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A cities metabolism as it relates to innovation and society

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I hereby confirm that the assignment is a product of my own work and research and has been written by me and further all sources used therein have been acknowledged.

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Part a:

Introduction

Cities are growing exponentially with critical consequences to the environment that supports them (Doshi et al., 2007). This in turn affects the ability of the environment to provide services on which cities are reliant. Climate change and the end of cheap oil compound the risk to sustaining the urban environment. Both ecosystem services and the infrastructures that deliver them, require imaginative and innovative development and management in order to ensure their capacity to provision a city. Investments in ecosystem services, closed loop systems and strengthening local resilience to climate change are essential strategies to ensure a sustainable future for cities (SACN, 2011).

Considering the statistics (Girardet, 2013; SACN, 2011; Swilling and Annecke, 2012; Satterthwaite, 2007; UN-Habitat, 2012, 2008) it is easy to see the divide between utopian and dystopian ideas of the future (Davis, 2010; Pieterse, 2010). This paper reviews the challenge of sustaining cities centered in Jacobs (1961) and Girardet's (2004) discourse on cities as nature. The potential for sustainable socio-technical systems is then reviewed in Guy et al (2001), and

Wilsenach's (2010) discussion on metabolic flows. The innovative capacity of cities to build resilience is discussed in the work of Davis (2010). Two examples of innovative interventions that worked are described, following that is a discussion on the actors responsible for implementing sustainable solutions in cities.

City Growth

For the first time in history, in 2013, the majority of the world's population lives in cities (Brown, 2008; Satterthwaite, 2007). This is a trend developed over the last two centuries. In 1900 15% of the world's population lived in cities (Satterthwaite, 2007). By 2000, it was almost half. In 2009, the United Nations Human Settlements Programme named the 21st century, the century of the city (UN-Habitat, 2008). By 2025, we can expect to see cities growing in a projected amount of eight new cities of ten million people each year (Wilsenach, 2010). The wave of urbanization underway, is happening mostly in the developing world of Africa and Asia (Wilsenach, 2010).

Urban Poor

Growth in urban centers in the developing world, is centered in the rapid growth of the urban poor. African Cities are characterized by a high percentage of urban poor who live in slums or informal settlements. In sub-Saharan Africa 62% of the urban population live in informal settlements (Swilling and Annecke, 2012). Urban slums and informal settlements now currently house one sixth of the world's populations (Satterthwaite, 2007).

In the century of the city, we must contend with a new kind of city, made up largely of slums (Davis, 2010; Swilling and Annecke, 2012). This growth in a time of environmental limits, provides unprecedented challenges.

Consumption impacts

As the primary places of consumption and production, cities play a significant role in the current global crisis of resource limits and carbon emissions (Brown, 2008; Satterthwaite, 2007; Sebitosi, 2012). Urban consumption contributes to almost half all global carbon emissions and uses 50% of the global photosynthesis capacity to power their economies (Davis, 2010; Girardet, 2004; SACN, 2011; Satterthwaite, 2007).

The dispersed impacts of resource use and waste are felt globally as ecological imbalance (Satterthwaite, 2007). Measuring the ecological footprint of a city illustrates the cost of consumption on the ecosystem (Girardet, 2004; Satterthwaite, 2007 as in Reese). The image in the literature is of the three to five planets we would need if every person used resources the way urban populations in London or Los Angeles did (Girardet, 2004).

Cities are at risk

The global economy is centered in an urban lifestyle (Doshi et al., 2007) which is dependent on natural resources (SACN, 2011; UN-Habitat, 2012). Globally a limit to resources is evident in the impacts of the urban environment on the ecosystem services that sustain it. (Girardet, 2004; Satterthwaite, 2007).

Cities, then, are faced with a series of crisis, including a continuing population surge, particularly amongst the urban poor, and diminishing resources on which economies are reliant. In addition, aging infrastructure to deliver services (Doshi et al., 2007) and insufficient infrastructure to

provision the population growth compound the problem, particularly in the developing world (Swilling and Annecke, 2012).

