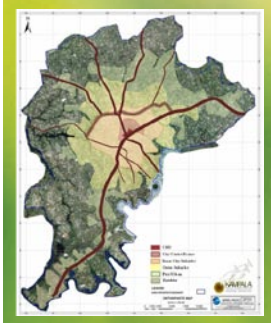
Strategies for mitigation of emissions by low emitting cities

1. Introduction

Several cities have been reporting greenhouse gas emissions in the last decade. This is motivated by the need to develop city mitigation plans, which require baseline data for benchmarking and target setting. Low emitting cities have conducted GHG inventories with the community scale approach using activity data within and outside the geopolitical boundaries. This policy brief summarizes the GHG inventory carried out in city-region of Kampala. Emissions estimates are based on both consumption and production activities with accounting taking into considerations required adjustments for non-double counting. Data was collected from both formal and informal energy-consuming activities responsible for emissions in the city. The major objective of the inventory is to profile the energy consuming activities of the city and calculate emissionsin Kampala city. The five broad sectors of stationary units, mobile units, wastes, industrial processes and production and agriculture, forestry and land use were inventoried. This brief presents the results and suggests pathways for mitigation actions in low emitting cities like Kampala.



Map 1:
Kampala City and City-Region
Source KPDP 2012

2. The Global Protocol for Community-Scale Greenhouse Gas Emissions estimation

Future impacts of climate change on cities are projected to increase and thus mitigation is necessary but it requires an understanding about the sources of emissions andcalculation in cities. The GHG inventory is a critical pre-requisite for policy response towards mitigation that can be supported by strategy development and implementation. The inventory was conducted with the Global Protocol for Community-Scale Greenhouse Gas Emissions, which is adapted from various frameworks based on internationally accepted tools for quantifying the GHG emissions attributable to cities and local regions. Emissions are calculated on three levels which include Scope 1; GHG emissions that occur within the territorial boundary of the city or local region; in the context of Kampala, the city is administratively limited to the 196 sq km surface area of the most recent Kampala Physical Development Plan boundaries followed according to the Kampala Capital City Authority (KCCA). Scope 2 covers the indirect emissions that occur outside of the city boundary as a result of activities that occur within the city, limited to only electricity consumption which is generated from thermal plants some of which are in the city-region. The city region is the area outside the city administrative boundaries covering and estimated 941 sq km around the city's administrative boundaries, which was defined in the recent Kampala Physical Development Plan. For this category emissions were also calculated for agriculture, forestry and land use changes in the peri-urban zones of the region focused on biomass consumption. Scope 3; is any other indirect emissions and embodied emissions that occur outside of the city boundary, as a result of activities of the city. In this category of emission sources, marine and air transport were the focus as they apply to Kampala with estimates of activities originating from the city.

" Energy efficient infrastructure development and use"

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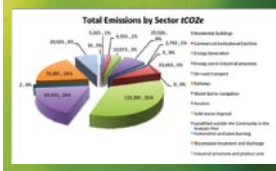
"Low-hanging' fruit options related to transportation like Mass-transit systems that incorporate Non-motorized transport"

Measuring GHG emissions

The GHG inventory utilizes the GPC and is in line with the revised IPCC emission guidelines and emission factors. Emissions are calculated based on activity data from multiple sources and checked for minimization of over estimate and under estimate. Emission factors for the different sectors are applied to calculate city-specific and city influenced emissions. Estimates of CH_4 and N_2O are calculated as CO_2 equivalents using the standard warming factors defined by the GPC. The principles of GHG inventory are adhered to in the inventory especially measurability, accuracy, relevance, consistence, transparence and completeness. For the informal sector, a sample of activities in economic zones was taken and average energy utilization estimated from usage data. Emissions related to specific activity sectors such as land use change and deforestation associated with urbanization were calculated basing on adjusting scientifically derived emissions based on available peer-reviewed literature on deforestration.

3. Emission Results

Urban Sector	Direct *tCO2e*	Indirect *tCO2e*	Total *tCO2e*	Proportion by sector
Residential Buildings	366.8	4,957.7	5,325	1.39
Commercial Institutional Facilities	1,386.8	5,568.2	6,955	1.82
Energy Generation		10,972.5	10,973	2.87
Energy use in industrial processes	15,408.6	14,517.9	29,926	7.82
On-road transport	2,230.4	512.9	2,743	0.72
Railways	1.3	1.3	3	0.00
Water-borne navigation	0.0	0.0	0	0.00
Aviation	-	23,662.7	23,663	6.18
Solid waste disposal	63,792.9	69,592.2	133,385	34.83
Landfilled outside the Community in the Analysis-Year	11,598.7	57,993.5	69,592	18.17
Incineration and open burning	0.2	1.4	2	0.00
Wastewater treatment and discharge	70,385.2	-	70,385	18.38
Industrial processes and product uses	29,926.4	-	29,926	7.82
AFOLU	6.7	28.8	36	0.01
Total	**195,104.1**	**187,809.1**	**382,913**	**100**



"Material flows especially biomass and nutrients options exist in recycling for multi purposes including utilization for food production, energy and use in buildings"

Kampala's setting and development trajectory

Kampala City dominates urban areas in Ugandawith its shear share of the urban population and urban functions. The city is central to national economic growth that has averaged 7.4% in the last 7 years. Kampala is the industrial, commercial and educational center of the country attracting various activities that are energy intensive. The city's population is estimated at 1,659,600 (UBOS 2009) and 3.56 million in the city region. A range of activities in the city that underpin energy use include industries of different scales, electricity generation, residential buildings and the skewed reliance on biomass energy particularly wood fuel and charcoal.

