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Informal Settlement Upgrading in South Africa: A Preliminary Regenerative Perspective

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Abstract: Informal settlement upgrading is commonly practised worldwide, but often in technical ways, paying little attention to the physical environment. Regenerative development provides an ecological response and emphasises human development concerns. In this paper, we adopt a social constructivist approach to investigating the meaning of construction processes and the value of regenerative development in an informal upgrading process in South Africa. We used data from 18 projects and five in-depth interviews. Our findings show how waste can be used in this process, and that regenerative development delivers houses that are better insulated and avoid some of the risks associated with houses constructed by informal settlers. The value of the project lies in the acceptance of eco-building and the development of an attachment to the physical environment. Regenerative development facilitates self-help, which in turn supports the user value of these houses. We found considerable human development linked to regenerative development. Our findings show that, in addition to providing shelter, regenerative development encourages artistry and imagination, gets members of the community to work together, promotes social empowerment, improves physical and mental health, and fosters enjoyment.

Keywords: informal settlement; upgrading; sustainability development; regenerative development; eco-building; housing policy; South Africa

1. Introduction

The built environment of cities is a significant contributor to global warming. It creates waste, consumes intense energy and requires large-scale engineering. Green building has become a prominent response to addressing climate change [1]. Green building includes earth building, which is a centuries-old building technology [2,3], applied by many people across the globe [4]. Earth building has substantial benefits for sustainability, cost reduction and energy saving. However, sustainability debates have evolved beyond a narrow focus on green building and earth construction. There is pressure to re-use building materials, reduce waste and create energy-efficient buildings. Regenerative development has become a prominent feature of city development [4,5]. It emphasises natural building processes (like earth building), the re-use of materials and the co-evolution of the human system with the ecosystem. The Natural Building Collective (NBC) is one of a handful of organisations that have been actively applying regenerative development through construction. Globally, their work is the best known and they have developed the best resource materials, warranting reflection on their work. The NBC emphasises building materials that are "locally sourced, natural and kind to the environment" and help to reduce energy use and the carbon footprint of buildings [6]. At the same time, the NBC emphasises the sensory and tactile experience of construction in nature, with products

from nature. A range of technical support materials has been developed within the broader principles of regenerative development [7]. However, despite technical and conceptual progress in regenerative development, practitioners and governments have not applied it to informal settlement upgrading.

Higher levels of urbanisation after World War II caused informal settlements to mushroom in many cities of the Global South. A typical government response was to demolish them. Work by various scholars, notably Abrams, Mangin and Turner, helped to change this negative response in favour of a more accommodating policy position [8–10]. More recent work points out that self-help housing was not unknown at the time, and was common practice in some Latin American countries [11,12]. Nevertheless, undoubtedly Abrams, Mangin and Turner brought the value of self-help housing to the attention of a wider audience. Turner emphasises what he called "dweller control"—i.e., the notion of the user being in control of design, construction and management—and argues that this concept is essential if people are to be satisfied with their houses [10].

Turner's ideas laid the foundation for the World Bank to devise a strategy for informal settlement upgrading. By the 1970s, the World Bank had provided an economic rationale by emphasising affordability, cost recovery and replicability [13,14]. In practice, the World Bank supports site-and-services projects. Consequently, informal settlement developers who implement the World Bank's approach often emphasise physical infrastructure at the expense of human development [15]. Turner did not support these large-scale site-and-services projects, as they required large-scale investments from residents and they took for granted that building standards would be adhered to [11]. By the 1980s, the World Bank had begun to emphasise macroeconomic housing reforms and private-sector housing finance. By the 1990s, whole-sector housing development had become prominent [14] and sustainability concerns began to feature in housing responses. At the same time, the World Bank conceded that some countries needed a capital housing subsidy to deal with their problems. Currently, the UN-Habitat [16], the Millennium Development Goals [17] and the Sustainable Development Goals [18] dominate debates on informal settlement development. The debates feature terms like "cities without slums" and the "eradication of slums" [19]. In some circles, these terms have been interpreted as not supporting informal settlement upgrading; however, individual governments still fund informal settlement upgrading projects, but only a few have informal settlement upgrading policies in place [20].