Crisis of imagination

In light of the warnings in the literature of escalating crisis, it is easy to subscribe to what Davis (2010) terms, the pessimism of the intellect (Davis, 2010). The unsustainable projections of growth and resource use, point to total collapse as one possible future scenario (Davis, 2010; Pieterse, 2010). In response to the crisis, the literature presents the concept of resilient or regenerative cities, which adapt to the crisis through innovation. (Davis, 2010; Girardet, 2004; SACN, 2011; Swilling and Annecke, 2012; UN-Habitat, 2008).

However, innovative approaches will not be sufficient if purely technical (Davis, 2010; Wilsenach, 2010). An imaginative and integrated understanding of the relationship between technical concepts, society and the human environment is necessary (Davis, 2010; Guy et al., 2001; Wilsenach, 2010).

City as nature

Although Jacobs (1960) wrote more than 50 years ago, she points out a perception of the city that is prevalent today. Jacobs (1960) argues that cities are seen as “seats of malignancy and the enemies of nature” (Jacobs, 1961: 444). Urban sprawl is in response to this perception (Jacobs, 1961), which Jacobs (1960) describes as the sentimentalization of nature evident in the fictionalized construct of nature in suburbs (Jacobs, 1961).

Jacobs (1960) reminds us that, “we and our cities by virtue of being part of nature are involved with it in much deeper and inescapable ways” (Jacobs, 1961: 444).

Metabolic flows

Indeed, the physical functions of a city can be likened to a natural organism (Girardet, 2004). The electrical grids, sewage systems and other networked infrastructure are the metabolic pathways (Swilling and Annecke, 2012). Metabolism is the action of transformation of energy within the cells of an organism. The connotation of this descriptor is of something that it is alive.

If a city is a live organism, then water and power, are its primary flows, and waste and pollution are the result of its metabolic process (Swilling and Annecke, 2012). Some resources stay fixed in stock like concrete in buildings (Swilling and Annecke, 2012). Like a cell, these flows allow a city to grow and reproduce.

Cities can be likened to a natural organism, but they do not work like nature (Girardet, 2004). The infrastructures that channel eco-system services do so in a linear flow (Girardet, 2004). Resources are imported, used, depleted and deposited, relying on nature as a sink (Girardet, 2004). As an example, a resource such as water is used in great quantity for transporting and flushing waste (Sebitosi, 2012). Transporting waste out of a system results in the loss to the system of important nutrients (Girardet, 2004). To consider a sustainable future, cities will need to adopt symbiotic cyclic flows and mimic a natural system and its closed loop processes and resource exchange (Girardet, 2004; Pieterse, 2010).

Socio-technical flow

The way cities use resources will equally depend on the socio-economic and political constructs that are intricately part of the system (Guy et al., 2001; Wilsenach, 2010). Metabolic flows are

not purely physically or technical, nor are the infrastructure or pathways that conduct ecosystem services (Guy et al., 2001; Swilling and Annecke, 2012). The city is a social theatre, and its metabolic infrastructure is described in the literature as being created, influenced, controlled and facilitated by politics, economy and society (Guy et al., 2001; Kaden, 2012; Wilsenach, 2010).

Society engages in a collective and synchronized tapping into ecosystem service networks (Guy et al., 2001) creating a cumulative socio-material system [Guy et al., 2001 as in Otnes, 1998]. Once adopted (Guy et al., 2001) networks of services then structure social behavior (Guy et al., 2001). The intricate nature of socio-technical flows between ecosystem services, technical processes and society (Guy et al., 2001) underscore the idea that cities and the way they function are inseparable from human nature.

Human ingenuity and imagination will be necessary to adapt socio-technical flows and make them sustainable and resilient (Davis, 2010; Wilsenach, 2010). Imaginatively identifying the necessary is required, instead of assuming the practical (Davis, 2010). Ingenuity, according to Wilsenach (2010) is the greatest resource society has (Wilsenach, 2010) and must overcome orthodox approaches to infrastructure (Guy et al., 2001; Wilsenach, 2010).

Interventions

Human ingenuity and an unorthodox approach to providing socio-technical infrastructure services can be seen in the response of the Municipal Department of Water and Sanitation in Durban, to growing urban population pressure. The eThekweni municipality has implemented a project to install Urine Diverting toilets (UD's) in informal settlements, and in the port of Durban. The toilets separate urine and feces, harvesting urine for its nitrogen, potassium and phosphorous for use in agriculture. Some 70 000 dry toilets are now in use, making this one of the largest dry toilets projects in the world (Frederikse, 2011).

