SYNERGISTIC INTERVENTIONS FOR SUSTAINABILITY IMPROVEMENT

J. Gibberd, itshose@gmail.com

Abstract

The International Panel on Climate Change (IPCC) indicates that 'multiple synergies will be required to achieve the goals of sustainable development, including climate adaptation and mitigation, poverty eradication and reducing inequalities'. This paper explores what 'multiple synergies' may mean for neighbourhoods. Sustainability analysis of an existing neighbourhood in Pretoria, South Africa is undertaken using the Built Environment Sustainability Tool (BEST). This is used as the basis to propose, and test, interventions. These interventions are evaluated using the BEST to understand their impact and ascertain whether they support multiple 'multiple synergies'. The study finds that the interventions identified and tested created multiple impacts across several areas, which can be regarded as synergistic. These synergistic interventions are analysed to understand these in more detail and identify their characteristics and commonalities. The paper contributes to an understanding of how 'multiple synergies required to achieve goals of sustainable development and climate change and adaptation' can be derived in built environments and neighbourhoods.

Keywords: BEST, built environment, neighbourhoods, sustainability tool, synergistic

INTRODUCTION

Developing countries are experiencing multiple challenges that must be simultaneously addressed. On one hand, they have to achieve global environmental commitments on issues such as responding to climate change and biodiversity and on the other hand, having to address urgent local, social and economic development priorities linked to education, health, employment and infrastructure backlogs. Increasing the exposure of vulnerable communities to climate change and associated natural disasters mean that time frames are limited and Butler (2014) estimates that a window of just three decades remains to build the adaptive capacity required to cope with projected climate change impacts.

The IPCC proposes place-specific climate change adaptation pathways as a means of addressing this situation (Roy, *et al.* 2018). These pathways should include a diversity of options based on people's values. Structured, inclusive and participatory methodologies are needed to identify 'synergistic and transformative strategies' that maximise climate change and sustainable development impacts (Butler, 2014). Sustainable development challenges must be met while by-passing environmental impacts. Butler describes this approach as 'leap-frogging the Sustainable Development Goals' and proposes the following principles:

- Climate change must not be addressed in isolation but needs to be considered as a part of a dynamic social and ecological system.
- Climate change adaptation needs to recognise competing values and goals of different stakeholders and negotiate shared solutions.
- Proposed systems must span spatial scales, jurisdictional levels and sectors.
- Planning processes must design and implement approaches which tackle systemic causes of disadvantage.

This paper explores what a synergistic, leapfrogging approach may mean for built environments. In particular, it develops a methodology that can be used to explore and analyse synergistic interventions for a neighbourhood. Proposed interventions are critically analysed to ascertain whether these may achieve the 'multiple synergies' referred to by the IPCC. The study finds that some of the interventions identified appear to meet the requirements set out by the IPCC and proceeds to identify characteristics and commonalities of these types of intervention.

METHODOLOGY

The methodology for the study is as follows. First, the Sustainable Development Goals and climate change targets are introduced. This is followed by a description of the case study neighbourhood and the Built Environment Sustainability Tool (BEST).

The assessment process using the BEST is then described and the tool applied to assess the case study neighbourhood and ascertain 'Existing' sustainability performance. The results of this assessment are used to identify interventions for sustainability improvement, and these are described. This leads to the second BEST assessment that takes into account the proposed interventions to reflect the performance of a 'Proposed' neighbourhood.

The results of these assessments are analysed and discussed to develop conclusions and recommendations for the paper. These reflect on the Sustainable Development Goals, climate change targets, the BEST, the case study neighbourhood, the proposed interventions and IPCC's proposed 'multiple synergy' solutions.

Sustainable Development Goals

The Sustainable Development Goals (SDGs) are goals developed by the United Nations to supersede the Millennium Development Goals, which expired at the end of 2015 (United Nations, 2015). UN member countries are expected to adopt the Sustainable Development Goals and use them to guide the development of national targets, policy and strategy. Table 1 lists the SDGs.

Table 1: *The Sustainable Development Goals* (United Nations, 2015).