In South Africa, policies on the upgrading of informal settlements have progressed since the market-oriented policies of the mid-1980s, which were closely associated with World Bank policies. The various developments have generated a substantial body of literature [20–23]. In 1992, the Independent Development Trust introduced a capital subsidy (in accordance with the World Bank proposals), and this subsidy became the dominant approach of post-apartheid policy. With the adoption of the White Paper on Housing in 1995, the housing subsidy programme—funded through a capital subsidy—became the de facto approach to informal settlement upgrading. The subsidy gave beneficiaries a house and services through a contractor-driven process. This approach was soon criticised for being inflexible, over-technical and neo-liberal [24,25]. By 2004, the government had embarked on a new informal settlement upgrading policy that was far more flexible and emphasised incremental processes. However, implementation was slow and historical thinking dominated implementation [26]. The term "sustainability" became embedded in policy on housing with the adoption of the Breaking New Ground housing plan. However, the term "sustainability" is under-utilised in practice and the policy makes virtually no reference to regenerative development practices.

The work is preliminary as an extensive set of interviews with a larger group of people is currently underway. We highlight three elements of regenerative development in this paper: an ecological worldview associated with regenerative development, the use of regenerative building materials for housing construction, and the contribution of the projects to user value and human development (including health). We argue that regenerative development builds on some of the advantages associated with self-help, but adds extensively to this way of thinking by emphasising eco-building and an ecological worldview and supporting a range of human development efforts. Furthermore,

housing and housing construction processes hold benefits for creating shelter, and, what is more, contribute to the enabling capacity of human development.

2. Towards Regenerative Development

The Brundtland Report, published in 1987, provided the institutional framework for the sustainable development paradigm. Brundtland defines "sustainability" as meeting the needs of the present without compromising the ability of future generations to meet their own needs. International conferences and events have laid down the principles for assessing sustainability. Major conferences in this regard were the Habitat Conferences, the World Summit on Sustainable Development, and the Rio+20 Earth Summit. Specific documents that contributed to promoting regenerative development were Agenda 21, the Millennium Development Goals and the Sustainable Development Goals. By the dawn of the 21st century, regenerative development had become one of many responses to the sustainability debate. Mang and Reed define *regenerative development* as approaches that seek to reverse the degeneration of the earth's natural systems while designing human networks that can co-evolve with natural systems [27].

2.1. Regenerative Development and the Ecological Mindset

The Industrial Revolution of the 18th century contributed to the development of a mechanistic worldview [28]. The rapid increase in the use of fossil fuel energy sources, such as coal, oil and natural gas, created growth that led to ever-increasing fossil-fuel dependency. A mechanistic worldview implies human control over nature, in the way that growth, production and consumption are controlled in a mechanical world [29]. This mechanistic worldview is often associated with climate change. The growth in the demand for ecological resources exceeds the planet's capacity to replenish itself [30]. The sustainability paradigm, rooted in an ecological or living-systems worldview, rose to prominence in the 1990s as the leading development framework addressing climate-change challenges [31].

Proponents of regenerative development emphasise an ecological worldview [29,32,33]. This worldview seeks to reconnect humans to nature and emphasises the use of natural rather than engineered processes. Mang and Reed trace the discourse on the ecological worldview and the built environment back to the late 1800s [27]. However, it was not until the 1970s that regenerative development gained momentum in the built environment [34–36]. The main aims of regenerative development are to revitalise, restore and renew materials, rather than to discard, and to create and improve ecosystems [37]. Regenerative development requires a design that is environmentally responsible [37] (see Figure 1).

Figure 1 shows Reed's idea of a continuum, ranging from a degenerating system (conventional practice and green) to one that is sustainable, restorative and ultimately regenerative. The design stages along the continuum are *sustainable*—sustaining the health of the earth's organisms and systems over time; *restorative*—using the activities of design and building to restore the local natural systems to a healthy state of self-organisation; and *regenerative*—engaging the co-evolution of the whole system [36]. The principles of the ecological worldview, encompassing sustainability, restoration and regeneration, require a new view of human relationships in development and design practices. Sustainable development mostly focuses on dealing with environmental constraints, limits and resource depletion. Regenerative development aims instead to extend development practices to integrate ecological and social development [32]. It advocates for a change in both human behaviour and worldviews relevant to how we design and create the built environment [27].

