Tackling urban challenges in sub-Saharan Africa through indicator-based Sustainability Assessment

Tjark GALL
Urban Framework, Germany/Malawi

This paper examines the scientific background and practical possibilities of indicator-based sustainability assessment in urban sub-Saharan Africa. The proposed method acts as a platform for site and project selections as well as an evaluation tool for existing approaches of different stakeholders. For the purpose of this paper the method examined will be applied in the context of Malawi.

1. Introduction

Fifty percent of the global population currently resides in cities. By 2050 it is expected that more than two-thirds will live in urban settlements. This growth will mostly occur in African countries. Today approximately one billion people live in Africa and it is anticipated to grow to more than four billion people by the end of the century, to make up more than one-third of the world's population. The United Nations expect twenty-eight (28) African countries to double their population by 2100 and ten (10) countries including Malawi, are expected to quintuple (United Nations 2015).

The rapid growth of the global urban population has steadily increased the importance of sustainability in urban planning. Many assessment methods and indices created for this purpose, use indicator systems to evaluate the sustainability of urban development and thus generate spatial and temporal comparisons. To date, most models have been created to describe existing city patterns and fabrics. An indicator-based approach on sustainable growth could further be used to evaluate urban development concepts prior to its implementation and make data-based changes accordingly. The main focus of this paper will be centered on these opportunities and their feasibility.

This paper includes a thorough analysis of existing approaches as well as the suggestion of a preliminary assessment framework. The paper starts with an overview of the theory and methods currently in use, providing a background to understand the proposed framework as well as the applied ways of selecting and aggregating indicators.

The paper aims to contribute to the discussion 'Envisaging Planning Theory and Practice for the next decades' by assessing social-spatial relations in existing settlements and proposing possible improvements through planned developments. Further, the indicator-based assessment the underlying basis for 'Urban Framework', a main project of our NGO, which aims to automatize several aspects of urban planning due to its rising complexity. This approach allows for new: data based and informed decisions, planning approaches, adaptable case-studies, generations of possible future developments while ensuring a sustainable, human-scale progress of urban agglomerations in sub-Saharan Africa.

2. Background

2.1 Theory of Sustainability

The paper is based on the theory of sustainability from the World Commission on Environmental Development, founded by the United Nations for the purpose of a better understanding of long-term sustainable development. The commission stated in its report "Our Common Future" the following explanation, which is even if not precise, unchanged in use until today and underlies all recent approaches for the sustainability assessment:

> 'Sustainable development is a development that meets the needs of the present without compromising the ability of future generations to meet their own needs' (WCED 1987).

While the sustainability aspect was initially applied only to the environmental dimension, it was extended over the years by Elkington to the Triple-Bottom-Line, including the economic and social dimension (Elkington 1998). Later the Quadruple-bottom-line was introduced by Teriman adding governance through its major contribution on every scale of sustainable development (Teriman et al. 2009). The latter is nowadays mostly used and underlies this paper as well, even if the dimensions are not divided or as strict anymore to avoid the occurrence of problems with multi-dimension indicators, which will be discussed later in this paper.

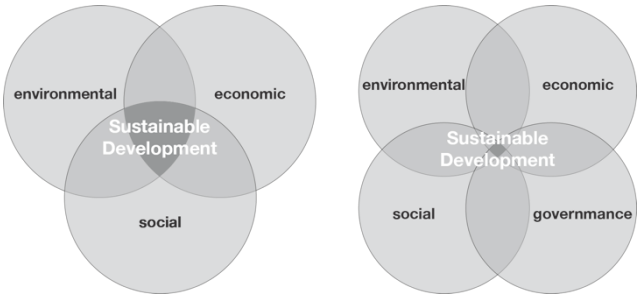


Figure 1: Left – Triple-Bottom-Line based on Elkington (1998); right – Quadruple-Bottom-Line based on Teriman (2009)

2.2 Assessing Urban Life-Quality

The leading prospect of the developed assessment system focuses on tackling urban challenges. These challenges ultimately start with the human populations living in urban agglomerations. The biggest impact urban planning can have on these populations is on a spatial scale. Regardless if it's through infrastructural projects or small-scale interventions they all affect the overall urban fabric in an acupunctural manner. Therefore, the primary goal is to assess Urban Life-Quality to measure the consequences that planning initiatives and/or projects can have on people's wellbeing. But assessing the wellbeing or social aspects in general, is always a challenge in itself. In the past, the Gross-Domestic-Product (GDP) was mostly used as an assessment indicator, but as pointed out by Richard Easterlin in the so-called 'Easterlin-Paradox', even if a growth of the personal income affects the life-quality of the individual, it has no effect on the general well-being of the country's inhabitants, which is even more relevant in sub-Saharan countries, where the gap between the poor and rich is much higher than in Western countries. The OECD (Organization for Economic Co-operation and Development) published the highly acknowledged paper 'How's life? Measuring well-being?' in 2011, covering most measurable aspects of the quality of life and is one of the

primary sources for social indicators (OECD 2015). Additionally, Maslow's hierarchy of needs is still a relevant tool to prioritize the different aspects and therefore acts as a base to organize the aggregation of the individual indicators, and further shows both the importance and influence of the urban fabric on the individual's life. The following figure is adapted to the studied field of social-spatial relations of urban development (Maslow 1943).