4. Emission attribution and contribution by sector

Results indicate that waste sector in general specifically solid waste and waste treatment sub sectors rank first and second representing 34% and 18%. Industrial energy use (combining energy use and processes and product use) ranks third with 16.1% of the emissions. This shows that waste sector produces higher emissions due to the nature of waste management, the landfill that generates methane. Emissions distribution is related to the population and the different practices for waste and waste water treatment, which are characterized by pit-latrines and scattered dumping grounds for solid wastes. The emissions from wastes also relate to the chemical transformation to methane from decomposing wastes. The summary results provide insight into the life cycle of materials in the city as well as pathways for emissions generation. In that respect the distribution of emissions by sector also gives insight into entry points for mitigation planning. The city's plans for a low-carbon city will be informed by the baseline data. The GPC provides an opportunity to estimate in-boundary emissions, which requires detailed activity data for the geographic units. This bounding is useful in attributing the estimates to the communities where activities are undertaken.

5. Mitigation Options

Emissions saving and or reduction in future will have to incorporate future growth in city economy, activities and the level of energy use. Given the proportional emissions estimates by sector, there are mitigation opportunities with a range of options. The options are related to infrastructure development in the city that is yet to be built. The waste sector is by far the largest emitter according to the inventory and thus mitigation options exists in the use, reuse and rechanneling of waste-laden energy. The options can occur from household to citywide scales ranging from energy briquettes, bioenergy generation, alternative energy use, sustainable biomass use using conservation technology and hybrid systems that can recover energy from wastes. Urban infrastructure and mobility are also major emission sources in Kampala based on the inventory. Options for low-carbon infrastructure include off-grid energy systems, decentralized systems for water-sewerage-energy infrastructure that leverage local resources and may reduce the energy used for pumping. Buildings and building technology options exist ranging from revision of building codes, green rating and energy saving technologies. 'Low-hanging' fruit options for transportation are underway for piloting a Bus-rapid transit preceded with a feasibility study that incorporates Non-motorized transport. Transportation related emissions are also high and likely to increase with improvement in roads as well as rise in private modes of transport within the city-region. This is explained by several factors including, mode, vehicle-kilometers traveled, energy use and number of trips per day per person for those who access vehicles. In respect to material flows especially biomass and nutrients, options exist in recycling for multi purposes including utilization for food production, energy, building and enhancing ecosystem services that offer co-benefits of mitigation that potentially link with adaptation. Urban form and spatial configurations of the city is unsustainable largely due to the sprawled nature of urban development that hikes costs of infrastructure delivery as well as associated energy use. There is a potential to enhance ecosystem services for resource efficient settlements if land use planning and implementation starts to check the sprawl nature of development in the region and enables different spatial configurations. This is because the city is at a stage where the strategic spatial planning is underway and if implemented can be a vehicle for mitigation. Options include urban patterns with green belts, mixed-use, compact development and infrastructure-led city development that are less carbon intensive. These strategies have a potential for reducing embodied and indirect emissions.

6. Conclusion

Solid waste wastewater treatment has the highest emissions representing. Stationary units emissions are low but with a potential to increase as more buildings are being constructed. In respect to scope of the inventory, scope 2 activities emit more than scope 1 and scope 3. The total community emissions under scope 3 are influenced by mobile combustion out side the boundary and particularly aviation. The percapita emissions for the population in the city is lower than the percapita for the city-region even when the population is split by 50% between the city and the environs. This is related to scope 3 of the activity and calculated emissions. A number of mitigation options have been identified for Kampala including urban infrastructure specific measures, measures for buildings and transportation but perhaps the spatial development framework if designed and implemented with low-carbon targets offers the long term emissions reduction entry point.

Further reading

1) *Uganda Bureau of Statistics, 2007, Report on the UGANDA BUSINESS REGISTER 2006/7, Kampala, www.ubos.org*
2) *Kampala Capital City Authority, 2012, Updating Kampala Structure Plan and Upgrading the Kampala GIS Unit , Final Report, Kampala, November 2012*
3) *Academy of Science, South Africa. Towards a Low Carbon City: Focus on Durban. Pretoria, South Africa: Academy of Science, South Africa, 2011.*
4) *C40, ICLEI, WRI, Global Protocol for Community-Scale Greenhouse gas Emissions (GPC), 2012.*
5) *Cities and Climate Change - Initial lessons from UN-HABITAT, UN Habitat, UN Habitat, Cities and Climate Change: Global Report on Human Settlements, 2011, Earthscan / UN HABITAT, 2011.*
6) *Lwasa S, and C. Kinuthia-Njenga, Reappraising Urban Planning and Urban Sustainability in East Africa, (2012).*

" Enhancing ecosystem services that offer co-benefits of mitigation that potentially link with adaptation"

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Hub Coordinator and contact

Shuaib Lwasa
Department of Geography, Geoinformatics and Climatic Sciences
School of Forestry, Environmental and Geographical Sciences, CAES
Makerere University
P.O Box 7062, Kampala
CHUSS Building, South Wing Ground Floor Room 12
Tel: +256 (0) 772461727
Alt: +256 (0) 702461727
Office: +256 (0414) 531261
Email: lwasa_s@caes.mak.ac.ug