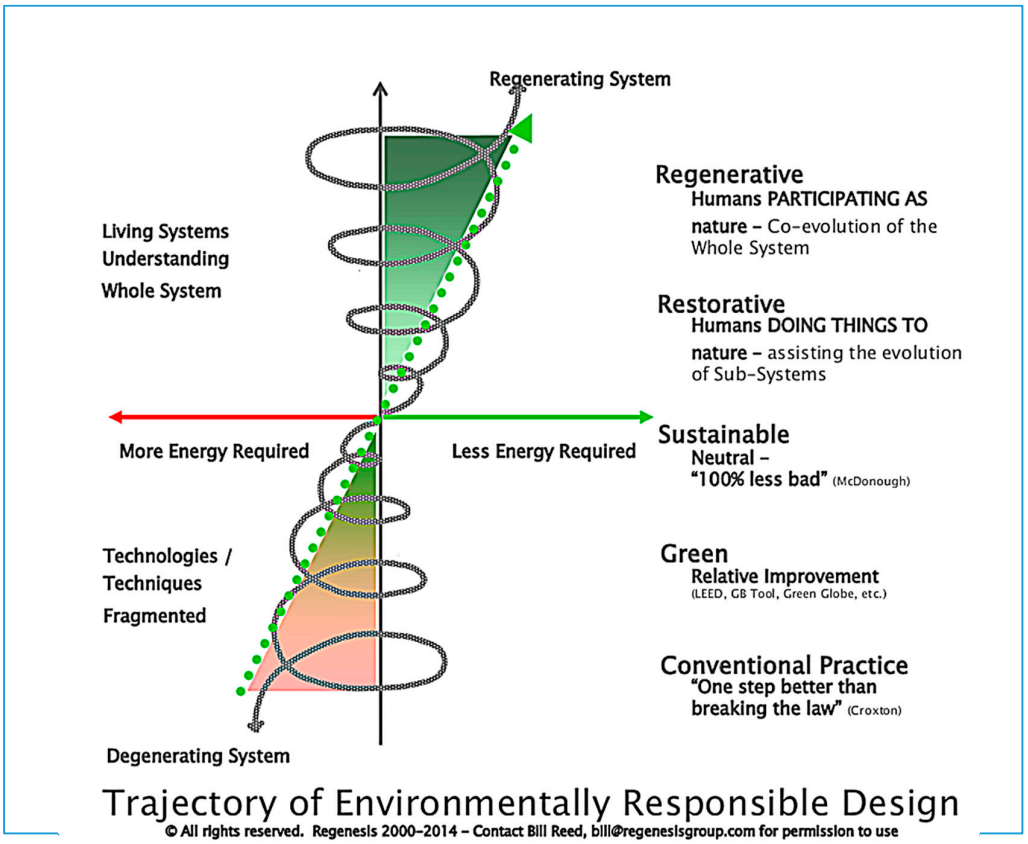

Figure 1. Trajectory of environmentally responsible design [33].

2.2. *Regenerative Development and Building Technologies*

Regenerative development also investigates the relationships between people, human activity and nature, and how these relate to buildings and architecture. Technologies associated with regenerative development and building are easy to apply and appropriate for a wide range of geographical contexts. Regenerative development applications are often in line with the appropriate technology [35], permaculture or living-systems methods [32]. Regenerative development technologies are environmentally sound applications, small-scale, decentralised, labour-intensive, energy-efficient, resilient to climate change, people-centred and controlled by the community [33]. Houses that are built in this way use a combination of indigenous building methods, natural materials and post-natural materials, such as recycled, re-used and repurposed waste material [38]. Other regenerative development technologies are rainwater harvesting and cultivating food in urban gardens. Implementation strategies include engagement in self-help processes and skills transfer [30]. Regenerative development provides a continuous learning platform on which experience is gained through learning by doing, sharing expertise, applying knowledge, focusing on the process rather than the outcome, and achieving results that could lead to generalisation and replicability [30]. Cole argues that a building is not "regenerated" in the same way that a living system self-heals and self-organises [38]. Within regenerative development, building activities become the catalyst for positive change at the unique place in which the activities are situated [31].