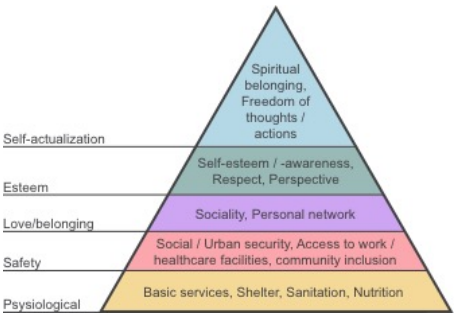


Figure 2: Maslow's hierarchy of needs, adapted to urban context (Maslow 1943; Gall 2016)

2.3 Assessment Frameworks

The developed assessment framework is based on several existing approaches and studies completed over the past 17 years. The 17 Sustainably Development Goals published by the General Committee of the United Nations, provide the aspired goals. The following six goals are directly connected to the proposed framework while the remaining 11 can be archived indirectly.

- Goal 3. Ensure healthy lives and promote well-being for all at all ages
- Goal 6. Ensure availability and sustainable management of water and sanitation for all
- Goal 7. Ensure access to affordable, reliable, sustainable and modern energy for all
- Goal 8. Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all
- Goal 9. Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation
- Goal 11. Make cities and human settlements inclusive, safe, resilient and sustainable (UN 2015)

Further, the various findings of UN-Habitat combine sustainable development with the field of Urban Planning and Design and name the three main aspects of (1) Gender/Youth/Human Rights/Climate Change, (2) Housing & Slum Upgrading, and (3) Urban Basic Services. Additional to the main driver of Urban Planning and Design, Urban Finance and Urban Legislation are two secondary involved fields and are important for sustainable development (UN Habitat 2015).

The BEQUEST Framework, developed in 2005 by Curwell provides a good overview of all themes and sub-themes of Urban Sustainability Assessment. It divides the sector in Development, Environmental & Societal Issues, the spatial level, and the time scale. The development activity is further divided into planning, property development, design, construction, and operation. The Environmental and Societal Issues use a slightly adapted version of the Quadruple-Bottom-Line sustainability dimensions (which will be discussed more in detail on the next page). The spatial level spreads from the global to material level, while the time scale uses three different time-frames, starting at short-term outcomes of less

than five years up to the long-term development of more than 20 years (Curwell et al. 2006, pp. 15–32). The sustainability dimensions as well as the time scale, is used in the same way, while the development activities and the spatial levels are adapted to a more specific assessment method. In 2014, the International Standardization Organization (ISO), aimed the first time to develop a standardized indicator set which could be used across every scale and context. The 17 proposed schematic themes of the ISO 37120 (Economy, Education, Energy, Environment, Recreation, Shelter, Solid waste, Telecommunications and innovation, Finance, Fire and emergency response, Governance, Health, Transportation, Urban Planning, Wastewater, and Water and Sanitation) provide another set of useful themes, which are integrated into the proposed framework (ISO 2014).

Lastly, the background theory of the application and evaluation of development initiatives is based on the approach of searching instead of planning from William Easterly, explained in his widely known publication of the development fields 'The White Man's Burden'. Additional to its various coverage of different scale aid projects, it concludes in the assumption, that large- scale planning rarely can fulfil its expectations and small-scale (grassroots) projects, combined into the term 'Searching' has a much better input-result-ratio. Further, he points out, that international organizations prefer to take action in areas, which sound better on paper. An example therefor is the preference of treating people's diseases instead of attempts to avoid the outbreaks in the beginning (Easterly 2007). Despite the influence on my personal decision, to reset my focus on the work more on the field instead of only staying in the research area, it lists endless well supported examples as to why a critical assessment of existing or planned projects in the development and aid sector, is fundamental in achieving better long-term effects. Therefore, it's crucial to evaluate projects before, during and after their execution on their actual results in comparison to the financial input and other resources spent.

2.4 Dimensions and Themes

As introduced in the Theory of Sustainability, the Quadruple-bottom-line divides sustainability into four dimensions or pillars. Even if they are still used in many contexts, it is not advisable anymore to differ between them due to the fact that many indicators affect several dimensions and therefore cause problems if only assigned to one. The United Nations introduced themes as a replacement for the pillars to cover cross-cutting issues and emphasize the multidimensional nature of sustainable development (United Nations 2007, p.10). In the proposed framework the dimensions remain but are detailed through the use of sub-themes and impacts as a way of better assessing particular fields and aspects of sustainable development.

2.5 Impacts

Indicator-based assessment always aims to study the impacts of a particular development field and compare it either spatially or temporally. Therefore, the developed framework must allow the prioritization of several aspects and needs to be adaptable to several effects. The impacts studied include amongst others the different dimensions of sustainability i.e. more specific issues like health care or infrastructural consequences on the social well-being of a planned development.

