ecosystems at KES. 362 billion per year, representing 5.0% GDP in the year 2017 (UNDP 2019, Chisika *et al.* 2020, Cheboiywo 2016). Nonetheless, such valuation efforts and studies should also extend to private lands, community, and private forest land under the direct jurisdiction of County Governments. In addition, there are inconsistencies in reporting on the share of the forest's contribution to GDP which need to be resolved if forests are to be more appreciated in Kenya (Wambugu *et al.* 2018).

However, the recent national-level legal and policy reforms, coupled with deliberate government efforts to increase tree and forest cover, could provide impetus to increased socio-economic development. The constitution of 2010 is explicit on Kenya's intentions towards achieving socio-economic development through tree cover expansion. Kenya's updated Nationally Determined Contribution (NDC) is one of the feasible ways of mitigating the highlighted climate vulnerabilities on the Kenyan economy. The NDC proposes reducing carbon emissions by up to 32% from the previous target of 30% by the year 2030. Other policy documents related to tree cover expansion such as Vision 2030, the Draft Forest Policy of 2020, Forest Conservation and Management Act of 2016, the Agriculture (Farm Forestry) Rules of 2009 and Environmental Management and Coordination (Amendment) Act of 2015 appear to be well aligned to the constitution 2010 in the quest to improve the contribution of trees to socio-economic development. At the county-level, the County Government Act of 2013 provides for the establishment of institutions within devolved units for implementing many development functions, including tree cover expansion. In order to fully implement development initiatives, counties develop integrated development plans. Unfortunately, most counties are now in the process of developing county forestry programmes which will propel tree cover expansion activities.

Forests have emerged as a critical national asset and represent one of the chief land uses supporting Kenya's socio-economic growth. Since 2005, the forest cover has been growing, translating to significant land-use changes in the country. Table 1 shows forest area changes between 1990 and 2015 and indicates that forest cover has increased steadily from 2000 to 2015.

However, other studies have contested the forest cover gains by indicating that deforestation and degradation are on the rise, mostly due to forests being converted for agriculture

TABLE 1 *Land Use Land Cover for Kenya*

Land use	1990	2000	2005	2010	2015
Forest land	4,724	3,557	4,047	4,230	4,413
Crop land	9,258	9,661	9,868	10,072	10,276
Grassland	41,522	41,654	41,496	41,080	40,664
Settlement	57	87	109	126	143
Other lands	1,004	1,574	1,035	1,044	1,053
Wetlands	1,472	1,504	1,482	1,485	1,488
Total area	58,037	58,037	58,037	58,037	58,037

Source: FAO (2015)

or development projects and unsustainable use resulting from energy demand, and institutional challenges amongst organizations managing forests where some actors are left out of forest management decision making processes (Draft Forest Policy 2020). However, there are inconsistencies in reporting the size of forest loss by various studies which may signal the unavailability of accurate and reliable datasets which may also extend to devolved units as well. Overall, the draft Forest Policy, 2020 provides a good basis for enhancing tree cover expansion on public, private, and community lands towards sustainable development. The policy highlights the need to promote partnerships for tree cover expansion in the country in efforts to accelerate and complement government actions.

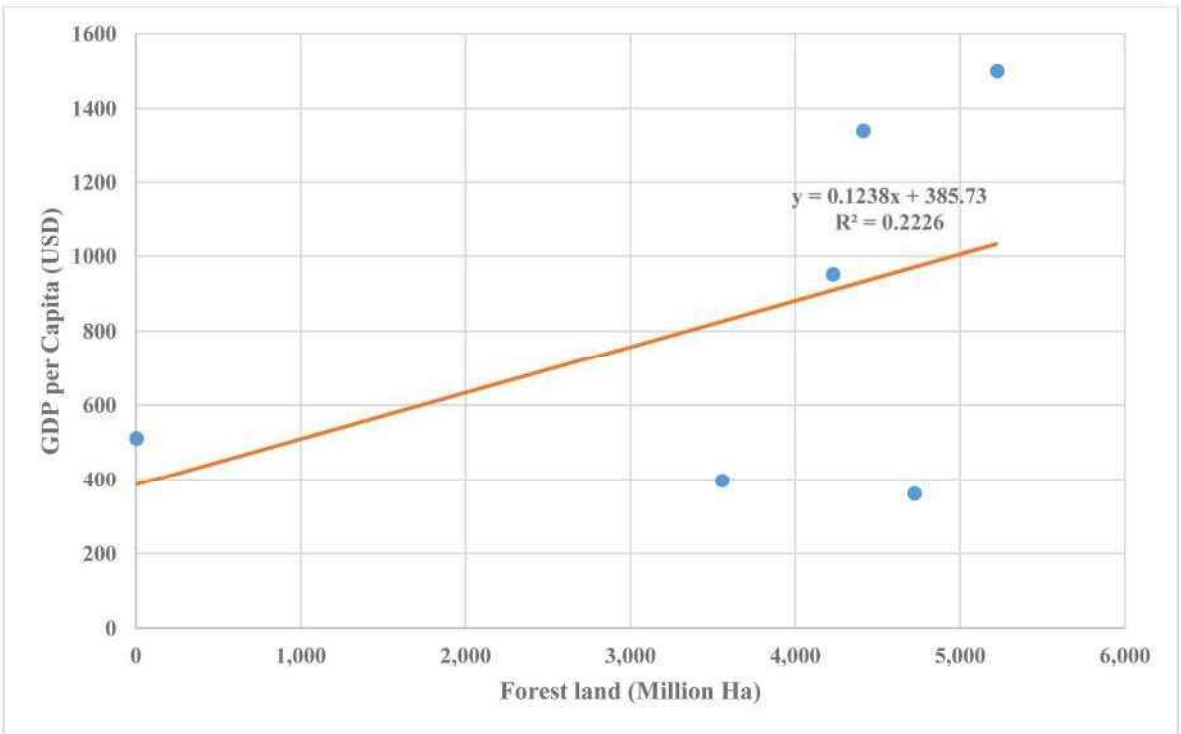
The correlation between forest cover and income per capita for Kenya between 1990 and 2021 is shown in Figure 1. There is a moderately positive relationship between GDP per capita and forestland.