Freney's comprehensive research on post-occupancy evaluations of the architecture of "earthships" provides scientific evidence and environmental credentials for building with waste [39]. Earthships are earth-covered autonomous houses that are constructed with waste products like discarded tyres and bottles made of glass or plastic. Our case studies incorporated many of the materials used in the earthships that Freney describes in his research. Freney's study provides evidence supporting decades of technical research on the fire-resistance of compact tyres used in earth buildings. Highlighted in

Freney's research are thermal performance and climate resilience when using post-natural building material. Tyres are filled with non-combustible compacted earth mixed with waste and then covered with earth or lime plaster, which enhances the fire resistance [39].

Freney's study includes a thermal analysis across a wide range of locations and climates. The occupants of the compacted tyre and earth houses indicated a high degree of thermal comfort. They noted that they used little or no energy to warm or cool their buildings in extreme temperatures. Numerous studies also show the robustness of tyre buildings in withstanding floods and limiting damage in earthquake-prone areas [39]. Natural-disaster teams, trained in the compacted-tyre and earthship methods, responded by building emergency housing in earthquake-prone places such as Haiti, Guatemala, California, New Zealand and Japan.

2.3. Construction as a Process of Human Development and Healing

This section links capabilities, the value of occupation, and eco-building. These three concepts emphasise health, social interaction, emotional well-being, and the notion of being. Regenerative development links construction, self-healing and human development. Our emphasis in this paper is on human capabilities and social justice in the pursuit of human development. We do not provide a comprehensive overview of capabilities; instead, our brief overview provides the basis for linking capabilities with concepts of self-healing.

Sen laid the foundation for thinking about human capabilities and provided a list of such capabilities [40]. As Nussbaum later put it, "Instead of asking about people's satisfactions, or how much in the way of resources they can command, we ask about what they can do or be". She expanded Sen's list of capabilities to include physical health, bodily integrity, the utilisation of senses and avoidance of pain, imagination and thoughts, emotions, reasoning, affiliation with other people, associations with animals, play and enjoyment, and being in control of one's destiny [41,42].

To highlight the role of construction and self-healing, we borrowed the concepts "occupation" and "eco-building" from occupational therapy [43]. A lack of occupation often leads to concerns for well-being. The empowerment that is associated with occupation improves life quality and promotes occupational, physical, emotional and social well-being [44]. Meyer suggested that eco-building had many advantages for uniting a community in a common purpose [45]. Occupational engagement relates to an individual's subjective experience of doing, being, becoming and belonging [46]. Doing can be seen as a mechanism for social interaction, social growth and development, forming the foundation of a community's occupational identity. Being is the dimension that shifts and transforms most during occupational engagement and refers to one's lived experiences and self-discovery. The *state of becoming* relates to change and development, which is a continuous process during a person's life. *Belonging* refers to the connectedness among people because of their social interactions, mutual support, friendships and a sense of inclusion and affirmation from others [46].

In engaging in eco-building as a community practice, a community develops while the individuals in that community concentrate on their own needs and capabilities. We can say that eco-building is not just about constructing physical buildings; it also "builds" a community. This process is based on four principles: every member of the community has strengths to contribute towards the success of the programme; all members are seen to be experts in the community; all members are committed to the programme by taking responsibility for it and ultimately operating without external inputs; and the members' cultural awareness is essential to the success of the programme [45].

3. Methods

We discuss the methods in two parts: first, we discuss the four overlapping phases of the regenerative development and eco-building training programme operationalised in the Free State between 2013 and 2017; and second, the methods we used to conduct the interviews for this paper. Figure 2a,b show an initially informal house, and the same building after eco-building.

Figure 2. Upgraded informal house: (**a**) The original house in Caleb Motshabi (Mangaung Metro Municipality), 2016; (**b**) completed self-build house in Caleb Motshabi (Mangaung Metro Municipality), 2018.

3.1. Eco-Building Training Phases

The first phase of the eco-building training programme started in 2013. The project manager and seven volunteers initiated small-scale eco-building activities over weekends in a suburb in Bloemfontein and the township of Freedom Square in the Mangaung Metropolitan Municipality. During this phase, they explored the properties of eco-building materials. Structures built during this phase included walls built of compacted tyres and covered with cob mixes (local clay soil mixed with manure and straw), raised vegetable gardens built with glass bottles and cob, benches, fences, a greenhouse made of plastic bottles, and a system to manage household greywater using lime in combination with eco-building materials (Figure 3a,b). In 2014, volunteers who had participated in eco-building activities were invited to participate in a skills development programme managed by the University of the Free State.