UD's solves several problems for the eThekweni municipality (Frederikse, 2011). The recovery of nutrients and re-use of resources is the primary one, in a city that is growing at a rate of hundred and fifty thousand people a year (Frederikse, 2011). In addition, the project has created jobs and is looking for ways to build the urine harvesting into small businesses (Frederikse, 2011).

In describing the project in *allafrica* article, Sanitation director, Neil Macleod, says:

“waste is the key for sustainable futures for developing countries. So treat it as a valuable thing, not something nasty.” (Frederikse, 2011).

This is sound advice, but attitudes prevail about what is adequate delivery for sanitation in informal settlements (Sebitosi, 2012). Despite the projects high profile partners, (the Gates Foundation as funder, and the Swiss federal Institute of aquatic sciences and technology, as technical partner) public perception in the informal settlement values flush toilets over this alternative systems (Frederikse, 2011).

Nevertheless the Durban municipality is prevailing (Frederikse, 2011). Almost a million people live in Durban's informal settlements and MacLeod notes that perceptions and attitudes have to be overcome (Frederikse, 2011). To that end, the municipalities outreach goal is to make dry toilets appealing in order for the informal settlement society to adopt them (Frederikse, 2011).

This innovative closed loop strategy, as noted above, is a public private partnership. Municipalities are charged with managing a cities resources, however evident in the literature (Department of Environmental Affairs and Tourism, 2008; Pieterse, 2010; SACN, 2011) is their limited capacity, especially in developing countries like South Africa, to prioritize investments in sustainable socio-technical systems and ecosystem services. Limited and competing budgets and a lack of good governance result in ineffective sustainable policies for urban expansion (Satterthwaite, 2007). Public private partnership can enable governing authority to overcome this barrier (Boyer et al., n.d.; Doshi et al., 2007; Frederikse, 2011).

Investments in ecosystem services and sustainable infrastructure can begin in city council despite budget limitations, political division, and time constraints. What follows is an example in the UK of an independent charitable foundation, Nesta that in partnership with local governance, funded a process to address service challenges facing city councils.

Nesta is an independent charitable foundation in the UK that funds radical innovations to address long term challenges facing cities. It seeks to improve quality of government services by developing efficiency zones. In a time of increasing budget deficits and budget cuts, an effective way to cut costs is by increasing efficiency.

Nesta's Creative Council initiative was launched in 2012 in partnership the local government alliance, to boost local authority's capacity to improve services. In the words of Philip Colligan, Executive Director of Nesta's Innovation Lab, Nesta supports, " Local governments taking the lead in shaping public services of the future" (Boyer et al., n.d.).

The Creative councils approach is modeled on the success of an earlier Nesta project named, Transforming Early Years (TEY). TEY worked with the Nesta Innovation Unit, a social enterprise NGO that focuses on public services (Boyer et al., n.d.). One of the six localities, Chellow, Bradford, introduced a TEY initiative named *Chellowships*. Through mutual community help, the city increased services to at risk families by 300%. Through engaging non-financial community support to assist vulnerable families, the cut council saved 38% in costs (Boyer et al., n.d.).

Nesta's strategy to fund initiatives that boost local government capability rests on four assumptions.

- “1) incremental change is not enough
- 2) local government is part of solutions
- 3) solutions must be replicable and
- 4) it is possible to codify innovative methods” (Boyer et al., n.d.).

The Creative Council called for initiatives that would focus on long-term investment rather than short term cost cutting strategies. An open call for proposals to the UK's 373 councils was informed by identification of important challenges facing the provision of services.

One hundred and thirty seven councils across England applied. Stoke on Trent council is one of the six funded projects announced in May, 2013 (Boyer et al., n.d.). The city plans to use the Nesta grant as part of its *Going Local Plan*, 2012. Nesta funds will be used to create a local authority power company (City of Stoke-on-Trent, 2013), which is possible in the UK now under the 2011 localism act (Boyer et al., n.d.). The city will exploit renewable energy and energy sourced from waste, as a way of creating a self-sufficient city. This strategy ties in with the city's

goal to promote its location as low cost and desirable for businesses. By attracting new business, it will increase its tax-based revenue to finance its services (City of Stoke-on-Trent, 2013),.

