International Journal of Scientific Engineering and Science
Volume 1, Issue 6, pp. 30-35, 2017. ISSN (Online): 2456-7361

Assessments of the Forest, Poverty and Environmental Security Nexus in Uganda

Oluwole O. Akiyode[1], Levi I. Nwankwo[2], Felix O. Iyalomhe[3], Yusuf A. Abdu[4], Anne Tumushabe[5], Daniel Omuna[6]
[1, 3, 5, 6]Department of Biological and Environmental Science, Kampala International University, Kampala, Uganda
[2]Department of Physical Sciences, Kampala International University, Kampala, Uganda
[4]Department of Mechanical Engineering, Makerere University Kampala, Uganda

Abstract— *The environmental security and quality of every society are important in the determination of human development and socio-economic developments and its level of peace. The potential of environmental security of a location depends on the sustainable management of its forest. This is because of the ecological services being rendered by forest to the environment. Thereby, the societal system will need to encourage forest sustainability and security in order to continue to enjoy its ecological services.*

Forest utilization and poverty are interlinked, since the level of poverty may contribute to the rate of utilization of forest while the rate of utilization of forest contributes largely to environmental security and quality.

The study examines the relationship between the level of poverty to the use of forest and its implication on environmental security using Uganda as a case. There has been a continuous reduction in the size of Uganda's Forest Area (Percentage (%) of Land Area) since 1999. The study interconnects the continuous reduction of the Forest Area (Percentage (%) of Land Area) to the country's well-being and livelihoods and suggests its implications on the environmental security and quality. The study advocates sustainable approaches to the management of forest.

Keywords— *Forest, Poverty, Environmental Security, Environmental Sustainability and Uganda*.

I. INTRODUCTION

The sustainable management of the interconnectedness between forest, poverty and environmental security is prime in the determination of the environmental quality of our immediate society. This is on the premise that the potential of the environmental security of a location depends on the sustainable management of its forest.

Also, the level of poverty may contribute to the rate of utilization of forest while the rate of utilization of forest may determine environmental security and quality of every society. Therefore, environmental security and quality of every society are important in the determination of human and socio-economic developments and its level of peace.

The definitions and usage of 'security' in the recent years have undergone several revisions by academia and professionals in a profound way that has given it a more solicitous, broader, explicit and tangible meaning which increases its scope and makes it appealing to be inculcated into topical global development policies or paradigms. This was in contrast to its conventional use for centuries when it was linked to war and peace.

Environmental security is one of the new promising and developing areas of security. Environmental security analysis implications of society on human and global ecology. It is a constituent of nowadays security paradigm that brings about a broader and explicit definition, which accommodates the protection of the physical environment apart from the external or physical aggression and encompasses the sustainability of the societal needs (Akiyode, 2013).

On the basis of redefining and expanding the concept of security and its relationship or connection with the environment and ecology, this study examines how the level of poverty is related to the density of forest in Uganda, and its implications for local and regional communities. It further relates the density of forest to regional climate changes. The paper concludes by establishing the interrelatedness of anthropogenic- man and natural- forest factors as important security issues which cannot be put aside.

II. METHODS

The study reviewed the literature to define and delineate the focus of environmental security as a concept that emphasizes the sustainability of the environmental goods with the intent of preservation of the society. It substantiated the importance of the forest to environmental sustainability with emphasis on its provision of ecological services. It also examined through some published articles on the forest in Uganda which is our case, the relationship between the level of poverty and utilization of forest relating it to environmental security. It further analyses Forest area (% of land area) data of Uganda from 1990 to 2015 and made a forecast of same for 2025 using polynomial model. Finally, the study further through literature analysis of other research articles on sustainable forest management advocated Payment for Environmental Services (PES) as an environmental security approach for the sustainability of forest in Uganda.

III. THE SCOPE OF ENVIRONMENTAL SECURITY AS AN ENVIRONMENTAL SUSTAINABILITY PARADIGM

The identifiable major scope of the concept of environmental security is the promotion and support of the sustainability of the local, regional and the mostly the entire global environment. This is on the basis that continuous degradation of the local environment in different parts of the world may ultimately have unavoidable impacts on the larger society.

