ARCHITECTURE FOR LIFE: EXPLORING REGENERATIVE AND RESILIENCE THINKING

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AS BUILT-ENVIRONMENT theory evolves, so does the awareness that built environments form an integral part of natural systems. Living systems are capable of regeneration, resiliently adapting to pressures in order to sustain life. Through this perspective, the role of architecture in our cities is an opportunity to catalyse renewal in the urban system by working with and integrating various systems of life. Using the theme of water, this paper explores the latent potential of degraded urban sites to inform architecture that unlocks processes of renewal, resilience and regeneration in natural and social systems.

AN ECOLOGICAL PERSPECTIVE

Many modern cities have been shaped by an Enlightenment world view, in which nature was seen as separate from humans and their habitats – a force to be controlled and bent to the service of humanity. Natural systems became resources to be exploited without consideration for the long-term effects; this in spite of the fact that humans have an inherent need to be part of nature (Wilson, 1984; Kellert, et al., 2008). This reductionist thinking sought to 'simplify the urban system and make it intelligible by breaking it down into sub-systems, whose individual optimisation leads to the sub-optimisation of the whole' (Salat, 2011: 476). Today, the disconnection between built and natural environments threatens the physical functions of cities, along with the physiological and psychological well-being of its citizens.

One response is to see the city as an ecosystem (e.g. McHarg, 1967; Lyle, 1994; Rees, 1997), instead of an engineering and economic system. This has led to several approaches: urban ecology; using ecological concepts as metaphors or guidelines for human activities (e.g. urban metabolism, ecological footprinting, resilience); and using nature itself as the metaphor to guide the physical development of cities (e.g. ecological design and engineering, biomimicry). These approaches are founded in an emerging world view that reintegrates humans and nature as partners in the biophysical world. The ecological worldview recognises the inevitability of change and that it is the quality and diversity of life on earth we need to sustain, rather than the status quo. The far-reaching changes in ecological, social and economic systems expected in the 21st century will change the world as we know it. From this proactive perspective, two complementary concepts emerge – resilience and regeneration – which are two powerful strategies for this transition.

Urban resilience can be described as the capacity of a city to adapt to change, brought about by slow pressures or rapid-pulse disturbances. It is a passive quality, representing 'the life-sustaining aspect of nature that yields to external forces and, in that yielding, keeps the system from failing or being destroyed' (Du Plessis, 2013: 35). Cities can experience both 'positive' resilience, brought about through healthy diversity (e.g. alternative roads to avoid a traffic jam), or 'negative' resilience brought about through lock-in (e.g. politics stalling the provision of affordable housing).

At times, the goal of creating a thriving city may necessitate that a system is allowed to collapse and regenerate. This places a responsibility on professionals hoping to be 'resilient and regenerative' – they must be able to identify which aspects may need to collapse in order to provide room for new life to take root (Du Plessis, 2013: 38). Transformative resilience recovers a system's health (Chapin, et al., 2009; Gotham and Campanella, 2010) and is brought about through regenerative design, an active quality that renews the system.

The point of departure for the projects discussed in this paper, is to build conditions for life to regenerate the degraded sites that require systemic transformation in Pretoria.

LATENT POTENTIAL: PRETORIA'S FRESHWATER SYSTEMS

The story of disconnection from natural systems in Pretoria is ironic, since its connection to water was integral to its establishment (Dippenaar, 2013: 6). The abundance of water and game drew many communities, such as the Bakwena in the 1600s and the Matabele in 1825 (Andrews and Ploeger, 1989: 2), to settle in the area between the Apies river and the Steenhovenspruit. British and Boer settlers began to arrive thereafter and, in 1853, portions of the newly established Daspoort and Elandspoort farms were consolidated to form the town.