Stoke on Trent's working framework is "*The Great Working City*" (City of Stoke-on-Trent, 2013). Its plan is to push energy regulation boundaries and use local energy sources of biomass, solar, hydro, and geothermal (City of Stoke-on-Trent, 2013). It will create a local ownership structure for the energy supply (City of Stoke-on-Trent, 2013). The city web site describes the process as "re-imagining the role of council as a strategic broker of resources". (City of Stoke-on-Trent, 2013)

The architecture of Nesta's process is notable. The process was divided into three stages, The open call stage, the camp stage where participants refined proposals and developed capability, and the implementation stage. Each stage was engineered to build alignments and networks within all participating councils, to give participants a broad understanding of critical issues facing the UK. The process was also sensitive to the time constraints of local authority and council. Participants were active in a community of innovators, but without the burden of administrating project capacitors. These were pre-selected by Nestor, freeing council members up and deflecting sabotage (Boyer et al., n.d.).

Teams received financial and non-financial support in all stages, to develop their proposals. Team building through "camps", provided coaches and ran through rigorous pitching exercises to test the expression of their proposals (Boyer et al., n.d.). Peer driven, productive critique as part of the coaching ensured the realistic engagement with delivery. Nesta followed emergent ideas of the councils rather than impose a theme for the proposals. It identified the need to keep key players within the project as it moved to inception (Boyer et al., n.d.).

While these projects are not examples of proven practical implementation, as yet, the Nesta model highlights the potential for private investment to leverage public talent and assets. It allowed for innovative solution to critical issues to begin within the city council, a body typically hampered by budget cuts, time constraints and endless meetings (Boyer et al., n.d.). Nesta's generous funds and non-financial support gave space to council to put radical ideas into action. Its focus on non financial support, and strong program design saved money and provided alignment skills in council often fractured by budget allotments (Boyer et al., n.d.; Pieterse, 2010). Private enterprise will benefit from the investment in public goods, as places to do business without the risk of collapse.

The Nesta model highlights the potential for private investment to leverage and build public intellectual capital.

Both examples illustrate how, with the right support processes and public private cooperation, cities have the potential to build resilience to crisis issues. The intellectual and technical talent in a city makes them particularly suited to cope with crisis (Girardet, 2013; Jacobs, 1961). However, the poorer countries may not be able to afford innovative processes or technologies (SACN, 2011). The counter argument in Davis (2010) is that cities of the global south, have the capacity to innovate and adapt sustainably through leap frogging, or an integration of innovation, home grown solutions and traditional knowledge (Davis, 2010).

Co-operative knowledge

Jacobs (1961) supports this idea of home grown solutions, in general, by promoting the concept of the unaverage (Jacobs, 1961). In this word we understand the idea of regular people or citizens as “great informal experts” (Jacobs, 1961). Everyday citizens have a particular awareness of their environment or an unaverage knowledge (Jacobs, 1961) that is often dismissed by planners as statistically inconsequential (Jacobs, 1961).

In the literature (Abbott, 2002; Mitlin, 2008; Pieterse, 2010), an effective strategy to leverage unaverage knowledge and take advantage of leap frogging opportunities is a coproduction approach between governance, citizen’s groups, and NGO’s (Abbott, 2002; Mitlin, 2008; Roberts et al., 2009).

Co-production can work as a strategy towards efficiency in both rich and poor communities, because of a growing need for a different kind of authority to provide services, one that is agreed upon and maintained through social relations (Mitlin, 2008 as in Wtaker, 1980: 243). But it is often used in the development process when the state fails to provide services to the poor (Mitlin, 2008 as in Adrain, 2005). Coproduction is coupled with an incremental approach, and seen as a strategy that can galvanize greater change (Govin, 2010; Pieterse, 2010). Incremental coproduction strategies maybe market driven or driven by the hardship conditions of urban poor (Castells, 2012). Key to the coproduction approach is the linkage with city government that can inform and endenger democratic participation (Govin, 2010; Pieterse, 2010).