MATERIALS AND METHODS

Study sites: Kenya's 47 counties

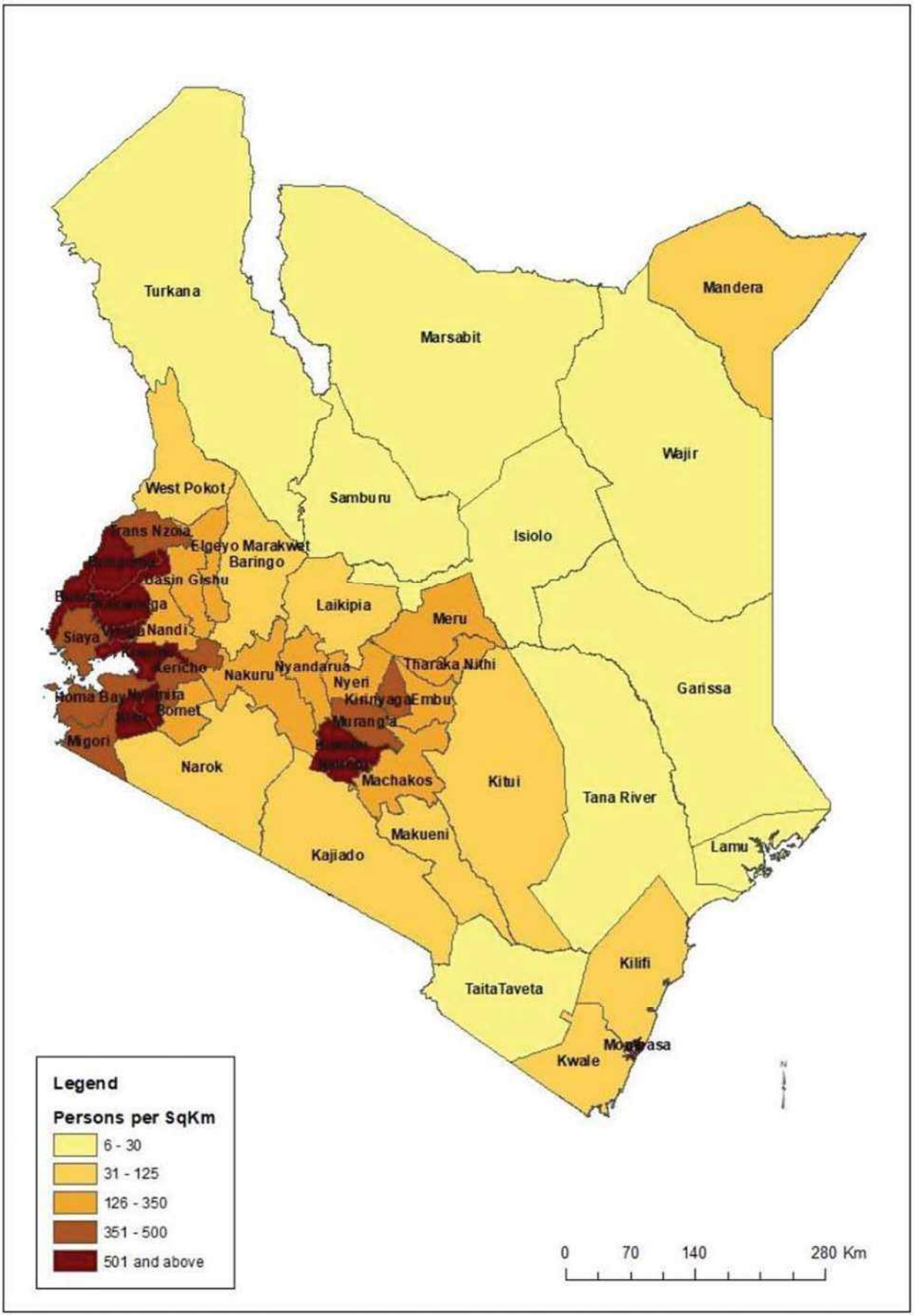
After the 2010 Constitution was enacted, a two-tier governance system was introduced consisting of one national government and 47 counties (Figure 2). The objective of this administrative arrangement was to spur Kenya's socio-economic development by bringing government services closer to the people. In this administrative configuration, Nairobi, Kisumu, and Mombasa counties retained their status as city counties under the Urban Areas and Cities Act, No. 13 of 2013. Nairobi City County is the most populous county with 4,397,073 people. It is followed by Kiambu with 2,417,735 inhabitants, Nakuru with 2,162,202 residents, and Kakamega, with 1,867,579 people, in fourth place (KNBS 2019). Figure 2 shows the population density per devolved unit in Kenya. Except for city

FIGURE 1 *Correlation between forest land and GDP per capita in Kenya (1990–2021)*



Source: Author's compilation from multiple sources

FIGURE 2 *Population density across devolved units in Kenya*



Source: KNBS (2019)

counties, agriculture is the main source of livelihood for inhabitants in all other counties.

Counties with low population densities have the highest percentage of people living below the poverty line with ounties in northern parts of Kenya having a high percentage of people living in poverty conditions (Mandera, Marsabit, Wajir and Tana River have over 77% of people living below the poverty line).

Kenya has fairly favorable climatic conditions for agricultural production and forestry. Counties in the Western and Central part of the country experience equatorial type of climate conditions whereas counties in the southern part of the country experience semi-arid climatic conditions. Counties in the Northern part of the country which happen to be the most expansive in-terms of land area experience largely arid conditions. Arid and Semi arid lands (ASALs) account for 89% of Kenya's landmass and a third of Kenya's population (Republic of Kenya 2013a). These ASALs have significantly diverse production systems and economic opportunities. However, due to a long history of political marginalization, pastoral livelihood culture and low population density, there have been many operational challenges leading to a low concentration of economic activities (Republic of Kenya 2012b).