As Pretoria evolved from a settlement to a city, the demand on local water resources could no longer be sustained (Dippenaar, 2013) and the unmaking of the city began. Water was mainly sourced from the Apies River through furrows, but the river would often burst its banks (Engelbrecht et al., 1952: 66). In 1863, the *Zuid Afrikaanse Republiek (ZAR)* increased its water supply by accessing two springs at Fountains Valley. The visibility of the water diminished after the early 1890s, when a weir was constructed just below the upper and lower fountains to feed water along the streets through brick-lined furrows with slate covers (ibid, 1952: 26). Andrews and Ploeger (1989: 6) describe the early town as 'disorganised; water from the aqueducts (water furrows) overflowed and the streets needed urgent care'. The 1880 floods (Engelbrecht et al., 1952: 100), led to the decision to canalise the seasonal Apies, Steenhoven- and Walkerspruits streams, thus interfering with their natural flow and denigrating rivers to stormwater channels (Jordaan, 1989: 28). These were eventually sunken underground and now present a high risk for sink holes. In most instances, the city's support systems have been removed far from sight, perpetuating the deterioration of the system. The urban water quality and quantity crisis is becoming so acute that many are recognising it as a pronounced environmental problem (Dippenaar, 2013), making the regeneration of this natural resource paramount to the resilience of Pretoria.

FIGURE 1
Pretoria in 1886, as seen from Daspoort Ridge. In the foreground is the confluence of the Apies River and Steenhovenspruit. (Le Roux (ed.), 1991: 64).

POINTS OF OPPORTUNITY: REMAKING THE CITY THROUGH THE REGENERATIVE POWER OF WATER

The restorative qualities of water have been recognised by urban dwellers since ancient times (Kellert, Heerwagen and Mador, 2008). Conversely, dysfunction in a city's water systems can have disastrous consequences. Pretoria's relationship to water and its influence in the 'making', 'unmaking' and possible remaking of the city is investigated through four MArch theses exploring regenerative architecture in neglected sites: Ingmar Büchner examined latent potentials at the Monument Park Quarry; Heidi van Eeden investigated industry at the Daspoort waste-water treatment works; Marié Cronjé tapped into networks at the Steenhovenspruit Canal; and Carla Taljaard explored transformative processes at the Era Brickworks.[1]

Abuse of water systems in these sites resulted in a reduced ability to provide services, such as clean water, social amenities and economic activity. This begs the question: in systems that have collapsed or are at the brink of collapse, how can a) collapse be transitioned or sped up; b) the latent potentials be harnessed for new uses; and c) existing narratives inform new interventions that build on positive qualities rather than trying to 'fix the problems'? This informed the following investigations, which aimed to make the symbiosis between the water system and its social system resilient in adapting to change and regenerative in its functioning.

MONUMENT PARK QUARRY: HUMAN ACTION MITIGATED BY PLACE-SOURCED POTENTIALS

The Rosema and Klaver coal-fired brick factory started production in 1933 (Van der Merwe, 2013: 41). The site has had many 'vocations, from ecological habitat, to resource deposit, productive industry [and, finally,] a naturally reclaimed habitat' (Büchner, 2013: 20). Although the quarry enabled the construction of the surrounding fabric *(Fig. 2)*, its intrusive operations met with community pressure in the 1980s, resulting in a court order giving the company 10 years to close down. Invasive Black Wattle species, which further compromised the ecosystems, were introduced to mitigate noise and dust. Mining operations were curtailed when the quarry excavation hit one of many underground springs and this, together with economic pressures and a workers' strike, resulted in the mine closure around 1993 (Van der Merwe, 2013:40).

The site is currently inhabited by a small group of homeless people and its infrastructure, partially demolished for safety reasons, is overgrown. While the 'unmaking' of the quarry site began through mining activity, it unlocked ecological potential in the form of a large water body. Without an understanding of this new potential for regeneration on the site, it risks becoming another gated estate in a city already suffering the consequences of this typology *(Fig. 2)*.

The water body has patent and latent potential for social and ecological resilience *(Fig. 3)*, represented by three 'potential sets' (Büchner, 2013: 34-47).

Social potential exists in the recreational and functional benefit it will offer the surrounding communities (Büchner, 2013: 38).