The second phase started with a three-year grant of R2-million (±138 000 USD) received from the Government of Flanders. The grant funded a capacity-building programme and emphasised innovative eco-building technologies in marginalised communities. Participants in the capacity-building programme explored innovative building technologies as a way to bring about social change. This phase focused primarily on developing the technical skills of seven trainees from disadvantaged communities. Training took place at a local orphanage, a health clinic, a care centre for intellectually impaired schoolchildren, two public schools, a peri-urban smallholding, and four informal settlement sites in the Free State. Trainees were encouraged to explore a variety of eco-building skills through a learning-by-doing approach. International and local building experts also taught trainees technical skills to complete an innovative climate-resilient arts, crafts and cultural hub at the Lebone Village orphanage in the Mangaung Metro Municipality. Training during this phase covered building with a range of conventional, natural and eco-building methods. Eco-materials were combined with waste materials, such as tyres, glass and repurposed materials. Specific technical elements covered by the training were soil assessment and soil testing, sourcing building materials, waste integration with diverse building methods, cob mixes, and making adobe bricks with moulds. The trainees applied the building methods to foundations, rammed earth packed tyres, building loadbearing and non-loadbearing walls, free-standing roofing, decorative earth-art elements and food production. The seven trainees received a subsistence allowance for participating in the training programme at Lebone Village two days of the week. Figure 3a shows the layout of the Lebone Village arts, crafts and cultural hub and Figure 3b shows the completed hub in 2016. Volunteering activities continued at the site in Freedom Square over weekends. Technical experts led Lebone Village training activities, while the core group of volunteers who received training during the week started to manage other technology exploration projects.

Figure 3. The arts, crafts and cultural hub at Lebone Village (**a**) Layout plans for the Lebone Village arts, crafts and cultural hub, 2014; (**b**) Completed arts and crafts hub, Lebone Village, 2016.

The third phase of the training saw a gradual withdrawal of expertise as the trainees gained skills and the confidence to manage projects themselves. From 2016 onwards, the participants' role shifted as they became trainers in a variety of projects in the Free State. These new trainers run projects as a group, as well as individually in various towns. Participants were encouraged to design projects based on the skills they had mastered and to experiment with locally sourced materials. The trainees were in control of the building and management processes and experts provided mentorship based on the individual needs of each participant. The mentorship focus shifted from technical skills to project management skills. The project management skills involved design and implementation theory, decision-making, project facilitation with groups, record keeping, time management, and conflict resolution. Only two of the participants mastered all the project management skills. The other trainees had trouble with selected aspects of the training, because of shyness or low levels of project management skills. The technology exploration projects were not housing-related and included the completion of the arts, crafts and cultural hub at Lebone Village, six benches in outdoor recreational areas, two cob ovens, two play parks, a skateboard park, and a community permaculture project in the Free State. Eco-building projects took place in Mangaung (Bloemfontein and Botshabelo), Springfontein, Trompsburg, Fauresmith and Bultfontein (see Figures 4 and 5).

Figure 4. The original concept and construction process in Freedom Square, 2014–2019: (**a**) Springfontein, (**b**) Trompsburg, (**c**) Fauresmith and (**d**) Bultfontein.

Figure 5. Lesedi multi-purpose community development village, 2018: (**a**) Springfontein, (**b**) Trompsburg, (**c**) Fauresmith and (**d**) Bultfontein.

The last phase of the research was interrelated with the other phases. From 2015 to 2017, five of the seven individuals who had received training started to apply their eco-building knowledge in their communities. During this phase, the five participants completed five self-build houses in the Free State. The skills-training objectives shifted from project management skills to specific regenerative development skills that we also call *change agent qualities*. The training focused on concepts related to mentorship and volunteerism, multi-cultural social skills, skills transfer in a specific place and community, working independently, problem-solving and reviving and evolving indigenous and natural building knowledge systems. All the participants mastered the specific skills related to regenerative development much more comfortably than the formal aspects related to project management in the previous phase. The project was interdisciplinary and involved staff from more than five university departments and a large number of students.