A clue from scholars' e.g. Soroos (1994) who argues that environmental security will prevent or minimize human-induced changes to the environment that degrade and disrupt and may avert adverse consequences for current and future generation. Therefore, environmental security is one of the concepts developed to enhance the goal of sustainable development.

The scope of environmental security was also emphasized by Pachauri and Benedick (2000) as a way to minimize environmental damage and promotes sustainable development with a focus on trans-boundary dimensions. For example, climate change impacts is a public good problem whose impending solution must also be global (Gillenwater, 2008).

Climate change is a global common issue having trans-boundary dimensions of effects. Sustainable forest management is one of the succor being advocated by researchers, academia and policy makers for the mitigation of climate change effects globally. Therefore, taking environmental security approach to climate change is essential in assurance and maintenance of the sustainable society. This may be logical than an economics approach since it takes a broader view on questions of equity and social justice (Moss *et al.,* 2011). In addition, Kremier*et al.,* (2003) following the trend in his own definition of environmental security also expounded the concept as a process of preventing and avoiding environmental damage.

Thereby, environmental security links local, regional and global environments alongside their continuous degradation to their security implications. Thus, from the foregoing environmental security may be seen as an avenue designed by researchers, academia, and professionals for preservation and protection of the environment. It embodied the current and future purpose of encouraging the sustainability of the global society and its occupants.

IV. Forest and the Current Societal Needs

The Brundtland Commission described sustainable development as a process of meeting the needs of the present without compromising the ability of the future generation to meet their needs. Sneddon, *et al.* (2006) classified sustainability or sustainable development through Brundtland report into three-legged overlapping stool model that was referred to as economic security, ecological security, and social equity. The ecological security aspect of sustainable development could be taking as environmental security.

Sustainable development is based on the assumption that societies will need to manage the three types of capital (economic, social, and natural) that may be non-substitutable and whose consumption might be irreversible (Dyllick & Hockerts, 2002). Forest is a prominent nature resource of the economy and social values in the world that require sustainable management.

The UN-DESA (2009:1) in its policy brief said 1.6 billion people depend on forests for their livelihood. Thereby, the need for the sustenance of global forests is indispensable for its unquestionable and unique significance as one of the vital resource useful in salvaging the universe from its current environmental woes. Global forest resources are essential for the conservation of biological diversity and soil resources as well as meeting our needs for wood and non-wood products (Siry*et al.* 2005). Also, the forest is among the most important providers of ecosystem services which cannot be replaced by technology (Nasi*et al.* 2002).

In forest valuation studies, carbon storage or hydrological protection which are service components frequently fetch higher values than forests products such ecosystem functions which are of benefits to man, these include better fishing and hunting, cleaner water, better views, safer or less vulnerable areas, free wild pollinatorsto natural disasters, lower global warming, new discoveries for pharmaceutical uses or more productive soils (Nasi*et al.* 2002). Even though most services rendered by forest are not paid for, but their overall importance to the sustenance of man cannot be over emphasized.

Human activities (development) led to the huge amount of greenhouse gasses emission (GHG) that has been continuously generated and steering the identification and progression of climate change whose negative impact is currently being felt around the world. This is also having its toll on the forest in different parts of the world. Nevertheless, forest and wood produce on the other hand traditionally trap and store carbon (carbon sequestration) which is a major role in mitigation of climate change (even though when also forest are over burnt it could also be a source of greenhouse gasses) (FAO, 2009).

Presently, deforestation is responsible for up to 20% of global emission which means protecting forests could noticeably slow global warming (Nature, 2009). Forests are also home to 80% of terrestrial biodiversity which is major carbon sink for regulating global climate (UN-DESA, 2009:1). Thereby, the preservation of the forest is an essential tool in the management of climate change; thereby man will need to encourage the sustainability and security of the forest in order to enjoy the services rendered by the forest.