Conclusion

As can be seen in the discussion, cities face tremendous challenges in providing ecosystem services in a time of limits and environmental crisis. Co-operative strategies within a cities intellectual capital build innovative and necessary interventions to offset crisis. In facing the risks of global crisis, cities do have the potential to become sustainable through adaptations of their socio-technical metabolisms. This can be seen in the example of UD toilets in Durban, where a waste system mimic nature’s resource exchange.

However, technical solutions will not be enough (Davis, 2010; Wilsenach, 2010). Davis’s (2010) argues for an optimism of the imagination (Davis, 2010) in response to the pessimism of the intellect (Davis, 2010). The challenge lies in supporting the imagination of a sustainable future (Davis, 2010; Doshi et al., 2007). To illustrate this, the Nesta example describes a process that supports necessary innovation. By defining what is immently needed, the first step in determining what is politically and culturally possible can be taken (Girardet, 2013).

Part B:

Splintered origins

Like most early settlements, the original town of Stellenbosch was founded along the banks of a river. The Eerste River sustained the town, providing water to support food production (Barnard, 2004). As agriculture and urbanization developed, the river has been impacted by use and waste.

Although technically not a city, Stellenbosch is an urbanized area facing increasing growth (Sebitosi, 2012). Demands on resources and the impact of pollution affect the capacity of ecosystem services to provide for the economy and society that depend on them. This challenge can be seen in Stellenbosch's waste and water system.

The literature points to a fundamental need to rethink orthodox approaches to implementing infrastructure (Barnard, 2004; Brown, 2008; Girardet, 2004; Satterthwaite, 2007; Swilling and Annecke, 2012). This is of importance to a town such as Stellenbosch that has a water and waste infrastructure at risk. The impact of growth and waste on the system threatens to diminish its capacity to provide the resource and services needed to sustain economic and population growth.

Stellenbosch presents as a segregated South African town, permanently shaped in an apartheid era structure of divided neighbourhoods with buffer zones or infrastructure as barriers, such as the Hells Hoogte road, that is intentionally located, to separate the white, black and mixed race communities (Roberts, 2009).

Social inequality based on technical or physical infrastructure can also be seen in the original spatial layout of the town. The socio-technical relationship of the river and the town was cemented during the founding of the town. The houses closest to the river are, to this day, most valuable.

The Eerste River has multiple offshoots and feeder perennial streams, as it runs from its source in the Jonkershoek Valley, down into the wider Stellenbosch basin (Barnard, 2004). In the late 1700's when the town was first settled, the river spread out in braids as it ran through the basin, branching and creating islands. The town's first administrative building, the Drosty, was built on one of these islands. This location of this important building, reinforces its value, authority and social standing by unequivocally dominating the spatial domain of the town's most valuable resource.

“ The way we treat our rivers reflects the way we treat each other”

Aldo Leopold

Stellenbosch is an African town in that 16% of its population live in informal settlements or as squatters in temporary dwellings on unserviced land (Tavener-Smith, 2012). The town's informal settlement is situated away from the main river, but is intricately tied to the river.

Enkanini is built on the steep slopes of a small drainage into the Plaktenburg river that runs into the Stellenbosch river basin. It is an area that is difficult to access. The adequate provision of sanitation services is therefore hampered by its geography, and the politics of the informality of the settlement. Because of inadequate investments in sanitation, informal dwellers that lack access to toilets use makeshift solutions. (Tavener-Smith, 2012). Run off from the steep hillside carries human waste or black water and solid waste into the river (Tavener-Smith, 2012). Grey water thrown onto the street, runs off into channels that eventually make their way to the river (Tavener-Smith, 2012).

The lack of services provided to the town's most vulnerable community therefore affect the ability of the city to provide healthy ecosystem services. The social divisions in Stellenbosch and in particular the social exclusion of Enkanini is represented in the way ecosystem services are provided, or not provided, and this is reflected in the river. The impacts of this are shared by the whole town.