2.6 Scalability

Urban sustainability assessment of one urban agglomeration can be mainly executed on four different scales. The largest is city-wide, where districts (4 in Lilongwe) or areas (62 in Lilongwe) can be compared, otherwise a grid of 1 km x 1 km (depending on the examined topic) is applied to the whole city and therefore creates a grid as a comparison tool. The next scale is the district level, which again allows the comparison of areas; or the application of a grid of 1 km x 1 km or smaller. The second last scale is an area, which allows the comparison through either the included neighbourhoods or a grid of 100 m x 100 m. The neighbourhood scale is the most detailed, which can compare (if applicable) the existing blocks or even go down to the individual households level depending on data availability. The scale must always be chosen depending on the studied topic; for a general analysis of larger infrastructure development, a city-wide scale should be selected, whereas a project site in an informal settlement can be determined through the comparison of individual blocks or households in the selected area.

2.7 Distinction of Indicator-types

Based on the model of the Global City Indicator Facility indicators are divided into profile and performance indicators. The first mentioned are necessary for a general classification but are not considered in the grading/evaluation process, whereas performance indicators describe the performance of the examined area and thereby the impacts on the sustainability (GCIF 2011). Indicators can then be distinguished in core and secondary indicators. The core indicators give comprehensive information about the area and can be used regardless of the intended impact or chosen scale and dimension. Secondary indicators are additional indicator-sets, which allow the addition of more accurate information based on the studied field of sustainability (OECD 2015, p.21).

2.8 Aggregation

Aggregation is a necessary weighting procedure to combine various indicator values to a grouped result. It always needs to be adapted regarding the importance and reliability of the used data and the sought outcomes. The grouped indicator scores result in a composite index score. Three aggregation methods are normally used, regarding the grouped data and its specifications: summing up (linear aggregation), multiplying (geometric aggregation) or non-linear techniques (multi-criteria analysis) (Yigitcanlar & Dizdaroglu 2015, p.182). There are two different kinds of aggregation that depend on the analysed impact: the content-based and spatial aggregation. A spatial aggregation can be executed on different scales, while a content-based aggregation always concentrates on one or several subject themes (Grunwald & Kopfmueller 2006, p. 61).

2.9 Data Types and Availability

For a fully functional indicator-based assessment extensive datasets are essential, which in sub-Saharan Africa is even a bigger challenge than in Western regions. Therefore, it's important to choose the indicator set according to the data availability and adapt the aggregation to ensure missing information does not affect the results to a negative extent. Further, it can be differentiated between quantitative, semi-quantitative, and qualitative data. Quantitative data is mostly the central element of indicator systems and can always be shown in exact numbers. Examples are the population or the density. Questions for semi-quantitative data can always be answered with yes or no. Examples for this are the general

availability or access to electricity or public transport. Qualitative data is the most challenging because it can neither be shown in numbers nor as yes or no information. The results are described in words and can therefore just be used for the general assessment if they are simplified and aggregated. Furthermore, data can be distinguished in subjective and objective, whereas objective indicators are using information, which is gathered by organizations or official institutions and rely exclusively on measurable data. Subjective information is collected from a group of people which are providing their personal perspective on something, exemplary their content with a particular context. Even if this part seems to be quite theoretical, it is crucial for understanding the full sustainability assessment including the weighting of different indicators.

3. Developed Methods and Results

3.1 Possibilities of Application

There are various ways the developed assessment framework can be used in the urban planning field. However, I am concentrating one the two major area which it can be applied to. Several real projects and initiatives and therefore are detailed in the following pages:

- The assessment of the existing urban setting and the possibility of locating projects in areas which can archive the best results
- Assessment of development initiatives and their ability to archive the sought goals, as well as results and sustainability of the work from several local and international NGOs and governmental initiatives

3.2 Proposed Assessment Framework

Based on the previously explained theory of sustainability and the main principles of indicator-based assessment of urban development, the following framework was developed. It is divided into nine categories, starting with the general theme/dimension of the assessed field. The second column shows the sub-themes, mostly based on the ISO 37120. The third column shows the approach or method, through which the impacts/goals of the following column are tried to be archived. The impact is the major category for the aggregation because every sustainability assessment should start with the aimed impact. The next two columns situate the indicators in a spatial and time level, while the last three provide more information about the type of the indicator and used data. Each indicator can be assigned to one or several of the first six categories, while the last three require (with few exceptions) an absolute assignment.