V. Uganda Forest and Poverty

The word poverty has been subjective, and its definition seldom depends on each person's perception, concept, and usage. Coudouel et *al.* (2009) in a World Bank publication defined poverty based on "whether households or individuals possess enough resources or abilities to meet their current needs and also compares individuals' income, consumption, education, or other attributes with some defined threshold below which individuals are considered as being poor in that particular attribute." The publication also defined "well-being' as the probability or risk today of being in poverty-or falling deeper into poverty-at some point in the future saying vulnerability is a key dimension of well-being, since it affects individuals' behavior (in terms of investment, production patterns, coping strategies) and their perception of their own situation.While, conventionally in different parts of the world poverty and well-being are equated to deprivation, and the poor are defined in terms of incomes and level of consumption (Pachauri and Spreng, 2013).

There is a strong link between poverty level and forest security. Poverty is seen as a cause of forest loss, and forest loss contributes to maintaining or even increased poverty, and

that development of forest resource can be an important vehicle for poverty reduction (Angelson and Wunder, 2003). Poverty alleviation may be the only way to conserve and protect the environment (Wunder, 2005).

Uganda is in the Eastern region of Africa. It is a landlocked country. Though having no access to sea but it is situated alongside the Great Lakes (i.e. Lake Victoria, Lake Albert and Lake Edward) serves as part of its border. It is bordered by Kenya in the East, Tanzania and Rwanda in the South, South Sudan in the Northand Democratic of Congo in the West.Uganda population is estimated to be 30.7 million in the year 2009 having a growing rate of 3.2% per annum and having 88% living in the rural areas and 31% living below the poverty line (UNFPA/Uganda, 2014:3).

Energy could be useful as one of the measure among others for poverty since it is a significant complement to monetary measures such as consumption and income (Pachauri and Spreng, 2013). Access to a dependable and affordable supply of energy is the only alternative to meet basic and essential needs that are fundamental to human health, well-being, and livelihood (Moss et al., 2011).Uganda's continuous growing population requires growing energy supply to match the consumption needs of its society.

Forests and woodlands cover in Uganda are approximately 4.9 million hectares which are about 24% of the total land area while 70% of this forest cover is on private land which is not regulated or managed with high rates of forest clearance for agriculture and charcoal production (The Republic of Uganda, 2016). The Permanent Forest Estate (PFE) is thirty percent of the forest which is a form of protected area, that is Forest Reserves (central and local), National Parks and Wildlife Reserves and of the PFE's 1,881,000 ha, while 60.9% (i.e. 1,145,000 ha) is under the management of the Ugandan Forest Department (FD) as central forest reserves and 0.3% (i.e. 5,000 ha) is controlled by local governments (LG) as local forest reserves and 38.8% (i.e. 731,000 ha) is managed by the Uganda Wildlife Authority (UWA) (Kayanja and Byarugaba, 2001**).** Though there is still fallow land in abundance in western Uganda, this can partially alleviate pressure on forests for domestic fuels, charcoal, brick and gin manufacturers (Naughton-Treves and Chapman, 2002**)**.

The continuous growing population of Uganda relies on fuelwood for their energy needs. Fuelwood remains the preferred energy source among the poor (especially in rural communities) because it has little or no monetary price attached to it since it can be collected from the nearby forest (Pachauri and Spreng, 2013). Firewood is the most important source of energy in Uganda, and it is engaged by the majority for domestic use and small-scale industries such as for brick and tile making, and also in agro-processing and fish processing (Agea et *al.*, 2010 and Tabuti*et al.*, 2003). While the charcoal consumption over the recent past is increasing at a rate close to urban growth of 6% per annum (Kyamuhangire, 2008).

Therefore, forest security in Uganda is indispensable to the human well-being and livelihood. The forestry sector in Uganda plays significant roles in employment, raw materials for industries, food security, cultural and spiritual values (the forest is a major source medicinal plants for about 90% rural dwellers) (Kanabahita, 2001). However, the forest security and worth in Uganda are mainly threatened by fuelwood consumption which on the other hand threatened environmental security. Agea et *al.* (2010) and Tabuti*et al. (*2003) surmised that the disruption in availability and use of wood for fuel energy might render marginalized households to be vulnerable to livelihood insecurity. Thus, the relationship between forest and livelihood security will need to be defined and sustainably managed in order not to hinder the environmental security.