The water quality of the river is poor (Robinson, 2012) in Stellenbosch, but Enkanini's sanitation issues are not the only contributor. The municipality has seven wastewater treatment works (Sebitosi, 2012) that have been rated as "less than satisfactory" by the South African Waste Water Quality Management Green Drop Performance Report, 2009 (Robinson, 2012). These inadequate treatment facilities seep sewage into the river when over capacitated.

Contributing to poor water quality is run off pollutants. Phosphate pollutants enter the river from Stellenbosch's large agricultural lands, and private gardens. Plastics, heavy metals and carbon enter the river, through run off on roads (Robinson, 2012; Sebitosi, 2012; Tavener-Smith, 2012). To support its growing population and sustain its resources, Stellenbosch will have to adopt a sustainable approach to services.

Biosphere Mandate

Despite its failing infrastructure and polluted river, the greater area of Stellenbosch has a mandate to fulfill as part of the Cape Winelands Biosphere Reserve (Robinson, 2012). According to Robinson (2012), the general requirement for a Biosphere region is: "to ensure that human development coexists sustainably with the natural environment." (Robinson, 2012: 221). The goals of the biosphere concept include the creation of an area of "good practice for people culture and nature." (Robinson, 2012, p. as in RSA DEAT 2007:1). However, neither Stellenbosch's water and waste water systems, nor the sanitation services in its informal settlement are congruent with this sustainability goal.

South Africa as a developing country does not have the option of attaining zero growth to maintain a sustainable future. In this context, The South African National Sustainable Development Framework (NFSD) identifies the need to support growth using resource efficient consumption patterns (Department of Environmental Affairs and Tourism, 2008). At the same time, the policy recognizes that Government has capacity and resource constraints to implement the infrastructures needed to support efficient consumption (Department of Environmental Affairs and Tourism, 2008).

Echoing the NFSD analysis, Sebitosi (2012) points to the Stellenbosch municipality's lack of available resources to deliver adequate infrastructure (Sebitosi, 2012). One of its constraints is in

prioritizing the allocation of limited budgets. Basic human needs are a priority (Robinson, 2012). In addition, the municipality is economically incentivized to provide services to socio-economic groups that pay levies (Robinson, 2012).

An investment in ecosystem services that support metabolic infrastructure is considered a luxury (Robinson, 2012). However, it has been shown that an investment in ecosystem services returns higher dividends than an investment in the economy. Robinson (2005) reports on a study carried out by the City of Cape Town that showed a return of R8 to R13.50 on every rand invested into the environment (Robinson, 2012). The return is double the value of an investment in the economy, and the benefits or value increase is in public goods and services such as water quality (Robinson, 2012)..

To meet its Biosphere mandate, and protect its water resource, Stellenbosch will eventually have to increase their investment in ecosystem services and efficient infrastructure.

Existing municipal initiatives

The Municipality plans to invest to some degree in its wastewater structure. These plans are included in a 2010 spatial framework (Robinson, 2012) that addresses water pollution and insufficient waste water treatment by:

- Upgrading waste water systems to achieve minimum DWA quality standards
- Implementing river conservation alongside river banks
- Protecting upstream ecosystems to ensure quality and quantity (Robinson, 2012)

Local and regional citizen's groups such as the NGO, Working for Water are also involved in maintaining a sustainable river ecosystem. Working for Water clears invasive exotic species to improve upstream water stream quality. Cape Nature runs educational programs to inform and ender behavioral change towards water and the river (Robinson, 2012). The Cape Action of People and the Environment [C.A.P.E.] and its 23 partners are coordinated by SANBI, who has an information database about ecosystem services available to enable the municipality manage its resource (Robinson, 2012).

In addition, private businesses such as agriculture that is heavily dependent on water as a resource are also involved in sustainable practices to minimize their impact on the river. Farms such as Spier, Reyneke wines and Laibacj wines are converting to organic or biodynamic farming and using closed loop systems that offset their contribution to water pollution and chemical runoff.

These closed loop systems are examples that the city can adopt to lessen the impacts of consumption patterns on the environment by providing innovative infrastructure. The current orthodox model of wastewater treatment in Stellenbosch is not sustainable for the future. The city can provide innovative infrastructure that supports efficient consumption.