Goal 1. End poverty in all its forms everywhere
Goal 2. End hunger, achieve food security and improved nutrition and promote sustainable agriculture
Goal 3. Ensure healthy lives and promote wellbeing for all at all ages
Goal 4. Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all
Goal 5. Achieve gender equality and empower all women and girls
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 industrialisation and foster innovation

Goal 10. Reduce inequality within and among countries

Goal 11. Make cities and human settlements inclusive, safe, resilient and sustainable

Goal 12. Ensure sustainable consumption and production patterns

Goal 13. Take urgent action to combat climate change and its impacts

Goal 14. Conserve and sustainably use the oceans, seas and marine resources for sustainable development

Goal 15. Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss

Goal 16. Promote peaceful and inclusive societies for sustainable development, provide access to justice for all and build effective, accountable and inclusive institutions at all levels

Goal 17. Strengthen the means of implementation and revitalize the Global Partnership for Sustainable Development.

Climate Change Targets

Goal 13 of the Sustainable Development Goals is addressed by the United Nations Framework Convention on Climate Change through international agreements. An example of this is COP21, also known as the Paris Agreement (UNFCC, 2015). This agreement aims to ensure that greenhouse gas emissions are reduced to a level that will limit global average temperatures to a rise of below 2^0C, compared to pre-industrial levels (UNFCC, 2015).

This target was determined as temperature increases of over 2^0C were regarded as likely to result in climate change that would be highly dangerous for life on earth. The agreement requires countries to set emission targets and ensure that these are achieved. Significant funding has been made available to developing countries to help reduce their emissions (UNFCC, 2015).

Case Study Neighbourhood

The case study neighbourhood is Groenkloof in Pretoria (-25° 46' 30.39" S 28° 13' 4.65" E) and is shown in Figure 1.

Figure 1: Case study neighbourhood: Groenkloof, Pretoria, South Africa.

The neighbourhood largely consists of houses between 200-400 m^2 on sites of around 1,000 m^2 (indicated in blue). One side of the neighbourhood abuts a fenced municipal park and the other sides have busy roads. Businesses line these busy roads and are located one site deep (indicated in red). There is a small shopping centre with offices, restaurants, hardware, grocery, supermarket, linen, pet food, pharmacy and butchery retail (indicated in yellow). In the south of the neighbourhood, there is a park and fenced wild area (indicated in green). This neighbourhood was identified as it represented a middle-class neighbourhood in a South African city and data on the site was readily available.

Built Environment Sustainability Tool

The Built Environment Sustainability Tool (BEST) was developed by the author as a tool for assessing the sustainability of neighbourhoods (Gibberd, 2014; 2020). It includes a facility in which the impact of interventions can be tested to understand their potential impact. This supports decision-making and the development of plans to integrate and address sustainability in neighbourhoods. Figure 2 shows the tool and assessment criteria.
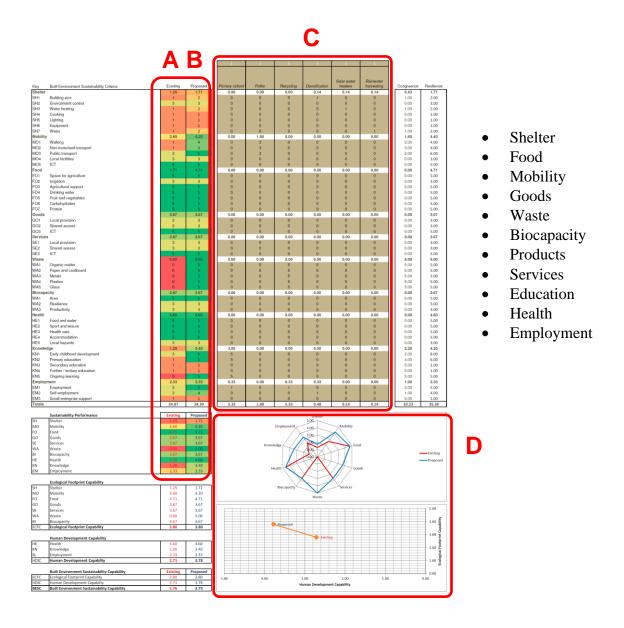
- Shelter
- Food
- Mobility
- Goods
- Waste
- Biocapacity
- Products
- Services
- Education
- Health
- Employment