VI. Forest and Environmental Security

Forest is indispensable to global environmental sustainability and security because of its ecological services. This agrees with Edwards and Heiduk (2015) position that the potential securitization of environmental concern is recognized at a global level which is beyond the boundaries of nations.

The ecological services provided by forest is beyond the boundary of nations when quantifying its usefulness in the sequestration of carbon. Mostly in developing nations, agriculture and food production including fishery rely on ecosystem services whose failure may have effects on economies (Pauchari and Benedick, 2000). The relationship between energy use and poverty has its toll on environmental security. This is because poverty correlates to low energy usage and heavy biomass use since the poor mostly in developing nation lack access to more modern energy sources, equipment and electricity (Moss*et al.*, 2011 and Pachauri*et al.*, 2004).

Also, for several years now, Uganda forests have faced pressures from agricultural conversion as a result of population increases, urban demands for charcoal, overgrazing, uncontrolled timber harvesting and failure which made the forest shrink from 45% in 1890 to the present 13.7% (Kanabahita, 2001:7 and The World Bank IBRD-IDA, 2016). Kayanja and Byarugaba (2001)reiterated that unsustainable domestic tree-harvesting for firewood and non-timber forest and woodland products that have persisted in Uganda is due to many people not measuring the environmental services that are provided by forest.

Forest area in Uganda has been shrinking for some time now. The table 1 below shows that Forest Area (% of Land area) in Uganda was 23.7775887% in the year 1990, 1995 was 21.570492%, 2000 was 19.3633952%, 2005 was 17.1613032%, 2010 was 13.7293038 and 2015 was 10.358069%.

TABLE 1. Uganda's Forest Area (Percentage (%) of Land Area).

Year	Forest area (% of Land Area)	Year	Forest area (% of Land Area)	Year	Forest area (% of Land Area)
1990	23.7775887	1999	19.8048146	2008	15.1313748
1991	23.3361694	2000	19.3633952	2009	14.454732
1992	22.89475	2001	18.9229768	2010	13.7293038
1993	22.453307	2002	18.4825584	2011	13.050569
1994	22.0119113	2003	18.04214	2012	12.3808099
1995	21.570492	2004	17.6017216	2013	11.7065629

1996	21.1290726	2005	17.1613032	2014	11.032316
1997	20.6876533	2006	16.4846604	2015	10.358069
1998	20.2462339	2007	15.8080176		

World Development Indicator Data. The World Bank IBRD-IDA (2016). Forest area (% of land area). Food and Agriculture Organization, electronic files and web site Accessed 2017-02-15 at http://data.worldbank.org/indicator/AG.LND.FRST.ZS

The continuous downward trend in the Uganda Forest area (% of land area) through deforestation and forest degradation as depicted in table 1 is shown in the graph below (figure 1).

Figure 2 below extrapolated through the Uganda's Forest Area (Percentage (%) of Land Area) of the World Bank IBRD-IDA (2016) data of Table 1 to predict the Forest Area (Percentage (%) of Land Area) of Uganda by 2025 as about plus or minus 6 percentage if the forest deforestation and degradation continues.

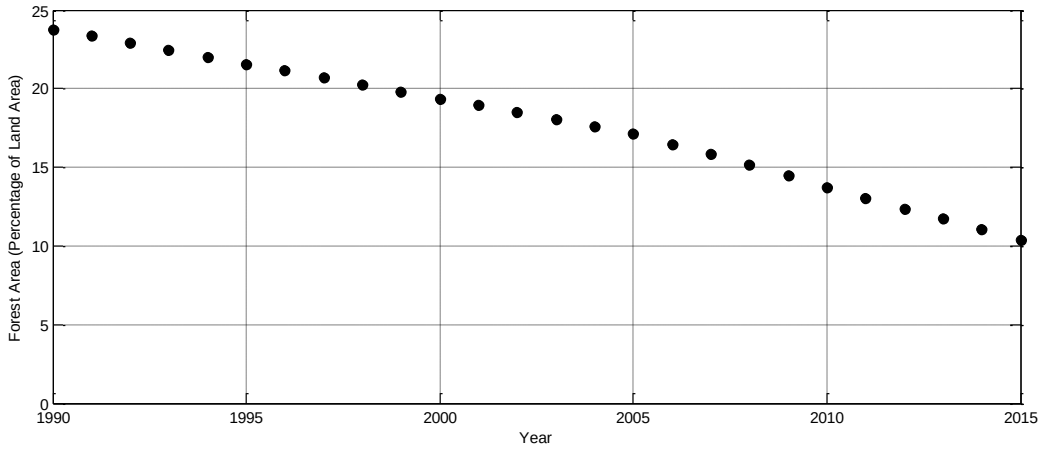

Fig. 1. Uganda Forest area (% of Land Area) from 1990 to 2015 (World Development Indicator Data. The World Bank IBRD-IDA (2016).