Intervening in water

Traditionally wastewater treatment is carried out with large amounts of water, where effluent is treated and eventually dumped in a cleaned formed in the ocean or rivers (Sebitosi, 2012). Up to thirty percent of household water is used in the flushing systems of toilets (Frederikse, 2011). Orthodox water and waste systems, such as those in Stellenbosch, use rivers and the ocean as one giant flush system (Brown, 2008; Sebitosi, 2012).

Brown (2008) points out that removing waste using water, or this flush and forget system, is unsustainable and economically unviable (Brown, 2008). Disposing of waste streams with water also disrupts the nutrient cycle (Brown, 2008). The ocean cannot sustain the amount of nitrates in waste water that enter its system (Brown, 2008; Sebitosi, 2012). The result is environmental degradation miles from the source point of pollution (Sebitosi, 2012).

Stellenbosch is not unique in the challenge it faces in the use of conventional systems. In South Africa, only 7.4% of wastewater treatment plants manage their waste to Green Drop standards (Sebitosi, 2012). With rapid urbanization, wastewater treatment plants often are processing twice the amount of effluent they were built to cope with (Sebitosi, 2012).

Stellenbosch would benefit from implementing sustainable pilot projects now that will be effectively running by the time water and waste systems reach critical limits (Wilsenach, 2010). Sustainable closed loop systems that harvest nutrients from the waste cycle, and the separation of waste flows to minimize the quantity of waste that enters the main system are proven strategies that improve ecosystem services (Brown, 2008). Source control technologies (Wilsenach, 2010) can separate waste and offset overload on the one-pipe-to-treatment-plant model (Wilsenach, 2010). Organic waste can be treated on site, or in nutrient rich streams and storm water can be diverted so that it does not go into the sewers. In addition, waste-water treatment plants can be energy neutral, and capable of producing high quality waste water effluent output (Wilsenach, 2010). In the long run, the city will face less expense by implementing these types of sustainable system strategies now (Doshi et al., 2007).

As discussed, Girardet (2004) argues that to be sustainable, cities must mimic nature's circular metabolisms, where every output is an input for another biological function. Cities will only survive, according to Girardet (2004), if their metabolism, becomes circular like nature.

By creating infrastructure that supports efficient consumption, Stellenbosch could address the social implications of sustainability. Adequate sanitation services are needed in informal settlements, however, strategies such as UD toilets, as can be seen in the discussion, are considered inferior or not of adequate social standing. In general, sanitation service for the informal settlements are politicized in the South African context, weighted with bipartisan divisions, race, poverty, and human rights issues. The delivery of sanitation services is challenged to provide systems within perceived adequacy and with resource efficient infrastructures (Sebitosi, 2012). The delivery of services is hampered by these issues, which obscures the current threats facing resource use and the opportunity for sustainable solutions.

This is human behaviour as it relates to socio-technical systems. Modern citizenship, has perceived rights and obligations to services and goods. Its consumption patterns are attributes and responses to socio-technology networks (Guy et al., 2001). Services and technology support a perceived new quality of life and symbolize modernism (Guy et al., 2001). The development of modern infrastructure promotes a view of a stabilized social life, and creates forms of consumption related to the social construction of class (Guy et al., 2001). A standardization of products to meet economies of scale, creates homogenous patterns of behaviour, and the passive consumer, uses technology to "locate themselves socially in the world." (Guy et al., 2001, p. as in Wagner, 1994: 88). This cements social patterns of consumption and limits conservation and innovation (Guy et al., 2001, p. 30).

In Stellenbosch, there is a clear link and untold potential between providing efficient and adequate infrastructure, investing in ecosystem services and uplifting the poor. As Davis (2010) points out, there is an overlooked affinity between environmental justice and social conditions (Davis, 2010). In South Africa, the paradox is that the lack of adequate treatment plant capacity is affecting the ability of government to build new housing (Sebitosi, 2012).

The upliftment of the poor, can be tied to a sustainable response to global and local ecological crisis (Davis, 2010). Improving the services provided to the poor will result in an improved environment and its ecosystem services. It follows that improving the capacity of the environment to provide services, will benefit societies well being including the poor, and further the capacity of ecosystems for provisioning services to the poor.