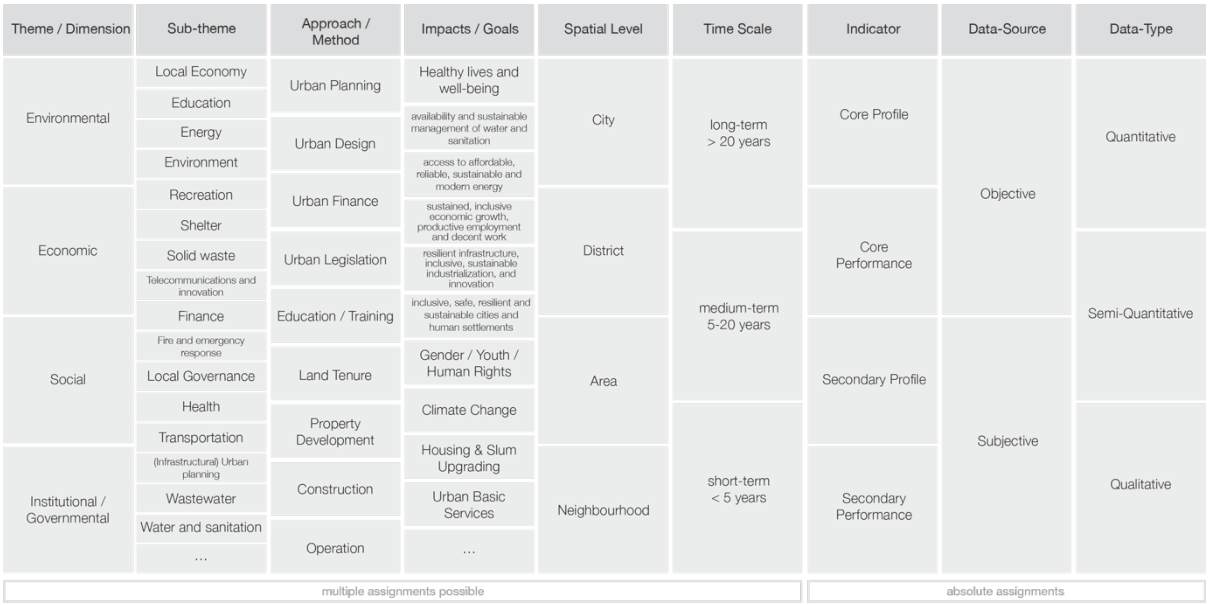


Figure 3: Assessment Framework based on several references and adapted to specific context (Gall 2016)

3.3 Indicator Sets

21 indicator frameworks and sets:

- Bossel (1999) : Indicators of sustainable development for different scales
- Hasan (1999) : List of key indicators
- Keirstead (2007) : UES indicators for London
- United Nations (2007) : CSD Indicators of Sustainable Development
- European Commission (2009) : EUROSTAT sustainable development indicators
- Salman & Qureshi (2009) : Selected indicators of urban regeneration
- UN-Habitat (2009) : Habitat Agenda Indicators
- Purevee (2010) : Sustainability assessment of Darkhan
- Yigitcanlar & Dur (2010) : Indicator System of the SILENT Model
- Alpopi et al. (2011) : Indicators for assessment of status of Romania
- Global City Indicator Facility (2011) : GCIF Profile Indicators
- Global City Indicator Facility (2011) : GCIF Performance Indicators
- Shen et al. (2011) : Compliance of practices with IUSIL
- Joburg (2011) : Proposed indicators for four outcomes
- Lynch et al. (2011) : Existing Indicator Database
- Lynch et al. (2011) : Sustainable Urban Development Indicator Matrix
- OECD (2015) : Indicators for measuring well-being
- CAPE PRC (2014) : Selected Urban Development Indicators, 1990–2013
- Saberifar & Falahat (2014) : Compact City Indicators
- UNEP (2014) : Core indicators
- Musakwa et al. (2015) : Indicators based on GIS / EO data

A total number of 1028 indicators were collected, some are similar and can be combined, while others cannot be applied to the context of sub-Saharan Africa. However, it still results in more than 500 indicators covering almost every measurable field of urban development that can be described by indicators. Each of these can be assigned to one or more fields of the developed framework. Following are four examples of various sets. The fourth indicator

only shows one exception, that some basic profile indicators are assigned to each category because of the general need for grading and aggregation based on, in this case, the density.

3.3.1 Indicator 1: Cost of the longest transit trip (Lynch et al. 2011)

Theme / Dimension	Economic | Social
Sub-theme	Transportation | Infrastructural Urban Planning
Approach / Method	Urban Planning | Operation
Impacts / Goals	Sustained, inclusive economic growth, productive employment and decent work | Resilient infrastructure, inclusive, sustainable industrialization, and innovation | Urban Basic Services
Spatial Level	City
Time Scale	Long-term | Medium-term | Short-term
Indicator-Type	Primary-Performance | Secondary-Performance
Data-Source	Objective
Data-Type	Quantitative

3.3.2 Indicator 2: Quality of life (Keirstead 2007)

Theme / Dimension	Social
Sub-theme	Recreation | Shelter | Health | …
Approach / Method	all approaches / methods
Impacts / Goals	Healthy lives and well-being | Gender / Youth / Human Rights
Spatial Level	City | District | Area | Neighbourhood
Time Scale	Short-term
Indicator-Type	Primary Performance | Secondary Performance
Data-Source	Subjective
Data-Type	Qualitative