Figure 2: Built Environment Sustainability Tool and assessment criteria (Gibberd, 2014
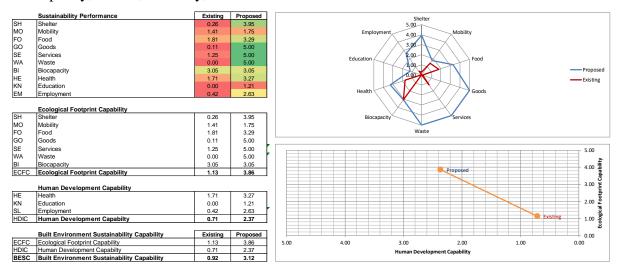
The 'Existing' column (A) is used to report on the performance of an existing neighbourhood or design of a new neighbourhood. Column C is used to test up to six interventions that have been identified to improve sustainability. Performance of interventions is reflected in column B (the 'Proposed' performance). The colours of the 'Existing' and 'Proposed' columns reflect performance, with high scores being reflected as a green and a low score as a red. The tool includes two graphs that show the impact of the interventions (D). In the spider diagram, the red line indicates the existing performance and the blue, the proposed performance. Similarly, in the line graph, the red text represents 'Existing' and blue text 'Proposed' performance. Comparing the columns in A and B and reviewing the graphs in D can be used to understand the impacts of different interventions on the overall sustainability performance of the neighbourhood.

RESULTS

Existing Neighbourhood Performance

The assessment of the existing neighbourhood is shown in Figure 3 (red line). This indicates that built environment sustainability capability is 0.92 and is low. Performance is particularly

low in the following areas: Shelter, Goods, Waste, Education and Employment. Scores in Biocapacity, Health, Mobility, Services and Food are better.

Sustainability Performance		Existing	Proposed
SH	Shelter	0.26	3.95
MO	Mobility	1.41	1.75
FO	Food	1.81	3.29
GO	Goods	0.11	5.00
SE	Services	1.25	5.00
WA	Waste	0.00	5.00
BI	Biocapacity	3.05	3.05
HE	Health	1.71	3.27
KN	Education	0.00	1.21
EM	Employment	0.42	2.63

Ecological Footprint Capability			
SH	Shelter	0.26	3.95
MO	Mobility	1.41	1.75
FO	Food	1.81	3.29
GO	Goods	0.11	5.00
SE	Services	1.25	5.00
WA	Waste	0.00	5.00
BI	Biocapacity	3.05	3.05
ECFC	Ecological Footprint Capability	1.13	3.86

Human Development Capability			
HE	Health	1.71	3.27
KN	Education	0.00	1.21
SL	Employment	0.42	2.63
HDIC	Human Development Capabilty	0.71	2.37

Built Environment Sustainability Capability		Existing	Proposed
ECFC	Ecological Footprint Capability	1.13	3.86
HDIC	Human Development Capabilty	0.71	2.37
BESC	Built Environment Sustainability Capability	0.92	3.12

Figure 2: The BEST report for the case study neighbourhood showing 'Existing' and 'Proposed' performance.

Proposed Interventions

An analysis of an existing situation, 'Existing', can be used to identify weakness in current performance and propose interventions. These interventions aim to improve the Built Environment Sustainability Capability of the neighbourhood and therefore support the achievement of the Sustainable Development Goals and climate change targets. These proposed interventions are described below.

Intervention 1: Education Hub

This intervention proposes an education hub that includes the following components and number of learner places: Early Childhood Development (60), Primary School (420), Secondary School (300) and an Adult Education facility (150). School infrastructure would be designed to be multi-use and so would accommodate adult learning in the evening and at weekends. The Education Hub would be located at A. in Figure 1 and use up some of the existing park.