Historical potential is evident in the residual industrial infrastructure; remaining building materials can be reused, while extant fabric tells the story of 'place' through original functional operations informing new production processes.

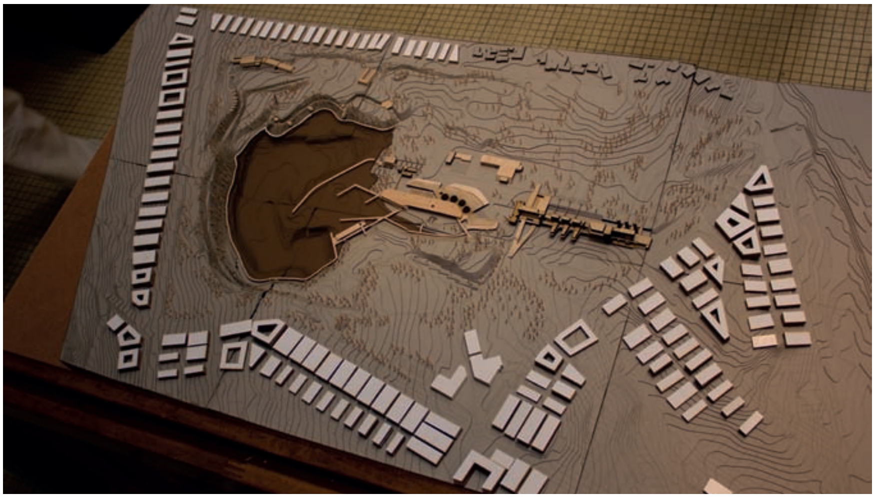
Biophysical potential exists in the landforms, microclimate, ecology and large water body; the by-products of clay mining are not too pollutive, so invasive flora can be replaced with indigenous species to increase biodiversity.

Integrated fish farming can be introduced in a closed-loop system, where the by-products of one process feed the next. These processes will include, among others, algae farming, mulberry farming and silk production, which in turn will foster industrial decentralisation, artisanal industry and various natural water-treatment processes.

Educational facilities will provide new knowledge, either directly through lectures and tours, or indirectly through movement routes that intersect historical elements, production processes and the natural topography. Recreation will be provided through restaurants, nature walks and water activities. But, most importantly, the architecture will be made and organised in a manner that allows visitors and inhabitants to reconnect with nature.

New buildings will be formally influenced by existing landforms; extant ruins will determine the architectural pattern for new production spaces, land forms and water-edge conditions, while new experiential routes will cross these elements creating internal and external pathways *(Fig. 3)*.

FIGURE 2
The quarry site in 1976, surrounded by the transforming Monument Park (Büchner, 2013: 29).



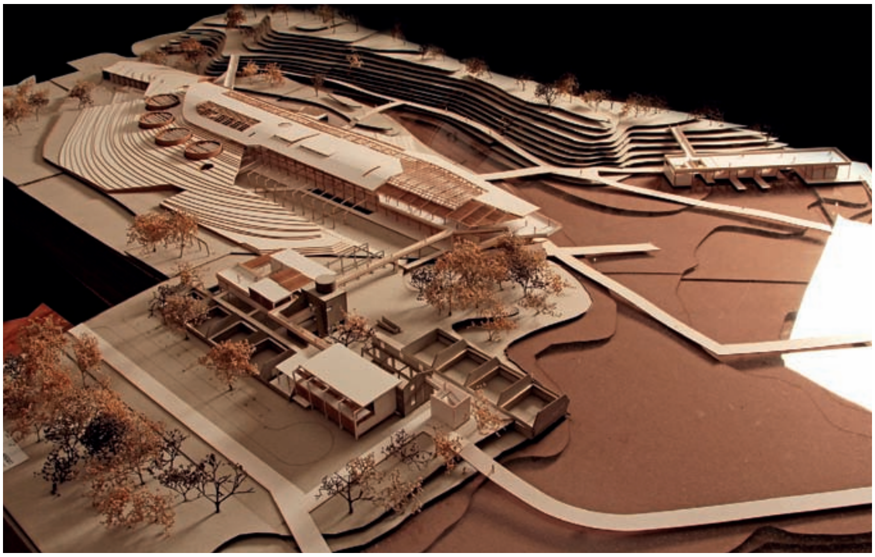


FIGURE 3
Top: The final site model showing the water body and various agricultural facilities housed in and alongside the new building, located in the centre of the site (Author B, 2013). Bottom: Model of the facility, with adapted heritage fabric in the foreground (Buchner, 2014).