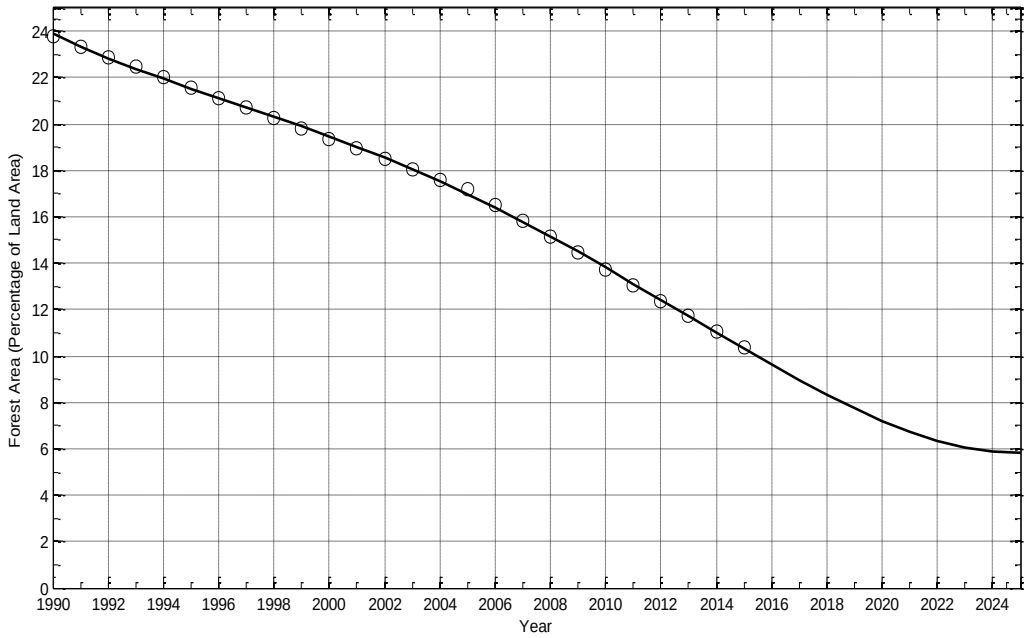

Fig. 2. Prediction of Uganda Forest area (% of Land Area) from 2015 to 2025 (World Development Indicator Data. The World Bank IBRD-IDA (2016).

The prediction was carried out using Polynomial Extrapolation Modelling (PEM) in Matlab programming environment. Since the forest area data in this study is not complimented, the PEM method is found to be appropriate. It has also been shown that extrapolation can produce the same quality of forecasting results as more complex forecasting strategies (Armstrong, 1984).

VII. About Polynomial Models [1]

Polynomial models are given by

[1]Polynomial Models - MATLAB & Simulink. (n.d.). Retrieved from https://www.mathworks.com/help/curvefit/polynomial.html

$$y = \sum_{i=1}^{n+1} p_i x^{n+1-i}$$

Where $n + 1$ is the *order* of the polynomial, n is the *degree* of the polynomial, and $1 \leq n \leq 9$. The order gives the number of coefficients to be fit, and the degree gives the highest power of the predictor variable. Polynomials are described in terms of their degree e.g. a third-degree (cubic) polynomial is given by

$$y=p_1x^3+p_2x^2+p_3x+p_4$$

The continuous shrinking of the forest in Uganda will also decrease the environmental services being provided even when there has been a continuous increase in the population of the country. Invariably, the decreasing and downward trend of the percentage forest area of land area in Uganda also depicts that there might have been a reduction in the level of carbon sequestration or mitigation of climate change which thereby indicates negatively implications on global environmental security.