For the purpose of forest management, counties are broadly grouped at national level by Kenya Forest Service into 10 regional forest conservation areas (Appendix A). Ewaso North regional forest conservation area is composed of Isiolo, Marsabit, and Samburu counties whereas North Eastern is composed of Mandera, Wajir and Garissa. Nairobi is the smallest regional forest conservation area. Each regional area is headed by one Regional Forest Conservator who reports to the Chief Conservator of Forests based at Kenya Forest Service Headquarters. Each county is headed by a County Forest Conservator who is also in-charge of a number of Forest stations and sub-county forest offices under the respective county. There are over 150 forest stations and over 250 sub-county forest offices around the country.

Kenya has a total of 7,180,000 ha of tree cover against a national land mass area of 59,196,877 ha which translates to 12.13% of the total land area (KFS 2021). Tree cover in the country appears unequally distributed. The Central, western and coast regions of the country have more tree cover than other regions of the country. This regional variation in tree cover could be attributed to varying social, economic, political, environmental and technological factors.

Nyeri (45.17%), Lamu (44.06%), Vihiga (35.92%), Kirinyaga (30.39%) and Elgeyo Marakwet (29.95%) counties are the top five counties with a tree cover percentage greater than the constitutional target of 10%, whereas Kilifi (14.20%), Kwale (13.99%), Nairobi (13.77%), Turkana (12.21%) and Homa Bay (10.40%) are the bottom five counties with a tree cover greater than 10% (Figure 3). Up-to 10 counties have a tree cover less than the constitutional target of 10%. Kisumu (8.85%), Busia (8.39%), Uasin Gishu (8.04%) are the top three counties with tree cover percent less than 10% whereas Machakos (6.03%), Siaya (5.27%), Wajir (4.45%) Mandera (3.61%), and Marsabit (2.06%) are the bottom five counties with tree cover less than 10% (KFS 2021).

In terms of the contribution of individual county's tree cover to the national tree cover, ASAL counties have the highest contribution to the net national tree cover (Figure 4). In detail, this means that Turkana, Kitui, Garissa, Samburu and Tana River counties have the highest contribution to the net national tree cover whereas Vihiga, Siaya, Busia, Nairobi and Mombasa are the least contributors to the net tree cover in the country (KFS 2021).

FIGURE 3 *Overall status of tree cover per county (source: KFS 2021)*

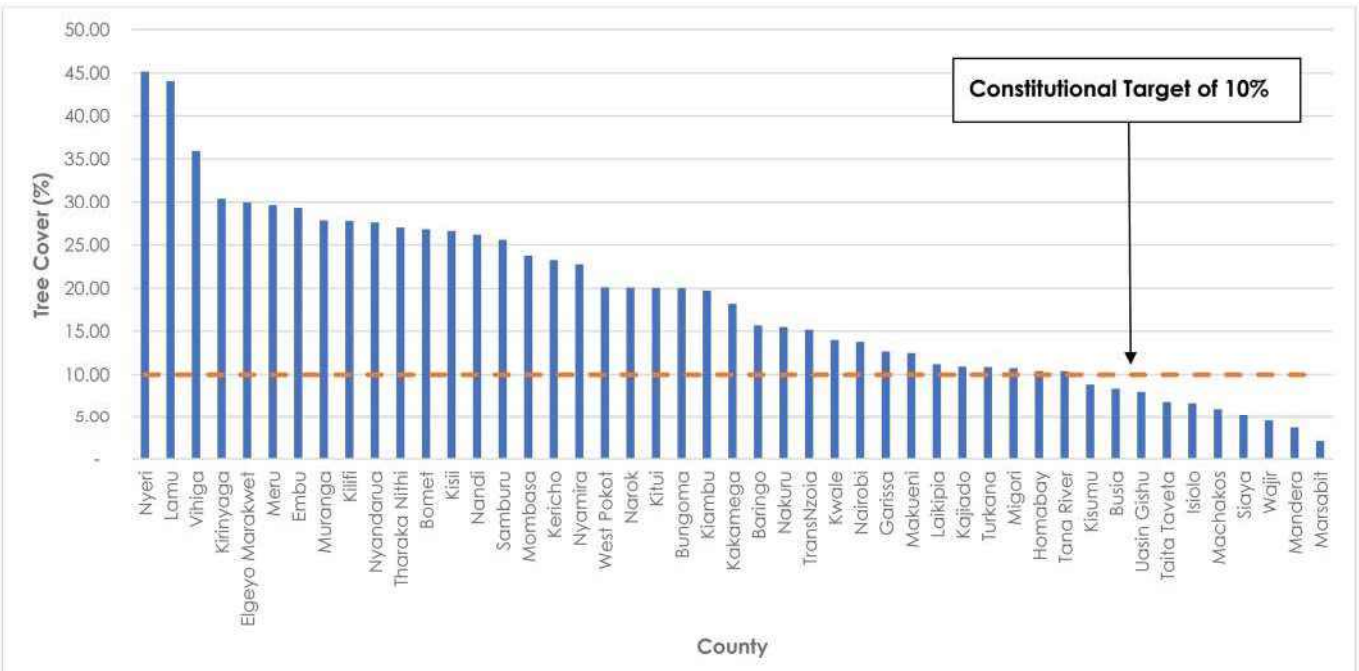
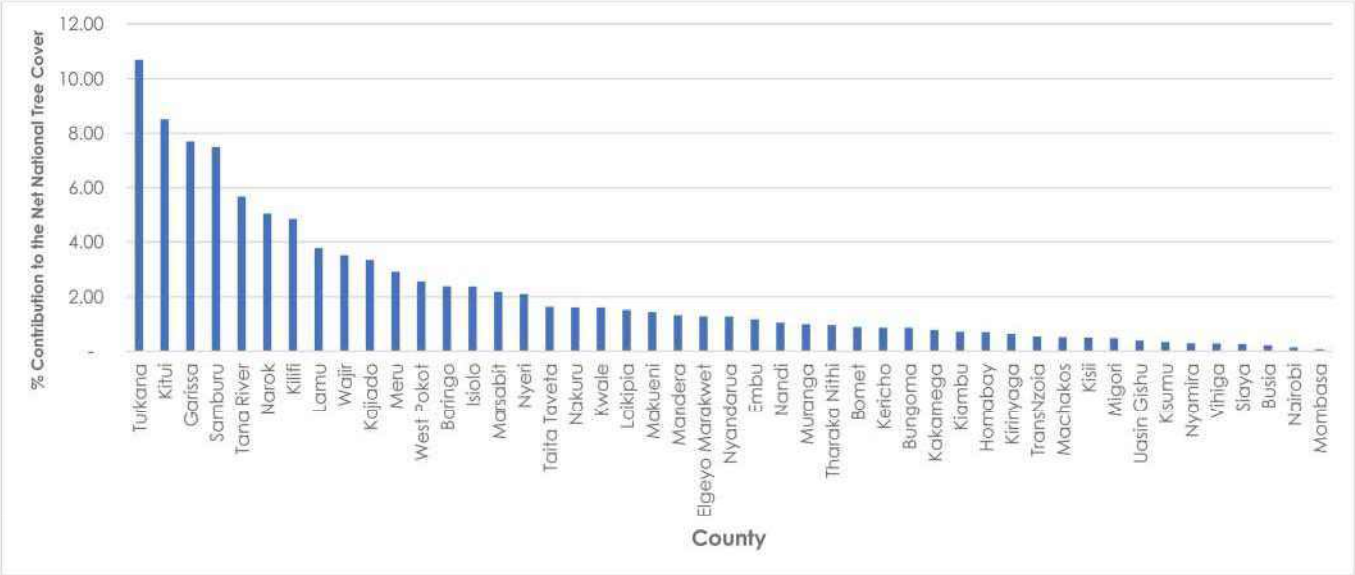