Intervention 2: Food Hub

The Food Hub consists of intensive vegetable gardens and a food market that would be managed by small enterprises. The market would sell locally produced vegetables as well as affordable locally grown low ecological footprint food. It would be located at B in Figure 1 and would take up a portion of the existing park.

Intervention 3: Work Densification

Work Densification would consist of demolishing some existing work units in a block indicated as C in Figure 1 on the site and replacing these with higher density work units to meet the BEST density criteria. A condition of the new development would be the inclusion of affordable units to meet the BEST affordability criteria and the addition of businesses that meet BEST criteria in the area of affordable Goods, Services and Health. This proactive targeting of specific business types and facilities that are required in the neighbourhood to meet sustainability criteria is referred to as 'conditional development'. New facilities would also be designed and managed to meet all of the BEST Shelter criteria.

Intervention 4: Residential Densification

The residential densification intervention would demolish a block of existing low-density residential units in location D and replace this with high-density housing that met BEST criteria for density and sustainability performance. New accommodation would be designed and managed to meet all of the BEST Shelter criteria. The accommodation would be highly serviced and provide facilities for self-employed people so would also contribute to local employment and enterprise development.

Intervention 5: Energy Microgrid

This intervention would promote building energy-efficiency measures and develop a local microgrid based on photovoltaic systems installed on roof spaces, battery banks and a local power network so that all buildings would have access to renewable energy. It would also include solar hot water systems so that all buildings had water heated from solar energy. These systems and the grid would be managed and maintained by small enterprises and building owners would be paid rent for the use of space used by renewable systems. Electricity and hot water consumption from these systems would be metered and charged for, to create a resilient self-financing system. Research in 2019 indicated that energy costs to users for systems like this could be the same or only slightly higher than costs charged by the municipality (Gibberd, 2019). It also showed that the revenue generated by these systems could employ between 10 and 20 people per 1,000 occupants in a mixed-use neighbourhood. The intervention would cover all the existing buildings in the neighbourhood as well as new buildings constructed as part of the Residential and Work Densification and the Education and Food Hub interventions.

Intervention 6: Recycling Scheme

This intervention would develop recycling depots at the two retail centres in the neighbourhood. There would also be a wide-scale programme to ensure that all existing and new buildings recycled all of their waste. Recycling systems would be managed by small enterprises and revenue from the recycling material would be used to sustain the system and enterprises. Gibberd (2019) shows that the waste disposal costs, combined with the revenue from recycled materials, could employ between 10 and 20 people per 1,000 occupants in a mixed-use neighbourhood.

Proposed Neighbourhood performance

A review of the 'Proposed' column and graphs in the BEST report shown in Figure 3 indicates that the proposed interventions have been able to improve the Built Environment Sustainability Capability of the neighbourhood from 0.92 for 'Existing' to 3.12 for 'Proposed'. In particular, significant improvements have been made in the areas of Goods, Service, Waste and Health. Improvements in other areas are smaller and in some areas such as Shelter, Mobility and Biocapacity, are negligible.

Impact of Synergistic Interventions

An analysis of the BEST results can be used to calculate the individual contributions of each intervention to the improved Built Environment Sustainability Capability found in the 'Existing' performance. These are shown in Table 2.

Table 2: Impacts of synergistic interventions on BEST performance.

Synergistic Interventions	Number of BEST Areas impacted	Contribution to the Built Environment

		Sustainability Capability improvement (%)
Education Hub	6	6
Food Hub	4	6
Work Densification	8	38
Residential Densification	6	19
Energy Microgrid	2	14
Recycling Scheme	2	18

Table 2 shows that Work Densification impacts 8 of the BEST areas and contributes to 38% of the sustainability capability improvement. The Recycling Scheme, Energy Microgrid and Residential Densification make between 10 and 20% contribution to improved sustainability capability performance. The Education and Food Hub intervention make the lowest contribution to sustainability capability improvement at around 6%.