3.3.3 Indicator 3: Number of noise complaints (Salam & Qureshi 2009)

Theme / Dimension	Environmental | Social
Sub-theme	Environment | Recreation | Health
Approach / Method	Urban Planning | Construction | Operation
Impacts / Goals	Healthy lives and well-being
Spatial Level	City | District | Area | Neighbourhood
Time Scale	Short-term
Indicator-Type	Primary-Performance | Secondary-Performance
Data-Source	Subjective
Data-Type	Quantitative

3.3.4 *Indicator 4: Number of inhabitants per km^2 (Shen et al. 2011)*

Theme / Dimension	all themes / dimensions (primary profile indicators are in general important for each category)
Sub-theme	all sub-themes
Approach / Method	all approaches / methods
Impacts / Goals	all impacts / goals
Spatial Level	all spatial level
Time Scale	all time scales
Indicator-Type	Primary Profile
Data-Source	Objective
Data-Type	Quantitative

However, there is a need for secondary performance indicators of the financial and resource field, which can be used to compare the improvement of the urban fabric to the invested resources. The most important indicators would be:

- financial resources invested (project cost, running costs, …)
- human resources (local / international)
- total time spend
- assurance of lasting and scaling effect on involved stakeholders
- installation of evaluation methods
- development of long-term controlling methods

4. Scenarios for Application

In the last part, I discuss two possible ways of applications of indicator-based sustainability assessment. The first is for locating the site with best results and consequences on the surrounding urban fabric, while the second functions as an evaluation and grading system of planned and completed projects. Both scenarios start with the selection of several fields in the framework which best cover the aspired outcomes. These selections result in an indicator set and an automated assessment process adapted to the available information. Due to the extent of this paper, one is described shortly, while the second is covered more in detail including sample indicators.

4.1 Scenario 1: Evaluation of project after completion / 1 year / 5 years / …

A donor organization wants to evaluate its recently financed projects in the urban development field to improve their investment-outcome-ratio. Their objectives are the decrease of negative environmental effects and the increase of electricity and water supply. The methods of funded projects concentrated on education/training and construction and aims for the availability and sustainable management of water and sanitation, as well as the access to affordable, reliable, sustainable and modern energy. The spatial level is the whole city, while their projects are based on medium-term development. Due to the fact that they want to involve the subjective opinions of the city's inhabitants, all kinds of data are included. This particular scenario would result in the following framework:

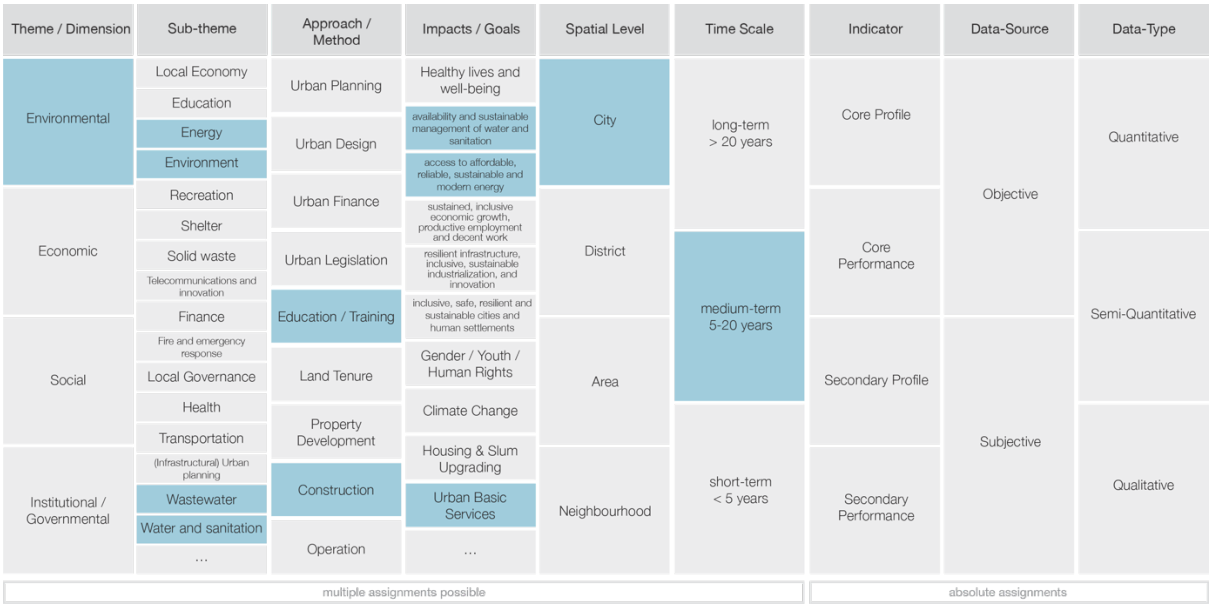


Figure 5: Assessment Framework adapted to Scenario 1 (Gall 2016)

4.2 Scenario 2: Organization / company searching for best location / topic for project

An NGO wants to start a project in the largest informal settlement of Lilongwe, Malawi. The main ambition is to tackle the social dimension, in particular, the shelter issue. Their aim is to reach an improvement through Urban Design and Education/Training and aim for Housing and Slum upgrading. Due to the challenge of data availability, they concentrate only on objective data to avoid negative effects on the concluding spatial grading. These decisions result in the following adapted framework.