FIGURE 4 *Proportion of county tree cover to the national tree cover (Source: KFS 2021)*



There are various reasons and drivers that may explain the observed differences in tree cover across counties. However, existing literature has indicated that the loss of tree resources in Kenya is largely driven by anthropogenic factors which manifest through growing human needs such as conversion of lands with tree resources to settlements, crop farming, and lack of geospatial plans to guide infrastructural development. Similar drivers of tree loss have also been acknowledged in global datasets and literature as the key contributing factors to changes in the state of tree resources (KFS 2021).

Based on the provisions of the Constitution of Kenya 2010 under articles 42, 69 and 70 on the need for protecting and conserving the environment while ensuring people have a right to an environment that is clean and healthyit is important to determine the tree cover available per person per county. Overall, Kenya has 1,507.58 m^2 tree cover per person. The devolved unit with the highest recorded tree cover per capita was 18,795 m^2 per person while the minimum index was 22 m^2 per person (Nairobi, Mombasa and Kisumu city cities have low tree cover per capita). Factors associated with this trend could be the growing human needs, especially the rapidly expanding physical infrastructure, low priority for green infrastructural development and population pressure, among others (KFS 2021).

Nairobi, Nakuru, and Kiambu counties are Kenya's top three counties with the highest GDP per capita, while Lamu, Samburu, and Isiolo have the lowest GDP per capita (Business Daily Newspaper 2020). In order to secure funding for implementing development activities, including tree cover expansion within counties, each county is meant to prepare a County integrated development plan covering all aspects of a county. The budgetary estimates for all activities are then submitted to the National Treasury for funding considerations.

Kenya's overall HDI for 2018 was predicted at 0.579, which puts the country in the medium human development category at position 147 out of 189 states and territories. During this period, Kenya's life expectancy at birth increased by 8.9 years, the mean years of schooling rose by 2.8 years and expected years of schooling increased by 2.0 years (James *et al.* 2012).

The 2010 constitution allowed devolved units to be semi-autonomous (SID 2011). Studies show that devolution has enhanced equitable resource distribution, improved economic and social development, and promoted accountability, transparency and national unity (KIPPRA 2016, UNDP 2017, Ngigi and Busolo 2019). However, devolution has also been blamed for being expensive to implement. Other criticisms include mismanagement of funds allocated to devolved units and corruption, duplicating roles, fostering uneven development, insufficient budgetary allocations from the National Treasury, insufficient public participation, and a lack of capacity to facilitate service delivery (Ngigi and Busolo 2019, The Star Newspaper, MENR 2020, Kisii County Website 2020). In view of these findings, the correlation between tree cover and socio-economic development indicators in devolved units was explored with the intention of providing suggestions on how to improve tree cover policies in the country.

Data collection and analysis

Data Collection

Both secondary qualitative and quantitative data were used. Secondary data on county GDP per capita, population, HDI, and county tree cover was collected from a literature search process which entailed an internet search, a review of County Integrated Development Plans (CIDPs) for the period 2013 to 2021, email correspondence, and visits to official websites. The distribution of tree cover data and selected socio-economic variables used in this study are as shown in Appendix B were sourced from the National Forest Resources Assessment Report for Kenya in the year 2021.

Data analysis

The resultant quantitative data was cleaned, sorted and analyzed using Microsoft Excel spreadsheet in order to generate

descriptive statistics (correlations) and other visualizations. Scatter plots were drawn to show the correlation between the study variables as described below and a test of significance conducted for variables under study.

Association between County Tree cover and county GDP per capita

In order to assess GDP's impact on tree cover expansion in a given devolved unit, the authors derived the county GDP per capita data from the Business Daily Newspaper (2020) and UNDP (2017). GDP per capita figures were added to the tree planting Excel dataset by matching every county with the respective figures. The entire dataset was later sorted by GDP per capita by arranging the GDP figures from smallest to largest. The association effect of GDP on tree cover was explored at two levels, (i) national level for the overall countrywide correlation, and (ii) county level, by comparing the results of the correlation between GDP and tree cover in counties with greater that the constitutional target of 10% against the results between county GDP and tree cover in counties with tree cover less than 10%.

Association between tree cover and county HDI

HDI is measured by assessing three basic dimensions of human development: (1) a long and healthy life, (2) access to knowledge, and (3) a decent standard of living (Business Daily Newspaper 2020). Long and healthy life is determined by life expectancy and was also explored. According to UNDP (2019) an HDI value between 0.35 and 0.549 represents low category of human development, while 0.55 and 0.699 represents medium category human development status. HDI values greater than 0.77 represent a high level of human development index. The authors mimicked these global level classifications and applied them in the context of Kenya's devolved units. The association effect of HDI on tree cover was explored at two levels, (i) national level for the overall countrywide correlation and (ii) county level by comparing the results of the correlation between HDI and tree cover in counties with greater that the constitutional target of 10% against the results between county HDI and tree cover in counties with tree cover less than 10%.