FIGURE 4
The Daspoort Waste Water Works site with its settling tanks in the foreground, leftover Marabastad heritage to the right and, in the background, the Daspoort ridge (Van Eeden, 2013: 6-5).

DASPOORT WASTE WATER TREATMENT WORKS: THE POLITICS OF SEPARATION ALLEVIATED BY A BIOMECHANICAL MACHINE

North of Marabastad, a culturally significant district and transit node, lies the Daspoort Waste Water Works that was constructed in 1913 *(Fig. 4)*, in response to polluted water furrows. It was erected at the confluence of the Apies River and Steenhovenspruit (Jenkins, 1955: 364), separating the community from a valuable resource. This separation was exacerbated by the canalisation of Steenhovenspruit in the 1920s and later by the railway line, Bel Ombre station and an incomplete freeway project. The plant's infrastructure has been upgraded over time, leaving in its wake abandoned structures and outdated technologies of which at least a third are currently underutilised *(Fig. 4)*.

The site provides opportunities to link Marabastad with its historic natural border, preventing further degradation, and to allow new resilient production processes to improve the local economy. A proposed 21st-century textile mill reflects the architecture of a 'living machine' (Van Eeden[2], 2013: 8_6). Unlike traditional production processes that drain natural resources, the new textile mill acts as a biomechanical device that links industry with nature and the community with economic opportunities. The 'Machinarium' (ibid, 2013: 1_3) consists of interactive parts that 'have some form of life, and are therefore unpredictable and largely uncontrollable' (ibid, 2013: 8_6). The Western edge of the mill borders the existing water-treatment works, and acts as a literal and metaphorical filter of its water and production processes.

Mills tend to consume large quantities of water, but 'Machinarium' takes over some of the functions of the Daspoort plant by directing water through an 'architectural aqueduct' (ibid, 2013:8_10), before discharging it through a series of filtering ponds into agricultural fields and the Apies River *(Fig. 5)*. Water is also used for hydropower, steam generation, algae cultivation, evaporative cooling and irrigation (ibid, 2013: 8_19). To the East, the truncated Jerusalem Street is extended to meet the Apies River, reconnecting the inhabitants with nature.

Industrial activities are exposed on the Eastern edge of the mill where steam, used to drive the rotating wheel, is expelled over the main public square. Spatial experience is heightened by algaculture water walls that filter daylight, and dying processes that exhibit through colourful canopies.

New functions such as fashion, education and crafts provide the visitor and local inhabitant alike with varied economic opportunities.

FIGURE 5
Top: Photo of 'Machinarium' model (Author B, 2013). Bottom: The use of natural dyes as walls and the extension of the natural habitat into public spaces (Van Eeden, 2013).

An existing furrow, possibly part of the old water-supply system of Pretoria, has been given new life as a stormwater garden that feeds the adjacent fibre-growing fields. The old Marabastad church is enveloped by a pond, celebrating its historical significance and renewal. 'By exposing water as an architectural device, hydrology becomes an embedded layer of the human environment and is no longer seen as a separate natural resource' (ibid, 2013: 8_10). The 'Machinarium' breathes life into a derelict environment. A true 21st-century mill adapts the old, mitigates the present and postulates a resilient future *(Fig. 5)*.