3.2. Empirical Data and Interview Methods

For this paper, we used two sets of data: qualitative data from semi-structured interviews with five individuals involved in eco-building from 2014 to 2018 (one project manager involved in completing the Lebone Village arts, crafts and cultural hub and four individuals who constructed their own houses), and construction data from records kept by the project manager. The five participants, three men and two women, completed all the phases of the training and continued eco-building activities after the conclusion of funding by the Government of Flanders. Two were stroke survivors and three were elderly. These five interviewees were the only ones who had received the training and put it into practice, either constructing their own houses or working on the Lebone Village hub. We used a social constructionist approach [47] to understand the meaning of regenerative development and to assess its value for housing and informal settlement upgrading. Our interviewees were trained to search for the meaning of regenerative development that goes beyond a narrow focus on construction.

Two student researchers conducted the interviews together with one experienced social researcher who had not been involved in the building process. An interpreter accompanied the researchers to two of the interviews. The researchers engaged with the participants in creating a collage of photographs of the eco-building experiences and projects they had been involved in over the previous five years, to

help them remember their involvement. This was used as a supportive tool for eliciting memories and constructing responses in the semi-structured interviews with the participants. Each interview started with the creation of the collage, which took approximately two hours, after which the interview took one and a half hours. The semi-structured questions had two aims: to understand the individuals and their histories better and to understand their experiences of eco-building. Follow-up questions focused on two broad aspects: their experiences of working on the project, the degree to which the project had created an ecological world view and how the participants created meaning from the house and the construction process. We recorded and transcribed the data and did a thematic analysis, focusing on the relationship between the building process, the environment and the people involved.

The construction data were records of the different kinds of waste and how they were used. As waste removal in many informal settlements and low-income areas is inadequate, waste is readily available. The project manager accurately kept the records over the construction period. At the time the projects were designed, we did not conceptualise issues of energy use. It was only during the interviews, when participants noted their experiences, that we recognised this oversight.

We acknowledge three methodological limitations: (i) the small size of the sample—only five houses were constructed (although 13 other structures were also constructed as part of the training programme); (ii) the short period of the project, which did not allow sufficient time for adequate testing of the technical advantages recorded in similar international projects (for example indoor temperatures); and (iii) the possibility of interview bias, as our interviewees received a subsistence allowance as part of the training programme. To reduce possible bias, a person who had not been involved in the project did the thematic analysis of the interviews. The small sample resulted from these five respondents being the only ones who had been part of the complete process and had constructed a housing structure.

The Health Sciences Research Ethics Committee at the University of the Free State approved the research components in 2018. Participation in the research was voluntary and the research team obtained written consent from participants to use the data for research purposes.

4. Findings and Discussion

We present our findings under three themes, in line with our literature review: the importance of using materials that support regenerative development through construction, the role eco-building plays in developing an ecological worldview, and the interrelationship between user control, human development and healing in informal settlement upgrading. As pointed out earlier, we argue that there are advantages associated with self-help in informal settlement upgrading and that regenerative development emphasises the contribution of eco-building to environmental concerns about pollution. The findings also point to the development of an ecological worldview and support a range of human development efforts. Regenerative development helps to integrate these three aspects.

4.1. Materials for Housing Construction

Regenerative development and eco-building emphasise the use of waste for construction. Table 1 shows the waste materials that the builders used during the construction process. Approximately 13 500 tyres, collected from the local landfill sites or supplied by the non-profit company Recycling and Economic Development Initiative of South Africa (Redisa), were repurposed as "bricks" in the 18 projects conducted between 2013 and 2018 in the Free State. Each tyre "brick" was filled with compacted waste soil, unsuitable for conventional building or agriculture, or building rubble, mostly collected from illegal dumping sites. Each tyre was filled with on average of 0.2 m^3 of uncompacted soil, that is, approximately three wheelbarrow loads, which means that 2700 m^3, or 40 500 wheelbarrow loads of waste soil were repurposed in the projects. The compacted tyre bricks each weighed between 100 kg and 140 kg. Some 745 cob (local clay soil mixed with manure and straw) units of 0.3 m^3/m^2 were used during the projects. The soil was gathered from landfills and soil heaps in and around the informal settlement areas. No new soil excavation took place. Approximately 4700 plastic bottles and 29,000 glass bottles were used as eco-bricks. The builders further used 3.24 tonnes of non-biodegradable

waste to fill the plastic bottles, which they used in experimental projects as an example of using waste materials.