DISCUSSION

The following questions can be used to discuss the methodology and results. Firstly, is the BEST methodology and tool a suitable way of measuring capacity or capability for achieving Sustainable Development Goals and climate change targets? Secondly, does the tool provide a useful methodology for identifying place-specific interventions? Thirdly, what insights do the results offer in terms of identifying high impact synergistic interventions?

Progress towards achieving Sustainable Development Goals

To ascertain whether the BEST methodology and tool are a suitable way of measuring capacity and capabilities for achieving the Sustainable Development Goals, these can be mapped to BEST criteria. This is shown in Table 3.

Table 3: *Alignment between BEST criteria and the Sustainable Development Goals.*

BEST Criteria	Sustainable Development Goals
Shelter	1, 3, 6, 7, 10, 11, 13, 15
Mobility	1, 3, 10, 11, 13, 16
Food	1, 2, 3, 8, 9, 10, 11, 12, 13, 15
Goods	1, 8, 9, 10, 11, 12, 13, 15
Services	8, 9, 10, 11, 13
Waste	11, 12, 13
Biocapacity	11, 13, 15, 16
Health	1, 2, 3, 10, 11, 13
Knowledge	1, 10, 11, 13, 16
Employment	1, 4, 8, 10, 11, 13, 16

Table 3 shows that all of the SDGs are addressed by BEST criteria other than SDG 5 ("Achieve gender equality and empower all women and girls"), SDG 14 ("Conserve and sustainably use the oceans, seas and marine resources for sustainable development") and SDG 17 ("Strengthen the means of implementation and revitalize the Global Partnership for Sustainable Development"). This analysis suggests that the BEST criteria provide a good indication of the extent to which the characteristics and facilities within a neighbourhood support the achievement of the Sustainable Development Goals.

A review of the alignment between BEST criteria and SDG 13 ("Take urgent action to combat climate change and its impacts") indicates that all of the BEST criteria support this. Therefore, it could be said that the BEST tool provides a good indication of the extent to which characteristics and facilities within a neighbourhood support the achievement of climate change targets.

Place Specific Interventions

The BEST methodology requires an initial assessment of the existing neighbourhood. The results of this assessment are used to propose interventions. The effectiveness of these interventions in addressing the shortcomings of the existing neighbourhood is then ascertained and the methodology allows a range of options to be tested to identify an 'optimum fit' for the neighbourhood. In this way, the methodology provides an effective way of understanding the 'place' (the neighbourhood) and developing interventions that respond to its sustainability deficits. Therefore, it could be said that the methodology is effective at identifying and testing 'place-specific' interventions, plans and 'pathways' for achieving Sustainable Development Goals and climate change targets.

Synergistic Impacts

The study identifies 6 possible interventions for improving the extent to which the neighbourhood addresses the SDGs and climate change targets. As can be seen in Table 3, some of these interventions are more effective than others in developing characteristics and facilities that support the achievement of SDGs and climate change. The 'Work Densification' intervention provides for 38% of the improvement and affects performance in 8 BEST areas. This performance is achieved by developing high density, high-performance buildings that comply with BEST criteria. The new accommodation provides increased employment which also helps address BEST criteria. Finally, the 'conditional development' requirement that requires the new development to include small businesses that meet the 'Goods' and 'Services' criteria and health facilities that meet the 'Health' criteria and make a substantial contribution to increased built environment sustainability capability.

The Recycling Scheme, the Education Hub, the Food Hub and the Energy Microgrid similarly affect several BEST areas. The Recycling Scheme reduces waste, vehicular transportation and creates jobs and small enterprises. The Education Hub creates improved awareness and affordable education locally, reduces vehicular transportation and creates jobs. The Food Hub provides affordable, healthy, low ecological-footprint food, reduces vehicular transportation and creates small enterprises and jobs. The Energy Microgrid provides low carbon energy to power the neighbourhood and creates local jobs and enterprises. The Residential Densification provides additional housing which meet all of the BEST sustainability performance requirements.