Association between county population density and tree cover

County population data from KNBS (2019) was added to the tree cover dataset. The resultant dataset was then sorted by county population density from the smallest to the largest population figure. The association effect of population density on tree cover was explored at two levels, (i) national level for the overall countrywide correlation and (ii) county level by comparing the results of the correlation between population density and tree cover in counties with greater that the constitutional target of 10% against the results between county population density and tree cover in counties with tree cover less than 10%.

RESULTS

The summary statistics associated with the key variables under study are as summarized in Table 2. The national tree cover was 12.13%, the mean tree cover was 18.18% while the median tree cover was 17.74%. The highest observed tree cover across counties was 45.17% while the lowest observed tree cover was 2.06%.

TABLE 2 *Summary Statistics*

Parameter	County Area (Km^2)	GDP per Capita	HDI	Population Density	Tree Cover (%)	Tree Cover per Capita
Mean	12595.08	2926.319	0.503191	500.8547	18.18648	2600.841
Standard Error	2605.046	202.8368	0.008555	172.5293	1.529864	600.6443
Median	3542.344	2545	0.51	219.0298	17.74209	1081.871
Mode	#N/A	#N/A	0.51	#N/A	#N/A	#N/A
Standard Deviation	17859.3	1390.579	0.058648	1182.802	10.48822	4117.81
Sample Variance	3.19E+08	1933710	0.00344	1399020	110.0027	16956359
Kurtosis	4.865962	1.425605	-0.44572	18.88455	-0.12323	7.914841
Skewness	2.263978	1.326768	-0.16967	4.358663	0.563405	2.790136
Range	75814.77	5988	0.27	6216.884	43.10926	18772.96
Minimum	216.0389	967	0.37	6.047351	2.056554	22.12927
Maximum	76030.81	6955	0.64	6222.932	45.16581	18795.09
Sum	591968.8	137537	23.65	23540.17	854.7648	122239.5
Count	47	47	47	47	47	47
Largest(1)	76030.81	6955	0.64	6222.932	45.16581	18795.09
Smallest(1)	216.0389	967	0.37	6.047351	2.056554	22.12927
Confidence Level(95.0%)	5243.686	408.2892	0.01722	347.2836	3.079456	1209.034

Tree cover and socio-economic development

The national level correlation results between tree cover and selected socio-economic indicators is shown in Table 3. County GDP per capita and HDI have a similar and moderately positive association with County Tree Cover at 0.38. This result indicates there is a chance that a county with higher GDP per capita and HDI could also be associated with higher county tree cover. In addition, tree cover has a negative correlation with county area (-0.44). This result implies the larger the geographical size of a county the higher the chances of having lower tree cover. Results also show that county population density has a slightly positive correlation (0.07) with a county's tree cover.

At county level, the association between county tree cover and selected socio-economic indicators is shown in Table 4. County GDP per Capita and HDI have slightly positive correlations with county tree cover for both counties with tree cover less than the constitutional target of 10% and those above the target. These results imply that GDP per capita and HDI could be the main factors influencing tree cover at county level. For this reason, keeping climatic factors and terrain factors constant, efforts aimed at improving county tree cover should focus on counties with higher GDP and HDI. Moreover, tree cover expansion activities should be in tandem with efforts targeting to raise HDI through improving county literacy levels and improving household incomes for rural populations. Results show that population density has a slightly positive correlation with county tree cover for counties with tree cover less than the constitutional target of 10%. County area has a negative correlation with tree cover for both counties with tree cover less than and greater than the constitutional target of 10%. This finding is similar to that from national level correlation (Figure 1). These results are contrary to an analysis of the contribution of county tree cover to the net national tree cover indicates that counties with large geographical size mostly in the ASAL area have the greatest contribution to net national tree cover (Figure 3).

County HDI and GDP per Capita appear to be the key socio-economic variables affecting tree cover expansion in counties. A test of significance conducted for both GDP per capita and HDI across all devolved units at 95% confidence interval reveals that there is a significant positive correlation between the two variables with county tree cover (r=0.38, p=.005, one tail) as illustrated in Tables 5 and 6.

TABLE 4 *Association between County Tree cover and Key socio-economic indicators*

County Socio-economic Indicator	Constitutional Target (10% Tree Cover)	County Tree Cover (%)
GDP per capita	>10%	0.31
	<10%	0.41
HDI	>10%	0.41
	<10%	0.31
Population Density	>10%	-0.12
	<10%	0.36
County Area	>10%	-0.27
	<10%	-0.39

DISCUSSION

When county GDP per capita, population density and HDI were explored against Kenya's tree cover data, the results show that all the 47 devolved units have a moderately positive correlation (0.38) between GDP per capita and tree cover in the year 2021 (r=0.38, p=.005, one tail) as shown in Tables 5 and 6. Further, 33 devolved units with tree cover percentage above the constitutional threshold (10%) have lower positive correlation (0.31) between county tree cover percentage and county GDP per capita compared to 14 devolved units with tree cover percentage below the constitutional threshold (10%) which have a moderately higher positive correlation of 0.41 (Table 4). These results imply the need to focus tree cover expansion efforts in counties with lower tree cover such as Laikipia, Garissa, Kisumu, Busia, Uasin Gishu, Wajir, Tana River, Taita Taveta, Machakos, Kajiado, Siaya, Isiolo, Mandera and Marsabit. Out of these counties, ASAL counties represent 78% hence pointing out the counties with the greatest potential for tree cover expansion in the country. Figure 4 supports this observation by highlighting that these ASAL counties have the highest contribution to the net national tree cover. Reviewed literature indicates that these regions account for 89% of Kenya's landmass and a third of Kenya's population and they have significantly diverse production systems and economic opportunities which should be leveraged for tree cover expansion (Republic of Kenya 2013a).

