

## **Ecourbanism in Rwanda – a whole system approach to city building**

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The World Bank forecast that the area covered by the planet's urban realm, as measured in 2000, would double by the 2030s, with 90% of urban growth occurring in the developing world (Suzuki et al., 2010). To avoid problems of resource depletion, pollution, poor human health and wellbeing etc. associated with past urbanism, new cities should acknowledge the concept of Natural Capital and Ecosystem Services, bolstered by comprehensive, interconnected green infrastructure.

Rwanda is a small land-locked country, located just south of the equator in the heart of Africa, and one of the poorest countries in the world. Rwanda's population density, has doubled since 1990 in spite of the genocide of 1994, and is one of the highest in Africa. The population is forecast to reach 26 million by 2050, giving a population density of 987 people per km<sup>2</sup>.

Like many developing countries, the majority of this population growth will be accommodated through rapid urban growth. The population of the capital city Kigali has grown from 6000 in 1962 to 1.3 million in 2012, and is on a trajectory towards 2 million by 2020. Such rapid growth absorbs farmland and natural habitats, and adversely impacts on local hydrology and microclimate.

Given these challenges it is encouraging that Rwanda's stable government promotes advanced green policies that are promoted in both urban and rural areas. Rwanda adopted the Millennium Development Goals (United Nations Millennium Declaration, 2000) in September 2000. The eight goals are subdivided into a series of targets that represent the highest of aspirations, mostly addressing health and equality, and provide a context to our work.

This paper outlines the rationale for green urbanism in Africa generally based on two catalyst masterplans for neighbourhoods - Batsinda II and Cactus Green Park – each accommodating 550-600 dwellings. The work is funded by the Rwanda National Climate and Environment Fund (FONERWA) that is built upon the newly adopted Green Growth and Climate Resilience Strategy (2011) and was launched at a UN Framework Convention on Climate Change event at the COP17 in 2011. It is supported by the UK Department for International Development, plus the Climate and Development Knowledge Network.

Ecourbanism is a pragmatic, whole-system approach to urban development that Studio Engleback has been researching, teaching, and practicing over the last two decades. Cities rely on a healthy natural environment that continuously provides a range of benefits, known as ecosystem services (ESS) that are classified into four interlinked and interdependent categories: supporting; provisioning; regulating; and cultural services. Of particular value in an urban context are Regulating ESS. Taking an ecosystems approach requires simultaneous intervention at the macro, meso, and micro scale, and recognition that natural processes do not respect political and land ownership boundaries.

The Service Météo du Rwanda has observed increasing average temperatures each year from 1971-2008 - a total of 2.6°C which is higher than the global average. In part this has been due to global warming, but amplified by local land-use change. Temperatures are expected to continue to rise, and average annual rainfall in Rwanda may increase by up to 20%, by the 2050. Together, with increased variability, heat may reduce some crop yields whilst heavier rainfall may trigger more floods, landslides, crop losses, and damage to infrastructure. Dependency of a growing population on rain-fed agriculture makes Rwanda highly vulnerable to climate change. Rwanda committed to address climate change when it ratified the United Nations Framework Convention on Climate Change (UNFCCC) in 1998. The main focus is on low carbon development and building climate change resilience through sustainable land use planning, water resource management and agro-forestry practices; ideas that can be applied to urban greenway design.

Vegetative land cover modifies regional and neighbourhood microclimate. Greenways have been shown to modify the urban heat island generally, and research in Singapore found that greenways had a cooling effect of 4°C at a macro scale (Wong & Yu). A study from 2009 indicates that the Kigali urban area is 2°C warmer than the surrounding rural areas (Henninger); in recognition of this, the Kigali State of the Environment Report 2013 notes that *'Even small urban green spaces can help tackle the heat island effect.'*

Paul Hawken wrote in 1997 that Natural Capitalism *'...is about making small, critical choices that can tip the economic and social factors in positive ways.'* An Action Plan for embedding an ecosystems approach in policy- and decision-making (Securing a healthy natural environment – an action plan for embedding and ecosystems approach, 2007) led to the UK National Ecosystem Assessment; stating that natural resources were a part of the wealth of the Nation. The concept of Natural Capital is fundamental to our thinking on ecourbanism and the value of green infrastructure (Jalouzot, 2011).