Clearly, the challenges facing Stellenbosch's waste infrastructure and water resources will require the participation of all the town's actors. Changes in societies behaviors and consumption patterns can be reinforced by the city through information and communication. "Public space has no meaning unless it is activated with our actions and life stories." (Kaden, 2012: 250)

Watershed principles

Society or, culture, economics and history, are defined by place and in turn define place. The town of Stellenbosch can endenger its citizens to embrace a concept of shared place and actions for the common good, by informing them about the greater watershed in which they live (State of California n.d.). In a town divided by race and class, the watershed principle creates a politically neutral point of reference, and one that is easily accessible (State of California, n.d.).

Water is a resource everyone uses. It is a visible resource as is its quality or degradation. To understand flows and run off is to understand actions and consequences as they relate to the common good of a river. Actions that support and enhance a watershed are acts of citizenship for the commons of water (State of California, n.d.). To understand one's place in the watershed system and act responsibly, is to understand relationships that are apolitical, yet profoundly active.

The historical definition of a watershed is the divide between two river drainages (State of California, n.d.). A more recent use of the word, and the one discussed here, is a river catchment or basin (State of California, n.d.). The management of a watershed is effectively, an organizing concept for managing the basic elements of a watershed systems, hydrology, biology, geology, and sociology (State of California, n.d.). This resource management approach means crossing municipal or provincial boundaries, as river systems typically are not contained within these lines.

For example, the Stellenbosch Municipality has two watershed systems. The Eerste River, which is fed by four perennial rivers and the Franschoek river, and its tributaries, which feed into the Great Berg. Both these systems flow to outlets outside of the Municipalities jurisdiction. The Eerste river is joined by the Kuils river in Cape Town municipality and the Great Berg also flows into and through the Cape Town municipality after leaving Stellenbosch boundaries. As these rivers leave Stellenbosch, they carry all rainwater, mountain stream run off, sewage seepage, water borne debris, and pollution.

According to the California Watershed program, a watershed approach can be interpreted in three ways, each with distinctly different outcomes (State of California, n.d.). The first two, both

a physical, or geographic representation, and a set of management actions, are mechanical in nature. Management is by separate teams or departments that emphasize procedure. These two approaches do not focus on complex dynamics nor do they demand a different perspective in viewing a watershed (State of California, n.d.).

The third approach, and the one relevant to this discussion is described by the California Watershed program, as a set of principles. This approach uses guidelines that integrate diverse processes that affect the conditions in the watershed (State of California, n.d.). The principles are:

- “Places emphasis on the dynamics that generate change
- Promotes creativity, consensus and collaboration
- Allows generation of new creative prototypes for natural resource management.
- Encourages creation of new approaches to meet the purposes of existing programs.
- Encourages the improvement of both the efficacy and efficiency of resource management efforts in achieving the goals of the watershed community.
- Emphasizes the way communication is developed and maintained, and values the quality of information exchange that informs the public dialogue.” (State of California, n.d.: 3).

Watershed management, guided by these principles, is an effective scale to manage natural resources for communities dependent on the sustainability of resources [CA Watershed Program]. Additionally,

“it presents a common reference point for the many different activities and actors that affect the system and promotes greater integration and collaboration among those actions.” (State of California, n.d.: 3).

Defining the resource of water as a watershed, extends the idea of public space to ecosystem services. Public space or shared space is where identity, citizenship, and a sense of belonging to a place and a community are negotiated (Kaden, 2012). It contributes to a community’s sense of place as a contact zone for imagining place (Kaden, 2012). It offers opportunities for interlinking diverse local cultures and sharing a common good (Kaden, 2012; State of California, n.d.).

Conclusion

Stellenbosch requires the innovation of its citizenry and municipality to build a sustainable future. It must upgrade its infrastructures in sustainable ways that mimic nature’s closed loop systems. Its citizenry must adopt efficient consumption patterns that are supported by efficient infrastructure. This all requires, as Kaden (2012) points out, the imagining of place. The watershed principle

replaces the orthodox thinking of a river as a single flow with the concept of a connected network. It is through the understanding of these connected networks, and implementing sustainable socio-technical relationships that Stellenbosch has a hope of becoming a sustainable town.

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