TABLE 3 *Correlation at National Level*

	County Area (Km^2)	GDP per Capita	HDI	Population Density	Tree Cover (%)	Tree Cover per Capita
County Area (Km^2)	1	-0.40	-0.54	-0.26	-0.44	0.43
GDP per Capita	-0.40	1	0.59	0.46	0.38	-0.11
HDI	-0.54	0.59	1	0.39	0.38	-0.37
Population Density	-0.26	0.46	0.39	1	0.07	-0.23
Tree Cover (%)	-0.44	0.38	0.38	0.07	1	0.06
Tree Cover per Capita	0.43	-0.11	-0.37	-0.23	0.06	1

TABLE 5 *Hypothesis 1 -There is a positive correlation between County Tree cover and HDI*

Regression Statistics					
Multiple R	0.38				
R Square	0.14				
Adjusted R Square	0.12				
Standard Error	0.05				
Observations	47.00				
ANOVA					
	df	**SS**	**MS**	**F**	**Significance F**
Regression	1.00	0.02	0.02	7.47	0.01
Residual	45.00	0.14	0.00		
Total	46.00	0.16			
	Coefficients	**Standard Error**	**t Stat**	**P-value**	
Intercept	0.46	0.02	28.76	0.00	
Tree Cover (%)	0.00	0.00	2.73	0.01	

Conclusion: There is a significant relationship between tree cover and GDP per capita (r=0.38, p=.005, one tail).

TABLE 6 *Hypothesis 2 -There is a positive correlation between County Tree Cover and county GDP per Capita*

Regression Statistics					
Multiple R	0.38				
R Square	0.15				
Adjusted R Square	0.13				
Standard Error	1297.74				
Observations	47.00				
ANOVA					
	df	**SS**	**MS**	**F**	**Significance F**
Regression	1.00	13164927.18	13164927.18	7.82	0.01
Residual	45.00	75785713.04	1684126.96		
Total	46.00	88950640.21			
	Coefficients	**Standard Error**	**t Stat**	**P-value**	
Intercept	1998.70	381.98	5.23	0.00	
Tree Cover (%)	51.01	18.24	2.80	0.01	

Conclusion: There is a significant relationship between tree cover and HDI (r=0.38, p=.005, one tail).

Even though tree cover in Kenya appears unequally distributed, trees and tree cover are highly valued for enhancing human well-being and sustainable development (UNEP website 2020, MENR 2016, MENR 2018, National Strategy for 10% Tree Cover, KFS 2010, KFS Strategic Plan 2017, Draft Forest Policy 2020, Chisika and Yeom 2020, Cheboiywo 2016). As such, concerted efforts are being up-scaled to enhance tree cover through a nationwide strategy to achieve and maintain 10% tree cover by 2022 (National Strategy for 10% Tree Cover). Kenya has a total of 7,180,000 ha of tree cover established on public, community, and private lands across 47 devolved units against a national land mass area of 59,196,877.24 ha which translates to 12.13% of the total land area. Similarly, global level reviews on the link between trees and development have widely acknowledged tree cover expansion as one of the ways of promoting human well-being and sustainable development (FAO 2015, FAO 2016, UNEP 2012, UNEP Website 2020, Ewers 2006, Assessment 2005, Baral *et al.* 2016, Kauppi *et al.* 2018, Corona *et al.* 2016, McGuire *et al.* 2012, Agrawal *et al.* 2013, Li *et al.* 2019, FAO 2008). Hence, efforts aimed at developing programmes and policies that promote tree cover expansion are increasing.

Results have also shown that the Central, western and coast regions of the country have more tree cover than other regions of the country. Even though a study on the impact of unequal distribution of trees across regions has not been

conducted, this study speculates there may be significant negative implications on sharing of ecosystem goods and services generated by tree resources and balanced regional development in Kenya because tree resources are green infrastructure that support socio-economic development. As such, tree resources should be fairly distributed in the country. Therefore, even though reviewed literature indicates that tree cover expansion is a complex process whose links to sustainable development are hard to document (Holl and Brancalion 2020, Strassburg *et al.* 2019), tree planting programmes that target tree cover expansion in Kenya's devolved units should consider county GDP per capita as the key guiding variable that guarantees success of tree cover expansion in the long-run. These results are agreeable with reviewed global level literature which indicates that tree cover expansion is a dynamic process that displays many patterns depending when, where and how tree cover is expanded. Moreover, GDP per capita and other socio-economic factor such as HDI, agriculture, other industries and a lack of data appear to be the most prominent challenges affecting tree cover expansion in developing countries (Watson *et al*. 2007, Agrawal *et al.* 2013, Li *et al.* 2019, Jha *et al*. 2006, Uusivuori *et al*. 2002, Miyamoto *et al*. 2014, Naidoo 2004, Zhao *et al.* 2011). Thus, studies have emphasized the need for careful planning and choosing appropriate locations for tree cover expansion in order to hasten truly transformative development (Holl and Brancalion 2020, Strassburg *et al.* 2019).

All of the 47 devolved units have a moderately positive correlation (0.38) between tree cover and HDI (r=0.38, p=.005, one tail) as shown in Table 6. Up-to 33 devolved units with tree cover above the constitutional threshold of 10% tree cover have higher positive correlation (0.41) compared to 14 devolved units with tree cover below the threshold which have a moderately positive correlation of 0.31 (Table 4). When HDI for each county was compared with the UNDP (2019) thresholds, all the 47 devolved units have HDI values in the low to medium range. Nevertheless, since higher HDI's appear to be positively correlated with higher county tree cover, the expansion of tree cover should be focussed on counties with medium HDI. As such, among counties with tree cover less than the constitutional target of 10%, tree cover expansion should focus on Laikipia, Kisumu, Uasin Gishu, Taita Taveta, Machakos, and Kajiado counties. Whereas, in the category of counties with tree cover higher than the constitutional target, tree cover expansion should focus on, Nyeri, Lamu, Vihiga, Kirinyaga, Elgeyo Marakwet, Meru, Embu, Murang'a, Tharaka Nithi, Bomet, Kisii, Nandi, Nyandarua, Mombasa, Kericho, Nyamira, Narok, Kiambu, Baringo, Nakuru, Kilifi, and Nairobi. Most devolved units with higher HDIs are located in high potential areas and could also be targeted with tree cover expansion on the account of their higher HDI. Higher HDIs tend to be associated with higher levels of awareness which could be leveraged to promote a culture of tree growing for tree cover expansion. Only Nairobi City County belonged to the medium category of HDI. However, based on the observed huge variations in the correlation between tree cover and selected socio-economic indicators, this study speculates that the tree cover expansion across counties may be affected by other factors beyond those examined in this study. Therefore, more studies are required to examine the level of significance of other variables in order to promote future tree cover expansion in devolved units.