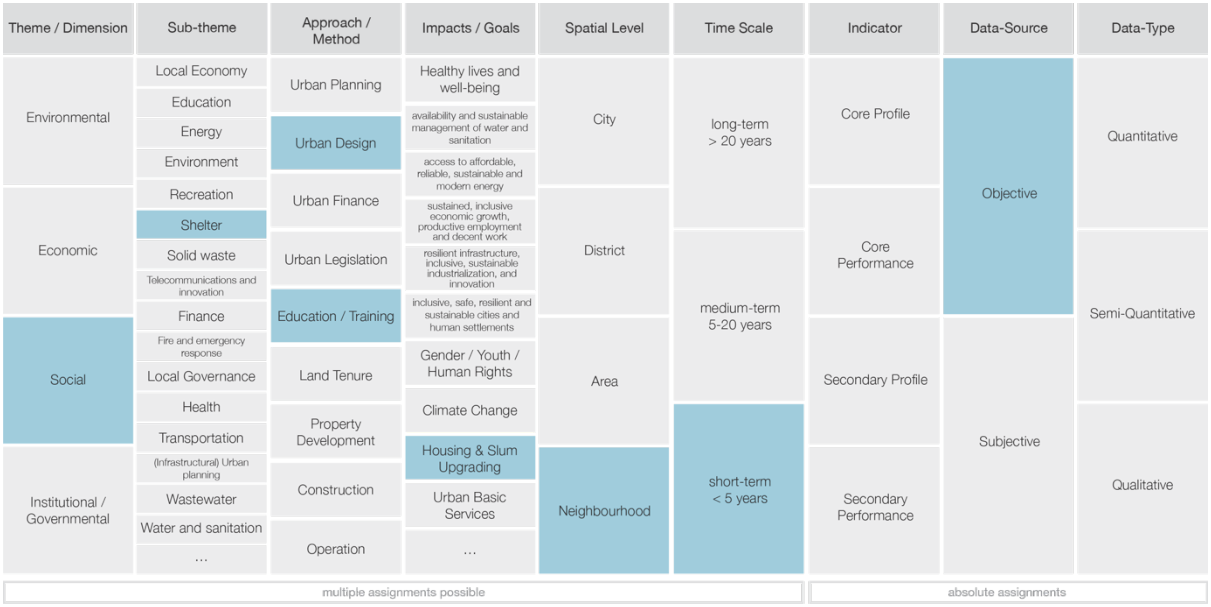
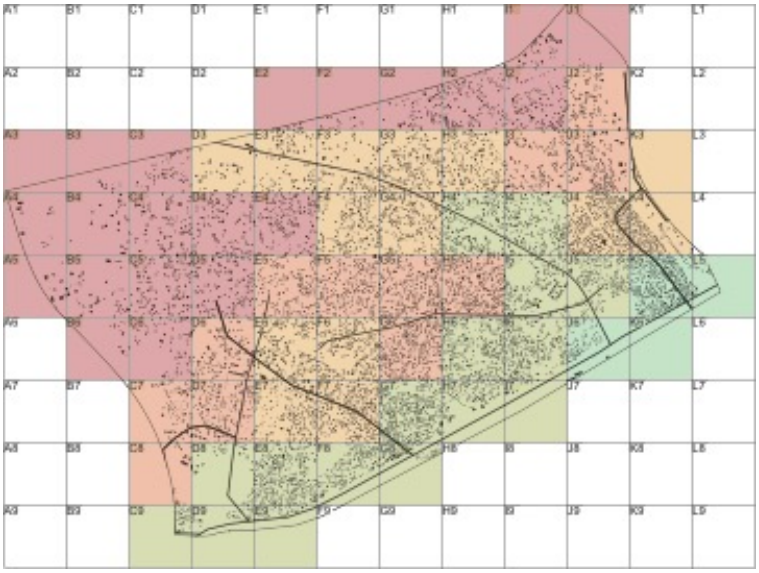


Figure 5: Assessment Framework adapted to Scenario 2 (Gall 2016)

List of sample indicators:

Core profile indicators	Population (by gender / age)
	Percentage of House Owners
	Density
	Average plot site
	Floor area per person
	Household size
	Automobile ownership
	Road length
	…
Core performance indicators	Distance to public transport / market / healthcare / recreational areas (in meter)
	Commute to school / work (in min.)
	Rent / Income ratio
	Permanent structures (in %)
	Quality of built structures (aggregated through floor type, wall and roofing materials)
	Access to water (defined through quality, daily period, minutes to access-point, stability)
	Access to electricity (in %)
	Access to private basic sanitation facilities (in %)
	Commonness and quality of solid waste management (aggregated through various factors)
	Housing affordability rate (aggregated through income, land-, construction, maintenance-cost, mortgage to credit ratio, …)
	…

