ACC DAR
Adapting to Climate Change in Coastal Dar es Salaam

International Workshop

TOWARDS SCENARIOS FOR URBAN ADAPTATION PLANNING
Assessing seawater intrusion under climate and land cover changes in Dar es Salaam, Tanzania

Activity 2.1 Review: Development of Methods for Monitoring Changes in Peri-Urban Settlements

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Project Evaluation of Methods for Monitoring Change in Per-Urban Settlements (Activity 2.1)

Presentation Objective:

– Review of Activity 2.1 – Development of Methodologies for Monitoring Change in Peri-Urban Settlements of Dar Es Salaam

Terms of Reference for the Review:

– Critically read the working paper on Activity 2.1 and evaluate its content on the basis of the expected output specified in the project proposal

– Give comments and recommendations on improvement of the working paper on the results of Activity 2.1

Approach Adopted for the Review of Activity 2.1

1. Perusal through the Activity 2.1 report to build up an initial understanding of what the project is about.

2. Desk study of previous ACC Dar Project reports downloaded from the Project Website

3. Reading through the document to ascertain consistency and in the flow of ideas and concepts

4. Literature review of past and current related studies

5. Application of the knowledge gained to make general and specific comments on research quality and recommendations on how to improve the Activity 2.1 report

Understanding of the Project: Motivation for Project Activity 2.1

- In Climate change adaptation literature it is widely acknowledges that the assessment of vulnerability should be based on the analysis of the interaction of climatic, environmental, and human factors.

- Reducing vulnerability also means addressing its underlying drivers, which include, besides climate change effects, non-climatic factors that play an important role in determining impacts and shaping adaptive capacity.

- Need for contribution to vulnerability assessment through the enhancement of knowledge of the relationship between LCC and climate change vulnerability in coastal Dar es Salaam

Understanding of the Project: Basic Assumptions

- The study assumed that in the Dar es Salaam region:

    - Urban sprawl represents the major non-climatic factor influencing the vulnerability to climate change of people living in peri-urban areas.

    - The assessment of land cover changes over time is crucial to the preparation of adaptation measures by Local Authorities

    - Population growth is the major driver for urban sprawl, thus the need for the correlation between these two phenomena to be analysed and for the relationship linking them to be better understood

Assumptions: LCC and Vulnerability Assessment in Dar Es Salaam

LCC is a non-climatic driver of environmental change, and it influences climate change for three reasons:

1. Soil plays a role in carbon fluxes and greenhouse gas emissions;

2. The characteristics of land surfaces indirectly affect climate processes;

3. LCC can alter the vulnerability of ecosystems to climate change.

4. Dar es Salaam's coastal plain is intensely suffering from a particular kind of LCC, namely urban sprawl, characterized by low-density development at the urban fringe; a mixture of agricultural and urban land uses

Understanding: Expected Results of Activity 2.1

- Development and validation of a methodology for monitoring LC and application for studying the urban sprawl adapted to the needs of the Local Authorities in the Dar es Salaam region such that it is:

    - i) economical, in order to guarantee practicability for municipal services;

    - ii) simple, in order to allow for regular updating of land use information;

    - iii) quick to execute, in order to reveal the land cover changes in a very dynamic area

Understanding: Expected Outcomes of Activity 2.1

- Analysis of the urban development dynamics in the Dar es Salaam region over the last decade in order to assess the change patterns which prevailed, leading to either the densification or the sprawling of peri-urban areas.