Reviewed literature has indicated that other elements that could affect tree cover outcomes in the Kenyan context could include differences in county climatic condition, terrain, county governance styles, differences in county development priorities (especially whether tree cover is considered important), awareness of the importance of trees, exchequer budgetary allocations, the socio-economic traits of local communities, and the effect of natural disasters (floods and landslides). In fact, a general review of most County Integrated Development Plans indicates that the highlighted reasons are the main underlying factors that explain the extent and distribution of tree cover in many devolved units. These reasons are similar to those reported by Li *et al.* (2012) and de Jong *et al.* (2006).

CONCLUSIONS AND RECOMMENDATIONS

Trees and forests are important for environmental stability and socio-economic development. As such, there are many emerging agreements, commitments and initiatives that appear to be geared towards promoting large scale tree planting. Kenya is experiencing the positive impacts of tree cover and is desirous of enhancing the beneficial impacts by establishing a favorable legal and policy environment for tree cover expansion. As a consequence, results have shown that in Kenya, all the 47 devolved units, named counties, have a moderately positive correlation (0.38) between GDP per capita, HDI and tree cover (r=0.38, p=.005, one tail). These results imply that future tree cover expansion should focus efforts on devolved units with high HDI and GDP per capita because they represent areas with the most potential for tree cover expansion. Most of the Arid and Semi-Arid counties (ASALs) are represented in this category, and most of them have denuded lands that require urgent restoration. Reviewed literature has given credence to the escalation of tree cover expansion activities in such regions, subject to careful planning. Furthermore, in view of other favorable socio-economic attributes in these counties in terms of the high county population, it would be rational and appropriate to amplify tree planting efforts to achieve sustainable and balanced regional development.

Findings on the association between GDP and tree cover in devolved units contradict those in reviewed literature such as Naidoo (2004), Ewers (2006), and Uusivuori *et al.* (2002), who found that a higher GDP is associated with the desire to increase tree and forest cover in a given region. However, further comparative analyses are required in light of the socio-economic, legal, and policy reforms that have taken place in individual counties since the initiation of devolved governance in 2013. Whereas it may be difficult to explore each of these variables in detail in the case of individual devolved units, the variabilities are largely attributable to the complex

and dynamic socio-economic and political realities of these devolved units as reported by SID (2011), KIPPRA (2016), UNDP (2017) and Ngigi and Busolo (2019). Further, in order to achieve balanced development, tree cover expansion efforts should be carefully planned by evaluating the relationship between tree cover and key socio-economic development variables in order to minimize negative impacts and choose appropriate locations that maximize positive economic or ecological, or social outcomes depending on the location (Foster and Rosenzweig 2003, Strassburg *et al.* 2019). Therefore, there is need for careful planning as a means of addressing most of these challenges in favor of tree cover expansion. It will be more interesting to investigate how these variables interact with GDP per capita and HDI for each devolved unit and the net effect on the tree cover expansion policies, projects and programmes. Nevertheless, this study establishes that high county HDI appears to be the most important socio-economic variable associated with the desire for tree cover expansion. Therefore, there is the need for concerted efforts to raise county HDI as a way of positively influencing environmental conservation, improved human well-being and sustainable development in Kenya's 47 devolved units.

This paper recommends the following actions,

1. The government, private sector and development partners should provide opportunities for improving the county human development index (HDI) as a way of increasing tree cover. These efforts should focus on initiating and implementing nature-based livelihood improvement projects for increased household incomes amongst rural communities and enhancing adult literacy which promotes greater awareness on the need for tree cover expansion.
2. The Government should identify and provide appropriate economic and fiscal incentives needed to promote tree cover expansion targeting ASAL counties with high GDP per capita and HDI,
3. Undertake research on tree cover equity and the impacts of tree cover expansion on livelihoods and sustainable development, especially in devolved units with nomadic pastoralists in order to improve ecological integrity.
4. Noting that tree resources contribute 3.6% to the GDP, which is an under reporting of the true tree and forest value as it does not include the value of ecosystem goods and services, it is recommended that a study be undertaken on the total valuation of all tree and forest resources and enlist the same in the National Accounts in order to inform funding and national official statistics reports.
5. County governments should develop their respective County Forest Programmes (CFPs) independently and/or as an integral part of their County Integrated Development Plans (CIDPs) and allocate resources for their implementation, including hiring of trained forest professionals, to support the implementation of the forest programme and provide extension services, monitoring and reporting.

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SUPPLEMENTARY MATERIALS

Appendix A: Distribution of devolved units in regional Areas

Regional Forest Area	No.	County/Devolved Unit
Central Highlands	1	Kiambu
	2	Kirinyaga
	3	Laikipia
	4	Murang'a
	5	Nyandarua
	6	Nyeri
Coast	7	Kilifi
	8	Kwale
	9	Lamu
	10	Mombasa
	11	Taita Taveta
	12	Tana River
Eastern	13	Embu
	14	Kitui
	15	Machakos
	16	Makueni
	17	Meru
	18	Tharaka Nithi
Ewaso North	19	Isiolo
	20	Marsabit
	21	Samburu
Mau	22	Baringo
	23	Bomet
	24	Kericho
	25	Nakuru
	26	Narok
Nairobi	27	Kajiado
	28	Nairobi
North Eastern	29	Garissa
	30	Mandera
	31	Wajir
North Rift	32	E/Marakwet
	33	Nandi
	34	Trans Nzoia
	35	Turkana
	36	Uasin Gishu
	37	West Pokot
Nyanza	38	Homa Bay
	39	Kisii
	40	Kisumu
	41	Migori
	42	Nyamira
	43	Siaya
Western	44	Bungoma
	45	Busia
	46	Kakamega
	47	Vihiga