Exemplary application in Area 58, Lilongwe, with 100 x 100 m grid, showing the distances to public transport / market / healthcare / recreational areas



5. Conclusion

Indicator-based sustainability assessment as a way of tackling urban challenges in Malawi in particular, and sub-Saharan Africa in general, can support the decision-making processes of all involved stakeholders in many beneficial ways. Even if urban development decisions always need to be adapted to the country and site-specific conditions, the challenge of social housing and rapid urbanization is comparable in many locations around the world and specifically in sub-Saharan Africa. Therefore, the methods and results of this paper can function similar in other places and are applicable in various situations, even more through the ease of adapting and re-selecting performance indicators and more site-specific target values. However, the system does not function productively in practice yet through several factors. Highlighting the importance of re-evaluating the framework and system on a regular basis. First and foremost, it needs to be applied on a larger scale with as many data inputs and indicators as possible to identify possible challenges and develop an aggregation system which best reflects the actual urban fabric. Further, the lack of data is a major challenge, which needs to be addressed through more and various ways of input, including governmental institutions, international organizations, universities, and community involvement. Without enough data provided on a regular basis, it is impossible to use indicator-based assessment on a viable scale. Another issue is the extent and complexity of data and its assignment to geographical features which can be best archived through a full integration of GIS-systems. Even if most governments work already with GIS-data, it is still not common on a large scale, which is crucial for an easier application of the proposed framework. In the long term, we are aiming for a fully covered and regularly updated GIS databank which automatically includes all existing spatially assigned data from various sources. Without this basis, the shown application will probably always remain exemplary or will just be executed on small scale assignments which unfortunately reduces the viability of the whole approach. However, through more work on the topic, a better involvement of all stakeholders and the advancing utilization of technical opportunities, indicator-based sustainability assessment can contribute an important part to urban development and assist and automate many decisions through better visualization, comparison and generally better-informed decisions.

References

Alpopi, C., Manole, C. and Colesca, S.E. (2011) "Assessment of the sustainable urban development level through the use of indicators of sustainability", Theoretical and Empirical Researches in Urban Management, Vol. 6 No. 2, pp.78–87. [pdf] Available at: http://www.um.ase.ro/no62/6.pdf [Accessed 20 June 2016].

Bossel, H. (1999). Indicators for Sustainable Development: Theory, Method, Applications – A Report to the Balaton Group, Winnipeg: International Institute for Sustainable Development.

CAPE PRC (2014). Sector Assessment: Urban Development. [pdf] Available at: https://www.adb.org/sites/default/files/linked-documents/CAPE-PRC-LD9d-Urban-Dev.pdf [Accessed 20 June 2016].

City of Johannesburg Metropolitan Municipality (2011). Joburg 2040. Growth and Development Strategy. [pdf] Available at: http://www.nature.com/doifinder/10.1038/nphoton.2007.125 [Accessed 20 June 2016].

Curwell, S., Deakin, M. and Symes, M. eds. (2006). Sustainable Urban Development Volume 1. The Framework and Protocols for Environmental Assessment, London & New York: Routledge, pp. 15–32.

Department of Economic and Social Affairs, Population Affairs (2015) World Population Prospects: Key findings & advanced tables. United Nations. New York. [pdf] Available at: https://esa.un.org/unpd/wpp/publications/files/key_findings_wpp_2015.pdf [Accessed 20 June 2016].

Easterly, William (2007) The white man's burden, Why the West's efforts to aid the rest have done so much ill and so little good. 1st ed. London: Penguin Books.

European Commission (2009). Sustainable Development Indicators: Overview of relevant FP-funded research and identification of further needs. [pdf] Available at: http://www.ieep.eu/assets/443/sdi_review.pdf [Accessed 20 June 2016].

Global City Indicator Facility (2011). Global City Indicators. [pdf] Available at: http://www.cityindicators.org/Deliverables/Core%20and%20Supporting%20Indicators%20Table%20SEPTEMBER%202011.pdf [Accessed 20 June 2016].

Grunwald and Kopfmueller (2006). Nachhaltigkeit. p. 61. 1st ed. Frankfurt, New York: Campus Verlag.

Hasan, S. (2002). Literature Review of Poverty and Urban Development Indicators, pp.1–43. [pdf] Available at: http://www.ucl.ac.uk/dpu-projects/21st_Century/freedom/Pov_Urb_Dev_Indicators.pdf [Accessed 20 June 2016].

ISO (2014). ISO 37120 briefing note: the first ISO International Standard on city indicators Sustainable. [pdf] Available at: http://www.iso.org/iso/37120_briefing_note.pdf [Accessed 20 June 2016].