The review, therefore, suggests the interventions identified have *significant, multiple impacts* across some BEST areas and therefore could be said to be examples of the 'multiple synergies'

referred to by the IPCC. A review of these synergistic interventions can be used to distil the following distinguishing features:

- **Meeting Everyday Requirements:** Synergistic interventions increase local access to facilities, goods and services required for everyday life. By doing this they also support non-motorised transport and reduce the need for vehicular transportation
- **Conditional Development:** Synergistic interventions proactively structure future development through requirements. These include targeting specific types of enterprises and facilities that support improved local sustainability capability
- **Creating Employment and Enterprises:** Synergistic interventions create local jobs and enterprises
- **Multi-use Infrastructure:** Synergistic interventions increase impacts by ensuring that infrastructure supports multiple uses
- **Local Governance:** Synergistic interventions rely on effective local governance to ensure that development prioritises local needs and are inclusive by addressing issues such as accessibility and affordability.

CONCLUSIONS AND RECOMMENDATIONS

The study describes how the Built Environment Sustainability Tool can be used to assess neighbourhoods to support the achievement of the Sustainable Development Goals and climate change targets. It establishes that the BEST methodology provides an effective way of identifying responsive 'place-specific' interventions which improve the sustainability performance of neighbourhoods. Finally, the study identifies interventions which have multiple impacts and appear to be able to improve the performance of the neighbourhood in terms of both Sustainable Development Goals and climate change targets. The study, therefore, argues that these 'synergistic interventions' are examples of the 'multiple synergies required to achieve the goals of sustainable development, including climate adaptation and mitigation, poverty eradication and reducing inequalities' identified by the IPCC (Roy *et al.,* 2018;447).

The study identifies and describes features of these synergistic interventions including Creating Employment and Enterprises, Meeting Everyday Requirements, Multi-use Infrastructure, Local Governance and Conditional Development**.** The paper provides valuable insight into how neighbourhoods can be developed to 'leap-frog the Sustainable Development Goals' as described by Butler (2014: 83). Further development and application of the methodology are therefore recommended.

LIST OF REFERENCES

Butler, J.R.A., Bohensky, E.L., Suadnya, W., Yanuartati, Y., Handayani, T., Habibi, P., Puspadi, K., Skewes, T.D., Wise, R.M., Suharto, I. and Park, S.E., 2016. *Scenario planning to leap-frog the Sustainable Development Goals: An adaptation pathways approach*. Climate Risk Management, 12, 83-99.

Gibberd, J., 2014. Measuring capability for sustainability: The Built Environment Sustainability Tool (BEST). *Building Research & Information*, 43(1)49-61.

Gibberd, J., 2020. *Applying the Built Environment Sustainability Tool to assess and improve neighbourhoods.* Available from https://jeremygibberd.com/2017/08/18/applying-the-built-environment-sustainability-tool-to-assess-and-improve-neighbourhoods/

Roy, J. P., Tschakert, H., Waisman, S., Abdul Halim, P., Antwi-Agyei, P., Dasgupta, B., Hayward, M., Kanninen, D., Liverman, C., Okereke, P.F., Pinho, K., Riahi, and A.G. Suarez Rodriguez, 2018. Sustainable development, poverty eradication and reducing inequalities. *In:* Masson-Delmotte, V., Zhai, P., Pörtner, H-O., Roberts, D., Skea, J. Shukla, P.R., Pirani, A., Moufouma-Okia, W., Péan, C., Pidcock, R., Connors, S., Matthews, J.B.R., Chen, Y., Zhou, X., Gomis, M.I., Lonnoy, E., Maycock, T., Tignor, M. and Waterfield T. (eds.). *Global Warming of 1.5°C. An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty* [. [ONLINE] Available at: https://www.ipcc.ch/site/assets/uploads/sites/2/2019/02/SR15_Chapter5_Low_Res.pdf [Accessed 4/6/2020].

UNFCC, 2015. *Adoption of the Paris Agreement, Conference of the Parties Twenty-first session*, Paris, 30 November to 11 December, 2015. Paris: United Nations Framework Convention on Climate Change, pp?

United Nations, 2015. *Resolution adopted by the General Assembly on 19 September 2016.* A/RES/71/1, 3 October 2016 (The New York Declaration) New York, UN.