VIII. Payment for Environmental Services (PES) as an Environmental Security Approach

Payments for environmental service (PES) is sometimes referred to as payments for ecosystems service. PES has a high poverty reduction potential with the ultimate aim of encouraging forest security when operated effectively. This is an environmental security approach that may require choosing of mitigation policies that impose economic costs that may exceed the expected economic benefits of such policies so that we may achieve equity thereby safeguarding human and environmental security (Moss *et. al.*, 2011).

PES scheme practiced in some countries in different parts of the world has boosted forest conservation. PES engaged in Costa Rica may be assumable the model for other countries because of the supposed success rate. In Costa Rica, landowners were paid for the protection of forest and about one million hectares of Costa Rica of forest has been part of the PES scheme since 1997 and the forest now cover more than 50 percent of the country's land area from the over 20 percent in the 1980s (Herbert *et. al.*, 2010 and Kalunda, 2016).

PES is not new to Uganda. There was a Global Environmental Facility (GEF) funded PES to test the effectiveness of the Payment for Environmental Services in enhancing conservation and production landscapes in Bungoma and Budongo in Albertine rift of Western Uganda between 2010 and 2014 which focused on private forest which was implemented in the forest reserves that covers about 140 villages in Hoima and Kibale districts[2].

Also, Mgahinga Bwindi Forest Conservation Trust (Uganda) which is a PES scheme targets conservation and management of the forests that is the habitat for more than half the global population of mountain gorillas which is run in a partnership with communities living around the national parks and in turn grants public fund (through grants) for development projects in the communities located around the parks (Kalunda, 2016). Thereby, the scheme has been contributing to the conservation and management of forest in different communities in different parts of Uganda.

On March 25, 2015, PES was formally launched to curb environmental challenges and encourage environmental sustainability through the use of economic means in Uganda alongside the carbon fund and the Eco-trust Endowment Fund[3]. Thereby, showing the commitment of the Uganda Government to environmental security and sustainability.

IX. Conclusion

This article concludes that the society is multi-facet dependent on forest and its services which are of high importance to the security of the world. This includes financial security, socio security and most importantly the environmental security. It has shown that forests could provide the basic needs of the people as well as the society, providing water, reducing poverty, conserving soil, preventing floods and assist in mitigating climate change. The survival, sustainability and the security of the forest also depend solely on the man effectively managing the forest in order for the society to sustain the enjoyment of its environmental/ecological services for its use. This inadvertently makes forests a tangible security issue which must be handled with care since the society will continue to depend and desires its benefits.

On this note, the study supports the adoption of Payment for Environmental Service (PES) which is also called Payment of Ecosystem Service scheme in Uganda as one of the prime processes for sustainable forest preservation and management. Also, the adoption of PES by the Government of Uganda falls in line with one of the sustainable approaches to the international climate change negotiations that are termed Reduced Emissions from Deforestation and Land Degradation (REED+) which encourages preservation of forest and competing with the drivers of forest deforestation and degradation. Nevertheless, for overall effectiveness and increased sustainable forest management, the PES scheme in Uganda will need to be more of pro landowners' scheme apart from the targeted forests of different communities in order to encourage private landowners to support forest preservation and conservation thereby decreasing the incidence of threats of deforestation in private forest and at end reduce deforestation and forest degradation.

Competing interests

The authors declare that they have no competing interests.

Reference

[1] Agea J.G., Kirangwa D.1., Waiswa D. and Okia C.A. (2010).Household Firewood Consumption and its Dynamics inKalisizo Sub-County, Central Uganda.*Ethnobotanical Leaflets 14: 841-855. 2010*

[2] This project was implemented on about 800 hectares of land and it provided incentives to some 400 private forest owners in 68 villages http://web.unep.org/stories/story/fresh-look-back-payment-ecosystem-services-pes-project-uganda

[3] Uganda First Payment of Environmental Services Fund Launched on March 25, 2015 in Kampala to provide cash payment for communities in providing conservation of natural resources. UNDP in Uganda. http://www.ug.undp.org/content/uganda/en/home/presscenter/articles/2015/03/27/uganda-s-first-payment-for-environmental-services-fund-launched-.html