Rwandan President Paul Kagame stated in 2009 that: '*The environment is our life-blood...our economies depend critically on good environmental stewardship.*' Such an outlook and approach is supported by the UN study on the *Economics of Ecosystems and Biodiversity* (2010).

Links between human and ecosystem health investigated in the 1990s (Constanza & Norton (eds) 1992) was noted in the first output of the UN Millennium Ecosystem Assessment (*Ecosystems and Human wellbeing*, 2003). The term ecotoxicology, coined by Professor Truhaut in the 1960s with regard to the effect of pollution, expanded in the 1990s to embrace the rebound that anthropogenic effects on ecosystems had on us all - both physical and psychological. Recently there have been a number of publications addressing the creation of healthy places including a position statement on *Public Health and Landscape* published by the UK Landscape Institute in 2013.

Air, land and water pollution are major environmental issues noted in the *Rwanda State of the Environment and Outlook* reports since 2009, particularly the problem of polluted run-off. Degraded and fragmented ecosystems are less effective than healthy and intact environments, at delivering regulating services that ameliorate the urban heat island effect, reduce energy use, improve air quality, attenuate surface water runoff, and enhance human health and wellbeing. The urban heat island effect in Kigali is already affecting health. The city's high altitude previously ensured that it was too cold for malaria bearing mosquitos, but cases of malaria are now increasing as city temperatures rise.

The 68th UN General Assembly declared 2015 as the *International Year of Soils*, thus recognising the finite and fragile status of this resource and its fundamental importance to humanity. Underpinning any attempt to deliver a robust green network, therefore, must include effective soil conservation strategies to prevent erosion, siltation, and downstream flooding.

In Rwanda, '*the land of 1000 hills*', the steeply sloping terrain is a major hinderance to development. The city region has 25 watersheds, many with gradients of 20-50%. Slopes greater than 5% are vulnerable to heavy erosion in the country's two rainy seasons (Kigali City analysis, benchmarking and visioning report, 2013). The space between the buildings, whether public or private realm, is part of the city's green infrastructure. Green or *Environmental Infrastructure* can include the local tradition of terracing hillsides for agriculture. This creates soil sinks that reduce erosion, thereby maintaining the health of wetland valley floors that, in turn, conserves water and bolsters the nation's food security.

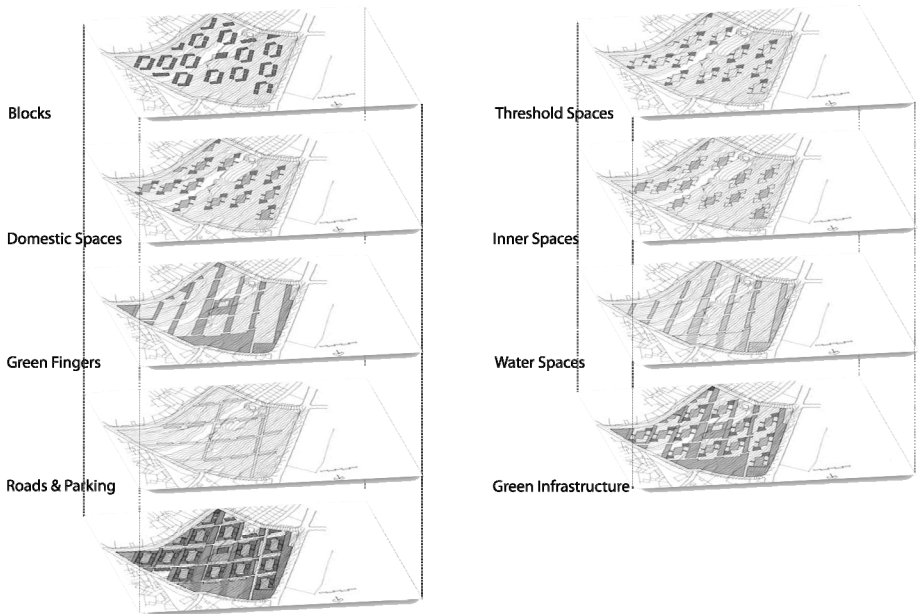
Rwanda there has experienced a rapid movement of population from rural to urban over recent decades. Urban dwelling is forecast to rise from 10% in 2000 to 35% in 2020. This great change in lifestyles has the potential to divorce the population from the natural processes they grew up alongside and understood, (as happened in the developed world). Provision of well managed urban greenways therefore play a role in retaining these deep cultural links, while also providing employment.