Keirstead J. (2007). Selecting sustainability indicators for urban energy systems, International Conference on Whole Life Urban Sustainability and its Assessment, Glasgow Caledonian University, pp.1–20. [pdf] Available at: http://www3.imperial.ac.uk/pls/portallive/docs/1/24289696.PDF [Accessed 20 June 2016]

Lynch, A.J. et al. (2011) Sustainable Development Indicators for the United States. [pdf] Available at: http://penniur.upenn.edu/uploads/media/sustainable-urban-development-indicators-for-the-united-states.pdf [Accessed 20 June 2016].

Mainguy, G. et al. (2012) Framework Elements for Assessing Urban Environmental Performance. United Nations Environment Programme. [pdf] Available at: http://www.unep.org/resourceefficiency/Portals/24147/scp/REC/UNEP%20framework%20report%2048pp.pdf [Accessed at: 20 June 2016].

Maslow, A.H. (1943). "A Theory of Human Motivation", Psychological Review, Vol. 50, pp.370–396.

Musakwa, W. and Van Niekerk, A. (2015). "Monitoring sustainable urban development using built-up area indicators: a case study of Stellenbosch, South Africa", Environment, Development and Sustainability, Vol. 17 No. 3, pp.1–20. [pdf] Available at: http://link.springer.com/10.1007/s10668-014-9560-7 [Accessed 20 June 2016].

OECD (2015). How’s Life?: Measuring Well-being, Paris: OECD Publishing. [pdf] Available at: http://www.oecd.org/statistics/how-s-life-23089679.htm [Accessed 20 June 2016]

Purevee, S. (2010). Sustainability Assessment of Urban Land-use Systems: Evaluation Impact Indicators of Darkhan. UNU-Land Restoration Training Programme, p.47. [pdf] Available at: http://www.unulrt.is/static/fellows/document/unu-lrt_2010_sodgerel-purevee.pdf [Accessed 20 June 2016].

Saberifar, R. and Falahat, M. (2014) "Assessment of Urban Development Plans Affecting on the West Central Area of the City of Mashhad by Compact City Approach", Journal of Novel Applied Sciences, Vol. 3 No. 10, pp.1167–1174. [pdf] Available at: http://www.unulrt.is/static/fellows/document/unu-lrt_2010_sodgerel-purevee.pdf [Accessed 20 June 2016]

Salman, A. and Qureshi, S. (2009). Indicators of sustainable urban development: A review of urban regeneration projects in Karachi, Pakistan. [pdf] Available at: http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.536.2743&rep=rep1&type=pdf [Accessed 20 June 2016]

Shen, L.-Y. et al. (2011). "The application of urban sustainability indicators – A comparison between various practices", Habitat International, Vol. 35 No. 1, pp.17–29. [pdf] Available at: http://linkinghub.elsevier.com/retrieve/pii/S0197397510000263. [Accessed 20 June 2016].

Teriman, S., Yigitcanlar, T. and Mayere, S. (2009). Sustainable urban development: a quadruple bottom line assessment framework. In The Second Infrastructure Theme Postgraduate Conference : Conference Proceedings,. Brisbane: Queensland University of Technology, pp. 1–12.

UN-Habitat (2009). Urban Indicators Guidelines - “Better Information, Better Cities”: Monitoring the Habitat Agenda and The Millennium Development Goals-Slum Target. (July), p.47. [pdf] Available at: http://www.who.int/kobe_centre/publications/urban_ indicators_unhabitat/en/ [Accessed 20 June 2016],

UN-Habitat (2015). Housing at the Centre of the New Urban Agenda. Nairobi. [pdf] Available at: http://unhabitat.org/housing-at-the-centre-of-the-new-urban-agenda/ [Accessed 20 June 2016]

United Nations (2007). Indicators of Sustainable Development: Guidelines and Methodologies 3rd ed. New York. [pdf] Available at: http://www.un.org/esa/sustdev/natlinfo/indicators/ guidelines.pdf [Accessed 20 June 2016].

United Nations (2015). Transforming our world: the 2030 Agenda for Sustainable Development. 69th General Assembly. [online] Sustainable Development. Available at: https://sustainabledevelopment.un.org/post2015/transformingourworld [Accessed 20 June 2016.

WCED (1987). Report of the World Commission on Environment and Development: Our Common Future. [pdf] Available at: http://www.un-documents.net/our-common-future.pdf [Accessed 20 June 2016].

Yigitcanlar, T. and Dizdaroglu, D. (2015). Ecological approaches in planning for sustainable cities. A review of the literature. Global J. Environmental Science Management, pp.159–188. [pdf] Available at: http://www.gjesm.net/article_10773_e831ed6bc19da0015298d8cb048883cd.pdf [Accessed 20 June 2016].

Yigitcanlar, T. and Dur, F. (2010). "Developing a Sustainability Assessment Model: The Sustainable Infrastructure, Land-Use, Environment and Transport Model", Sustainability Vol. 2 No. 1. pp. 321–340. [pdf] Available at: http://www.mdpi.com/2071-1050/2/1/321 [Accessed 20 June 2016]