[2] Akiyode O.O. (2013). Implications of Urbanization on Environmental Security in Developing Economy Countries: A Case Study of Nigeria. Journal of Sustainable Development in Africa, Vol. 15, No. 3. Clarion University of Pennsylvania, Clarion, Pennsylvania
[3] Angelson A. & Wunder S., (2003). Exploring the Forest-Poverty link: Key Concepts, Issues, and research implications. CIFOR Occasional Paper NO 40. Pages 18-41.
[4] Armstrong J.S. (1984). Forecasting by Extrapolation: Conclusions from Twenty-Five Years of Research. *Interfaces*. **14**: 52–66. doi:10.1287/inte.14.6.52.http://repository.upenn.edu/cgi/viewcontent.cgi?article=1083&context=marketing_papers. Accessed January 25, 2017.
[5] Coudouel A., Hentschel J. and Wodon Q. (2009). Chapter 1. Poverty Measurement and Analysis http://siteresources.worldbank.org/INTPRS1/Resources/383606-1205334112622/5467_chap1.pdf. Accessed January 31, 2017
[6] Dyllick, t. & Hockerts, k. (2002). Beyond the business case for corporate sustainability. *Business Strategy and the Environment*, 11(2): 130-141. http://instruct.uwo.ca/business/bus020-mwf/acs410/reading14.pdf. Accessed January 15, 2017
[7] Edwards S. A. and Heiduk F. (2015). Hazy Days: Forest Fires and the Politics of Environmental Security in Indonesia. *Journal of Current Southeast Asian Affairs* 3/2015:65-94
[8] FAO (2009). Forest and Climate Change. FAO Newsroom. *Foods and Agricultural Organisation.*http://www.fao.org/Newsroom/en/focus/2006/1000247/index.html. Accessed March 16, 2017.
[9] Gillenwater, M. (2008). Forgotten Carbon: indirect Carbon dioxide in greenhouse gas emission inventories. Environmental Policy 11(2008) (193-203). http://www.academia.edu/26092663/Forgotten_carbon_indirect_CO2_in_greenhouse_gas_emission_inventories. Accessed March 17, 2017
[10] Herbert, T., Vonada, R., Jenkins, M., Byon, R. & Frausto Leyva, J.M. (2010). *Environmental funds and payments for ecosystems Services: RedLAC capacity building project for environmental fund*. Rio de Janeiro, Brazil, RedLAC. http://www.forest-trends.org/documents/files/doc_2627.pdf .Accessed March 25, 2017
[11] Kalunda P.N. (2016).Payments for forest environmental services in sub-Saharan Africa.*Food and Agriculture and Organization of the United Nations*, Accra.http://www.fao.org/3/a-i5578e.pdf . Accessed March 26, 2017
[12] Kanabahita C, (2001). Forestry Outlook Studies (FOSA). Forestry Department, Ministry of Water, Land & Environment, Kampala, Uganda. https://www.scribd.com/document/50359784/ftp-fao-org-docrep-fao-004-AC427E-AC427E00-pdf . Accessed March 24, 2017.
[13] Kayanja F. I. B. and Byarugaba D. (2001).Disappearing forests of Uganda: The way forward.*Special Section: Science in the Third World. Current Science*, VOL. 81, NO. 8, Pp 936-947. http://tejas.serc.iisc.ernet.in/currsci/oct252001/936.pdf . Accessed March 23, 2017.
[14] Kremier A., Arnold M. & Carlin A. (2003). "Building Safer Cities. The future of Disaster Risk". *The World Bank Disaster Project Management facility*. Washington DC. http://documents.worldbank.org/curated/en/584631468779951316/pdf/272110PAPER0Building0safer0cities.pdf . Accessed March, 15, 2016.
[15] Kyamuhangire W (2008). Perspective of Bioenergy and Jatropha in Uganda. Paper presented at the *International Consultation on Pro-poor Jatropha Development* 10th -11th April, 2008 Casa San Bernado, Via Laurentina 289, Rome, Italy.