The Rwandan government set out a long term policy in *Vision 2020*, (adopted in 2000) including 48 indicators with targets. Environmental protection formed one of the main pillars of the policy document. It aimed to control pollution, environmental degradation, and depletion of natural resources such as land, water, and biodiversity. A governance framework was established to regulate use of natural resources, and to raise public awareness about the environment so that future generations might be bequeathed the basic wealth needed for sustainable development.

The World Bank's ECO<sub>2</sub> Cities initiative for Green Growth and Climate Resilience notes that *'Ecological Cities enhance the wellbeing of citizens and society through integrated urban planning and management that harness the benefits of ecological systems and protect and nurture these assets for future generations'*. This idea has been central to our masterplanning approach for Cactus Green Park and Batsinda II. Whilst food-growing areas are being retrofitted into cities in the developed world, sparking community engagement, in Kigali small vacant spaces are already used for growing crops. This has been formalised in some areas through the Kigali Urban and Peri-Urban agriculture project and the Gako Organic Farming Training Centre.

Two masterplans featuring urban greenways led by Light Earth Designs (Kigali) supported by Studio Engleback, drainage expert Jason Lorenzetti, and FBW engineers aspire to being green urbanism exemplars. Batsinda II, a higher density pilot project, is located within the 440 hectare Kinyinya Sector of Gasabo District to the north of the centre of Kigali. The development of robust low cost houses from 2007 had formed the first phase in response to 33 deaths due to landslides and poor drainage in 2006 (<http://www.kigalicity.gov.rw>). Cactus Green Park is also in Kinyinya, located to the north east of the city centre. This masterplan combines lower density villas as well as apartments for the city's emerging middle-income population, on the edge of planned urbanization set out under the City of Kigali masterplan.

The Batsinda II site has a 54 meter level change with gradients between 5-15%, and will accommodate up to 619 low cost homes at a density of 82 units/hectare, a school, neighbourhood centre, market, bus station and local shops. The aim is to integrate green local building technologies, sustainable drainage infrastructure, peri-urban agriculture, and active energy production, into a cohesive neighbourhood masterplan. The City of Kigali required a minimum of one fifth of the site to be '*landscape*', which we then categorised into three types of interconnected multifunctional public spaces – firstly *green fingers* that cross the gradient and connect to the valley floor wetlands, intersecting with civic spaces; secondly residential block threshold courtyards integrating green infrastructure into the streetscape; and thirdly inner communal courtyards. There are also limited private external spaces at grade and as balconies.



**Figure 1. Batsinda II – a landscape of layers – source studio engleback**

The *green fingers* will be a continuous productive urban landscape, terraced to accommodate the significant level changes providing small allotments for orchards or vegetables; they also accommodate pedestrian/cycle routes connecting the neighbourhood, attenuate and convey storm water. Biotic water filtration will remove low-level pollutants and silt that would otherwise adversely affect the valley floor wetlands. Slopes are to be stabilized using tall native bamboo at road crossings and lower vetiver grass between the small

growing plots. These blue/green corridors will play an important role in urban thermal regulation and ventilation; conserve a vestige of the pre-urban farming cultural identity; and provide a large vegetated surface area to filter particulates from the air, much of which derives from widespread use of charcoal stoves.