Appendix B: County variables used

County	County Area	County Area (Km^2)	Gross County Product (KNBS 2019)	County HDI (2015)	County Population Density (#/Km^2)	County Population	Tree Cover (Ha)	Tree Cover (%)	County Tree Cover per capita (m^2/person)
Baringo	1,091,197.13	10,911.97	2,545	0.51	61	666,763	170721.9741	18.59	2,560.46
Bomet	235,485.88	2,354.86	3,390	0.54	372	875,689	63059.49	26.78	720.11
Bungoma	303,273.55	3,032.74	1,957	0.48	551	1,670,570	60766.01	20.04	363.74
Busia	182,960.70	1,829.61	3,089	0.43	488	893,681	15342.71	8.39	171.68
Elgeyo Marakwet	301,804.67	3,018.05	6,561	0.53	151	454,480	90393.01	29.95	1,988.93
Embu	282,797.80	2,827.98	3,662	0.55	215	608,599	82812.9	29.28	1,360.71
Garissa	4,359,117.66	43,591.18	1,787	0.47	19	841,353	552300.2075	9.07	6,564.43
Homabay	475,950.47	4,759.50	1,981	0.41	238	1,131,950	49518.36	10.40	437.46

County	County Area	County Area (Km^2)	Gross County Product (KNBS 2019)	County HDI (2015)	County Population Density (#/Km^2)	County Population	Tree Cover (Ha)	Tree Cover (%)	County Tree Cover per capita (m^2/person)
Isiolo	2,538,172.90	25,381.73	2,015	0.45	11	268,002	170057.5843	4.25	6,345.38
Kajiado	2,189,902.11	21,899.02	2,387	0.59	51	1,117,840	239575.2908	5.96	2,143.20
Kakamega	302,306.31	3,023.06	1,910	0.48	618	1,867,579	55044.96	18.21	294.74
Kericho	261,671.55	2,616.72	2,816	0.52	345	901,777	60796.89	23.23	674.19
Kiambu	256,872.20	2,568.72	4,422	0.56	941	2,417,735	50700.03	19.74	209.70
Kilifi	1,250,506.55	12,505.07	1,645	0.57	116	1,453,787	347015.5676	14.20	2,386.98
Kirinyaga	147,530.49	1,475.30	3,248	0.57	414	610,411	44836.05	30.39	734.52
Kisii	132,111.76	1,321.12	2,373	0.51	959	1,266,860	35142.35	26.60	277.40
Kisumu	267,693.48	2,676.93	3,356	0.52	432	1,155,574	23695.24	8.85	205.05
Kitui	3,043,654.98	30,436.55	1,829	0.48	37	1,136,187	610503.0533	27.63	5,373.26
Kwale	822,988.71	8,229.89	2,032	0.44	108	886,820	115108.09	13.99	1,297.99
Laikipia	954,385.93	9,543.86	3,092	0.57	54	518,560	106891.2242	9.08	2,061.31
Lamu	613,997.61	6,139.98	4,880	0.5	23	143,920	270498.95	44.06	18,795.09
Machakos	601,643.18	6,016.43	3,863	0.54	236	1,421,932	36261.03	6.03	255.01
Makueni	817,246.42	8,172.46	2,080	0.48	121	987,653	101914.9972	17.74	1,031.89
Mandera	2,598,562.84	25,985.63	967	0.42	33	867,457	93847.63	3.61	1,081.87
Marsabit	7,603,080.53	76,030.81	2,131	0.44	6	459,785	156361.49	2.06	3,400.75
Meru	705,709.60	7,057.10	3,086	0.55	219	1,545,714	209069.5	29.63	1,352.58
Migori	316,512.59	3,165.13	1,756	0.45	353	1,116,436	34045.69	10.76	304.95
Mombasa	21,603.89	216.04	5,412	0.55	5,593	1,208,333	5130.93	23.75	42.46
Muranga	252,663.82	2,526.64	3,123	0.56	418	1,056,640	70237.19	27.80	664.72
Nairobi	70,659.19	706.59	6,344	0.64	6,223	4,397,073	9730.4	13.77	22.13
Nakuru	748,920.16	7,489.20	4,912	0.52	289	2,162,202	115815.13	15.46	535.64
Nandi	284,656.31	2,846.56	2,419	0.52	311	885,711	74471.41	26.16	840.81
Narok	1,794,296.94	17,942.97	3,206	0.51	65	1,157,873	360442.4718	22.33	3,112.97
Nyamira	90,095.35	900.95	2,886	0.54	672	605,576	20498.3	22.75	338.49
Nyandarua	327,033.81	3,270.34	6,955	0.53	209	683,289	90130.51804	24.44	1,319.07
Nyeri	333,623.41	3,336.23	4,291	0.59	228	759,164	150683.72	45.17	1,984.86
Samburu	2,102,371.37	21,023.71	1,800	0.43	15	310,327	537576.3593	14.82	17,322.90
Siaya	354,234.40	3,542.34	1,891	0.44	280	993,183	18676.37	5.27	188.05
Taita Taveta	1,712,006.69	17,120.07	2,777	0.54	20	340,671	117556.69	6.87	3,450.74
Tana River	3,915,344.06	39,153.44	2,134	0.4	8	315,943	407195.7822	7.39	12,888.27
Tharaka Nithi	251,374.75	2,513.75	3,377	0.51	156	393,177	67815.31	26.98	1,724.80
TransNzoia	249,587.49	2,495.87	2,169	0.5	397	990,341	37831.22	15.16	382.00
Turkana	7,058,553.20	70,585.53	1,393	0.37	13	926,976	767208.2364	12.11	8,276.46
Uasin Gishu	340,733.10	3,407.33	2,763	0.57	341	1,163,186	27384.11	8.04	235.42
Vihiga	56,310.25	563.10	1,848	0.5	1,048	590,013	20224.53	35.92	342.78
Wajir	5,664,907.60	56,649.08	1,587	0.42	14	781,263	251845.4129	7.98	3,223.57
West Pokot	910,763.85	9,107.64	1,390	0.45	68	621,241	183266.2936	24.09	2,950.00