[16] Nasi R., Wunder S., & Campos J. (2002). Forest Ecosystem Services: Can they pay our way out of deforestation? *GEF. Forestry Roundtable in conjunction with UNFF11*, Costa Rica on March 11.http://www.cifor.org/publications/pdf_files/Books/BNasi0201.pdf . Accessed March 1, 2017
[17] Nature (2009). On the road to REED. Nature International Weekly Journal of Science. Volume 462 Number 7269 pp 11-126. http://www.nature.com/nature/journal/v462/n7269/. Accessed March 10, 2017.
[18] Naughton-Treves L. and Chapman C. (2002). Fuelwood Resources and Forest Regeneration on Fallow Land in Uganda. *Journal of Sustainable Forestry*, Vol. 14(4) 2002 2002 by The Haworth Press, Inc. http://www.academia.edu/16962214/Fuelwood_Resources_and_Forest_Regeneration_on_Fallow_Land_in_Uganda . Accessed 24, March, 2017.
[19] Moss J., McMann M., Rae J., Zipprich A., Macer D.R.J., Nyambati A.O., Ngo D., Cheng M. Manohar N. and Wolbring M.,(2011). Energy Equity and Environmental Security. Ethics and Climate Change in Asia and the Pacific (ECCAP) Project. Working Group 7 Report. Published by UNESCO Bangkok. https://www.researchgate.net/publication/259219648_Energy_Equity_and_Environmental_Security . Accessed March 27, 2017.
[20] Pauchari, R. and Benedick, R.E. (2000). Environmental Security. A developing Country Perspective. Meeting report of Wilson Center, Environmental Change and Security Project. Current Events, OCT 17, 2000.
[21] Pachauri S., Mueller A., Kemmler A., and Spreng D. (2004). On Measuring Energy and Poverty in Indian Households. World Development. Vol. 32, No. 12, pp. 2083-2104. DOI: 10.1016/j.worlddev.2004.08.005
[22] Pachauri S. and Spreng D. (2013). Energy Use and Energy Access in Relation to Poverty, Centre for Energy Policy and Economics. Swiss Federal Institute of Technology. CEPE Working Paper Nr. 25
[23] Polynomial Models - MATLAB & Simulink. (n.d.). Retrieved from https://www.mathworks.com/help/curvefit/polynomial.html . Accessed March 27, 2017
[24] Republic of Uganda (2016). The Uganda Forest Policy. Ministry of Water, Land, and Environment.
[25] Siry J., Cubbage F. and Rukunuddin A. (2005). Sustainable forest management: global trends and opportunities. *Forest Policy Economies* 7(2005) 551-556.DOI: 10.1016/j.forpol.2003.09.003
[26] Sneddon, C., Howarth, R. and Norgard R. (2006). Sustainable development in a post-Brundtland world. Ecological Economics 57 (2006) (253-268). http://kfrserver.natur.cuni.cz/studium/prednasky/vyberclanku/pdf/p68_ucit/10_SNEDDON.pdf . Accessed March 5, 2017.
[27] Soroos, M. S. (1994). Global Change, Environmental Security, and the Prisoner's Dilemma.*Journal of Peace Research* 31(3):317-332.https://www.jstor.org/stable/pdf/425380.pdf . Accessed February 1, 2017
[28] Tabuti, J.R.S., Dhilliona, S.S. and Lye, K.A. 2003. Firewood use in Bulamogi County, Uganda: species selection, harvesting and consumption patterns. *Biomass &Bioenergy 25: 581–596.*DOI: 10.1016/S0961-9534(03)00052-7http://www.sciencedirect.com/science/article/pii/S0961953403000527. Accessed March 15, 2017
[29] UNFPA/Uganda (2014). Because Everyone Counts. The Government of Uganda and United Nations Population. https://www.unfpa.org/sites/default/files/portal-document/Uganda_CPAP%202010%20-%202014.pdf.pdf . Accessed March 2, 2017.
[30] UN-DESA (2009). United Nations. Department of Economic and Social Affairs. New York.
[31] Wunder S. (2005). Payments for Environmental Services: Some nuts and Bolts. Center for International Forestry Research. http://www.cifor.org/publications/pdf_files/OccPapers/OP-42.pdf. Accessed March 15, 2017