The passive design principle is also being applied to the building design to reduce the need for energy intensive air conditioning systems. Central communal spaces will be divided between sport, mother and child, kitchen gardens, and garden squares, with an upper and lower threshold courtyards addressing a grid of streets. The aim is to provide active, overlooked social spaces, with a variety of different functions along the same contour.

Cactus Green Park will occupy 13 hectares of farmland with 6-8% gradients. A vestige of forest is located on the ridge immediately above the site, and to the south is a green valley floor containing agriculture and marshland. Our concept was to link these two biomes with a continuous productive urban landscape - combining sustainable drainage, peri-urban food, and soil conservation - and a series of pocket parks, to maximise park frontage.



**Figure 2. Cactus Green park Model – source studio engleback**

The layout was constrained by roads and some storm drains being constructed to an earlier design. While some elements of the original were retained to save money; the key departure was the layout of a central parkway and associated proposals for green infrastructure based on a trinity of interlinked elements including:

- A ‘blue’ network of swales linking to a central broad open conduit with access for maintenance vehicles.
- A terraced landscape supporting urban food production, primarily in the form of fruiting trees such as avocado, mango, papaya etc. These terraces will be retained with vetiver grass, which can also be used as a fodder crop, conserving soil and aiding water infiltration.
- A green network for recreation, social mixing, improved air quality and to ameliorate micro-climatic extremes.

*Resilience thinking* seeks to anticipate, adapt, and transform the setting in which we live to ever changing conditions. In particular, this strategy moves away from regarding people as being set-aside from ecosystem dynamics, and instead considers how we are an integral interacting component of the biosphere. More rainfall, but also possibly longer dry periods and warmer weather, demands new water conservation strategies to sustain the Landscape across the site so that it can perform a range of ecosystem services.

The scheme is divided into homezone street-based mini-neighbourhoods, terminating in squares and pocket parks, linked to the central parkway. Porous paving, terracing, rain gardens and rills will attenuate and convey surface water to receiving rain gardens at the head of a network of swales in the park. Similar connected features are located in domestic courtyards and gardens. Standing water is avoided for fear of attracting mosquitoes, soil and stone below ground temporary water storage is favoured to support vegetation. Verdant streets as well as the dendritic nature of the park plan aim to facilitate urban ventilation to ameliorate the urban heat island effect, and improve local air quality.

The social side of human epidemiology has been investigated since the end of the 1980s, with increasing attention has been paid to the health effects of individual social networks, and local social capital. The parkway is a social enabler providing a practical means of directly connecting the extremities of this site with major community facilities. These are located lower on the slope at the entry points of the residential streets, where they act as gateways to the development and a bridges to surrounding areas. Main park paths curve to connect with homezones and to deal with inclines. A network of play areas no more than 2-3 minutes walk from any home is are distributed across the park, for both convenience but also to work as social hubs. Catering for the societal move from an active to more sedentary life style, there are also two 1 kilometer trim trails, with a sequence of exercise points, that will serve a similar function.

## Conclusion

*'The great challenge of 21<sup>st</sup> century urban design is mastering ecological and social design'* Geoff Mulgan, NESTA (Mulgan, 2010). The Rwandan Environment Management Authority aims to make Kigali a state of the art, aesthetically appealing city. From the outset our approach to masterplanning has been to grade opportunities for the inclusion of sustainable design features as being common sense, best practise, or aspirational. The potential effectiveness of each design feature was evaluated for inclusion within the masterplan in terms of the four ecosystems services.

Urban greenways operate at different scales, harnessing and bolstering ecosystem services are a key component to creating any resilient modern city. The masterplans for Batsinda II and Cactus Green Park, if effectively implemented, will play their part in achieving a vision for the goal of a seamless network of natural and urban spaces in the Kigali Green and Blue plan for 2040.

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NESTA is the National Endowment for Science Technology and the Arts founded in 1997, a UK public body promoting creativity, talent and innovation across a wide spectrum of areas and interests.