CONTROL VERSUS OPPORTUNISM: SYSTEMIC PARTICIPATION IN MARABASTAD, USING THE STEENHOVENSPRUIT CANAL AS A SOURCE OF TRANSFORMATIVE RESILIENCE

Initially, the Steenhovenspruit formed a natural boundary between racial groups that was aggravated by canalisation during the 1920s. Between 1938 and 1965, Marabastad was affected by forced removals and extensive demolition of its fine-grained urban fabric (Cronjé, 2013: 56). Only the Boom Street precinct remains, as evidence of a suburb previously described as the only area in Pretoria exhibiting the complex characteristics of a true city (Le Roux (ed.), 1991: 109).

Today, in the absence of adequate services, trade and opportunism (Cronjé, 2013: 57) extend to the use of the Steenhovenspruit as a sheltered hiding place to wash or discard waste *(Fig. 6)*. Marabastad's culture of opportunism is highly resilient and a source of economic energy, however it sustains perverse activities that inhibit local social and ecological well-being. Past strategies have focused on 'fixing the problem' by eradicating negative aspects, rather than understanding this resilience or its regenerative potential *(Fig. 6)*.

The service provided by Steenhovenspruit can be augmented by increasing direct dependence on its resource, thereby encouraging more responsible water use (Kellert, Heerwagen and Mador, 2008). The proposed design on a site adjacent to Steenhovenspruit and Boom Street makes water more accessible and builds on 'various and diverse interactions between different actors within existing systems' (Cronjé, 2013: 123). Social and ecological interactions were mapped and then systemically integrated to generate

FIGURE 6
The canalised Steenhovenspruit and surrounds, in 2013 (Cronje, 2013: 69).

an architectural solution that builds on historical production (beer brewing, bread baking) and existing trade. Interactions were grouped into three networks; 'natural' is seen as the primary and all-encompassing driver of regeneration, subsequently embracing 'social' and 'economic' renewal.

The 'natural' driver is tackled by filtering polluted canal water through wetlands and retention ponds upstream. Canal banks are stepped using vegetated gabions, and widened to mitigate flooding and improve visibility. The base flow in the canal is diverted into the building, where a spiral pump generates electricity.

Rain water is harvested and treated for use within the building and to irrigate productive gardens, while permeable surfaces allow excess rainwater to replenish the groundwater table. Perishable foods, currently discarded by traders on site, are 'harvested' for brewing or composting within an integrated collection space, located on the ground floor; 'social problems' will be harnessed for their potential to strengthen ecological networks.

The ability 'to recognise and exploit opportunity' (Cronjé, 2013: 40), as has been demonstrated through Marabastad's resilient history of subletting, illegal beer brewing and informal street trade, will also be harnessed. Building edges encourage 'exploitation', while social spaces link to the canal. The characteristic Marabastad retail street-edge typology, along Boom Street, will continue to support the strong networks between formal and informal economies *(Fig. 7)*.

FIGURE 7
The final model with canal, centre right, social spaces under the pergola, spiral-pump system with water tanks in the centre and formal retail on the street edge, left (Author P, 2013).

CONFLUENCE OF POTENTIAL: REVERSING INDUSTRIAL STIGMA AT THE ERA BRICKWORKS

The convergence of the Moreletta and Rietspruit rivers in Silverton was influenced by three significant factors (Taljaard, 2013: 12). Firstly, a third trade route North through a fault in the mountain range stimulated industrial production. Secondly, the deposit of silt and other soils, ideal for clay-brick manufacture, enabled the establishment of the Era Brickworks *(Fig. 8)*. Lastly, political forces perpetuated racial segregation on either side of the two rivers, with the use of an industrial buffer zone. The brickworks lies within the buffer, but clay levels have been depleted and production is in its final decade. Social amenities within the buffer zone have had limited success, while park areas remain unsafe and cut off, perpetuating the stigma of industrial activity *(Fig. 8)*.

FIGURE 8
The Era Brickworks, with clay factory in the foreground and Rietspruit, top right (Taljaard, 2013: 20).