- Opportunity for testing LCC indicators from the literature in order to select an easy-to-use indicator of urban sprawl to be adopted by municipal services for further assessment

Understanding the Project : Choice of Data

- ## Data requirements

  - LC classification only requires information about the reflected electromagnetic radiation (i.e. radiance)

  - LCC requires data about the planned and unplanned uses of territory, which are not always available

- Use of freely available data – Landsat data acquired in the period 1999-2011 from L5 and L7 sensors provided for free by the USGS

- 10 meter Pan SPOT imagery provided for free by the European Space Agency (ESA)

Understanding of the Project: Methodology

Approach:

1. Assessment of data sources and software for image analysis, and development of the methodology for semi-automatic LC classification;

2. Image acquisition and data analysis for the production of multi-temporal LC maps;

3. Validation of Land Cover maps (accuracy assessment);

4. Change assessment of built-up areas over time (urban sprawl);

5. Investigation of the links between LC and people's vulnerability to climate change

Understanding of the Project: Methodology

- Methodology for LC classification focused on urban development patterns – dense urban patterns (i.e. Continuously Built-up) and low-density development patterns (i.e. Discontinuously Built-up).

- Classification based on algorithms for a semi-automatic identification of materials that labelled image pixels according to the spectral characteristics of the covering materials (Richards & Jia, 2006).

- Use of Arc GIS 10 and ERDAS IMAGINE 2011 for LC classification and LC mapping

- Use of Plugin for QGIS to provide for software cost reduction

Understanding of the Project: Methodology

- Calculation of an indicator for providing a reliable tool for the assessment of urban sprawl over time.

- Population estimation method for the investigation of the links between LC and people's vulnerability to climate change, using integrated GIS spatial analysis of the LC classifications and a dataset of household locations drawn from a survey conducted in the coastal plain of Dar es Salaam in 2011.

- Evaluation of the reliability of the method that compares the 2002 estimates with the official GoT 2002 census data

Reviewers Opinion Based on Project Motivation

- Reading through Activity 2.1 report it is clear that the research output has met the overall project expectations (motivational) because it adds value to existing climate change vulnerability assessment methods in terms of:

    - Providing a simple method for detecting and mapping informal settlement expansion and rapid assessment of population expansion in rapidly expanding peri-urban settlements in a developing country

    - Giving accurate and timely information on spatial extent and nature of peri-urban settlement expansion - an important contribution to the assessment of non-climatic factors

    - The enhancement of knowledge of the relationship between population increase and LC in Dar es Salaam

Reviewers Opinion Based on Expected Results

- The Study called for the development of practical, simple yet economical method that could be used by Dar Es Salaam urban authorities to monitor change in peri-urban settlements.

    - It is the opinion of the reviewer that the method elaborated in Activity 2.1 paper fully satisfies the research ToR with regard to practicality, simplicity, affordability and scientific validation requirements

    - The method adopted also produced additional results (spin-offs) that clearly link LC to population expansion and thus allows City officials to obtain relatively accurate estimates of population expansion based on affordable Remote Sensing techniques

Reviewers Opinion on Adopted Methodology

- The researchers have clearly demonstrated the effectiveness of their approach for tracking urban development dynamics (urban sprawl and population expansion) in the Dar es Salaam region over the last decade using affordable remote sensing methods

- With respect to regional population assessment, the method is good at the city level but not as good for municipal level estimates. Nevertheless, a useful tool for estimating urban populations in large cities in between regular national census is now in place

- The study contributes to indirect testing of LCC indicators from the literature and it has demonstrated the utility of a particular urban sprawl indicator.

On Methodology: Effective-mess in demonstrating the link between LCC and vulnerability

- The study limits itself to the assessment of LC by affordable remote sensing techniques. The researchers have not demonstrated how LC can be used as the basis for assessing LCC. However, existing literature (e.g. Sliuzas et al 1998 and 2000) and Sliuzas (2004) PhD research on Urbanisation in Dar provide methods for effective LC and LCC assessment based on Remote Sensing data.

- The ability of the method developed to assess populations relatively accurately from LC assessments ultimately contributes to the efforts to develop methods for linking LCC and vulnerability

Reviewers Opinion on Methodology – Choice of Software

The reviewer accepts the researchers contention that the semi-automatic classification plugin for QGIS can satisfactorily replace commercial software for LC classification, making LC monitoring more affordable

However more case studies involving use of the Plugin and other available open-source GIS/RS software are required to create a body of knowledge and practical know how on effective use of such software tools.