The brickworks closure will profoundly affect the broader area. This revolutionary phase in the long-term evolution of the site is seen 'not as loss or abandonment of obsolete capital, but as the release of energy and potential that can be positively restructured' (Taljaard, 2013: 17). It represents an opportunity to re-envision the life of the site, by integrating its water sources into the broader context and stitching together the social-ecological pieces of the segregated urban wasteland.

Complementary potentials on site shift between evolution and resistance (ibid, 2013: 17). Water formed a primary component of the first potential set, which led to an intervention that harnesses the clay-producing potential and existing workforce, on site, to create a craft-based ceramic production facility (utilising the quarry, existing warehouses and kilns). The second potential, memory and imagination, involves perceptions towards industry and the buffering green space. By creating a porous public building that allows life to flow through the industrial structures, interaction is encouraged. Preservation of the cultural landscape allows obsolete industrial material to transform into a positive public amenity, which challenges the stigma surrounding industrial processes and evokes stewardship of the site.

Finally, the site has the capacity to transform, while maintaining its identity and primary functions. An imminent disturbance will be the brickworks closure; however skilled labour, flat open space, tangible cultural landscape, clay residues and a large water body will be immediately available. All these potentials can be utilised in the ceramic facility within existing buildings, with new studio spaces being built in a sunken courtyard along an inhabitable brick wall 'spine' that blurs the line between nature and industry *(Fig 9)*. New kilns sensitively replace some of the obsolete heritage infrastructure and create an efficient closed-looped system that also heats water for the entire building.

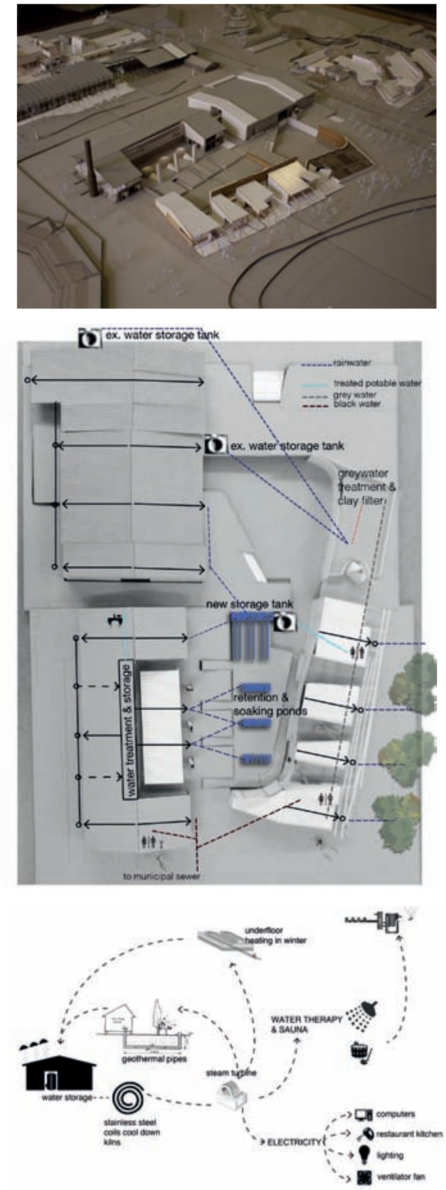


FIGURE 9
Top: Rendering of the final proposal, with new additions set against existing grey-coloured extant factory spaces. Bottom: Various water strategies (Taljaard, 2013: 104, 105).

CONCLUSION

The extension of buildings beyond their physical domain enhances their capacity to adapt, evolve and nurture the diversity of life within cities. Four Masters projects reveal latent potential, within derelict sites, that could rebuild urban quality and generate awareness about the broader urban ecology. Strategies are based on the unique story of place at each site, where water inspires resilience and regeneration in the architectural solution. Closed-loop food production and social activities inform the design of buildings that are moulded into their landscape, redirecting flows of energy to build social-ecological capacity. Resilience and regenerative thinking offers clues to a positive future vision for architecture, that can evolve and inspire the building practice to sustain a diversity of life.

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2. Heidi van Eeden recently won the national Corobrik student competition.

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