Overall Assessment of the Research Output

- A methodology for land cover classification based on remote sensing and GIS technologies, was successfully developed and used to prepare Land Cover maps for years 2002, 2004, 2007, 2009, and 2011

- Successful assessment of LCC occurring in the Dar es Salaam region over the period 2002-2011, with a special focus on urban development dynamics observed through analysis of LC classifications

- Successful development of method for population and population spatial distribution estimation based on analysis of the correlation between population growth and urban sprawl

Overall Assessment: Data Choice and Methodology

- Choice of data sets for LC and LCC classification

    - Review of past literature on urban sprawl studies shows the usefulness of SFAP and ERS SAR data for predicting new informal settlements (Gorte, 1998, Sliuzas and Gorte 1998, Sliuzas and Brussels 1998; Sliuzas, Gorte and Mtalo, 2000). The researchers could have experimented with SFAP and ERS SAR data sets to support visual and automated classification

    - The IHHs distance-based field method for determining housing density samples is an innovative contribution to population estimates using RS methods. However arbitrary-ness in the determination of the orientation of house units (transect) could be improved by use of SFAP for selecting transect direction as well as dwellings that should be interviewed.

Reviewers Recommendations

- The researchers should consider the use of SFAP in the selection of IHHs in combination with use of random spatial location choice of housing clusters and direction of transects for field interview. In Park (2003) an undocumented approach using randomly generated spatial point-set was used in conjunction with Dodoma city satellite image to provide an unbiased method for selecting housing units to be included in the social economic survey and focus group selection.

- The assumption that average housing density remains constant needs to validated for the purpose of ensuring consistent population estimates from housing densities

Reviewers Recommendations: IHH's selection Method

Successful estimation of population density based on the distance between IHH's is based on the assumption that the choice of transect direction is unbiased. In reality if the direction of the transect is changed at any particular housing unit one should expect the distance between IHH's to change significantly.

The above argument is one more reason that SFAP should be considered in either systematic or random choice of the IHH's

In present strategy repeatability of the performance cannot be guaranteed due to the arbitrary–ness of the IHH's selection.

Reviewers Recommendations : Cloud cover treatment

- Reading through the report it is seen that most of the sample images used for illustration have high cloud cover. The researchers used an innovative masking technique to replace the clouded (and cloud shadow) patches with unclouded patches from other other images covering the same area. The researchers need to assess the validity and impact of using standard image classification algorithms to an image composed of such image patches on the accuracy of the assessment of LC.

- Possibly the researchers could consider applying classification separately to the image under the negative cloud mask (flipping the cloudy bits to 0 and the unclouded bits to 1) and the infill patches

Reviewers Recommendations: Use of Commercial and Open Source Software

- It is commendable that the researchers investigated the use of an open source plug-in for the open source QGIS use for LC and LCC classification. Both EDAS IMAGINE and ArcGIS 10.0 are, however, expensive commercial packages

- In the open-source market there are many excellent open source software for Remote Sensing and GIS such as Grass GIS 6.x, SPRING 4.x, and ILWIS 3.8.3 as well as R 15 for statistical data processing and analysis which are user friendly and completely free.

Reviewers Recommendations: Local Capacity Building

- The reviewer notes the commendable involvement of an ARU technician in the cartographic processing of the spatial data used in the study.

- However the project could have done more in terms of involving more ARU or other local researchers at undergraduate and postgraduate level in the area of scientific geo-spatial data processing and analysis. This is an area that the reviewer considers crucial to the support of multi-disciplinary environmental studies by Tanzanian public organisations and university researchers and lecturers.

Conclusion

- The Researchers set out to make a contribution to the development of methods for climate change vulnerability assessment in informal settlements in peri-urban Dar Es Salaam and they have developed methods and tools that are effective in providing knowledge to urban sprawl dynamics

- Reading through Activity 2.1 report it is clear that the research has achieved what was specified in the ToR in terms of the project objectives, expected outputs, proposed methodology and research project spin-offs

- Improvements to the project methodology and choice of data can significantly improve and extend the proposed approach into an effective urban sprawl monitoring system