Table 1. Estimated waste material used in projects, 2014–2018.

Nature of the Project	Area and Details	Estimated Waste Resource Use		
		Tyres & Waste Soil		Glass Bottles (N)
		Tyres (N)	m^3 Waste Soil	
Self-build houses (5 projects)	Mangaung Metro Municipality (Freedom Square, Namibia Square, Caleb Motshabi, Roodewal) and Xhariep District Municipality (Springfontein)	1700	340	
Technology exploration (13 projects)	Mangaung Metro Municipality (9); Lebone Village arts, craft and cultural hub in Bloemspruit; Six benches and outside recreational structures in Freedom Square, Batho, Phelindaba, Phahameng, Roodewal, Botshabelo; Two cob ovens in Caleb Motshabi and Roodewal	11,800	2360	29,000
	Xhariep District Municipality (3); Two play parks in Springfontein and Fauresmith; Skateboard park with an outside recreational area in Trompsburg			
	Twelopele Local Municipality (1); Community and permaculture centre in Bultfontein			
	Total resources used	13,500	2700	29,000

As the table shows, the skills-training programme delivered five self-build houses and 13 smaller projects (see Figure 6) exploring the viability of various eco-building materials. The 13 smaller projects, which had mixed results, were the arts, crafts and cultural hub at Lebone Village; experimental play parks in Springfontein, Trompsburg and Fauresmith (Xhariep District Municipality); a variety of benches, walls, cob ovens and raised vegetable gardens in the Mangaung Metro Municipality; and an arts and community centre in Bultfontein (Tswelopele Local Municipality). Our data suggest four conclusions about the use of waste materials.

Figure 6. Experimental projects: (**a**) a cob oven in Caleb Motshabi (2018); (**b**) playground and fence-benches in Fauresmith (2016); (**c**) skateboard park in Trompsburg (2017); (**d**) and plastic and glass bottle demonstration workshop in Bloemfontein (2018).

First, the use of waste materials makes a significant contribution to waste recycling. Tyres and plastic bottles are major environmental polluters in South Africa. The South African government has been trying to reduce the negative environmental consequences of these products over the past two decades. While these numbers are small in the greater scheme of things, re-using over 13,500 tyres and 4700 plastic bottles is still noteworthy. Our interviewees pointed out how easy it was to collect these materials, since so many people were "getting rid of this stuff they don't want".

Second, building with waste materials cuts costs. One respondent observed that, "If you do not have money to put up a building, there is eco-building", and another noted that because they used natural and waste material resources, they only had to buy the roofing. Another respondent echoed this sentiment and added that, despite the low costs, the houses are strong.

Third, our qualitative data support international research findings that the temperature inside these eco-buildings generally showed an improvement on what was experienced in a corrugated iron shack. One respondent, comparing her current house with her original shack, said: "There is no window in a shack. In the winter, I would put my head in between my knees just so I could get warm". Then, in summer, she had to remove the blankets despite the risk of being bitten by mosquitoes. Another respondent said, "It is not nice living in a shack. My shack was small and had no windows, and it was very hot in summer". While these views are not based on a scientific enquiry about temperature, they provide anecdotal evidence of a benefit of eco-houses and confirm the international literature.

Finally, our respondents noted that alternative building materials contribute to a reduction in environmental risks. Informal houses, constructed from corrugated iron, pose considerable risks to personal safety, are vulnerable during thunderstorms and fires and are usually much smaller than eco-buildings. One respondent said that her house was safe and that "when there are thunderstorms people tend to run to my house".

4.2. The Ecological Worldview

According to our literature review, regenerative development supports the development of an ecological worldview. We noticed three distinct shifts in the worldviews of the five interviewees. They showed evidence of some form of attachment to nature and the future of the planet, which is central to regenerative development.

First, their view of waste had changed. One said: "You don't perceive it anymore as waste materials but as something you can use." This change is key to the ecological worldview. Second, three respondents linked eco-building to the need to address global warming concerns. One said: "And now the other positive impact is that you know that, when you look at the environment and poverty, [we're] looking at the climate change. I mean, for me, I've got to do everything to fight these things." Although our interviewees did not mention this, the better indoor temperatures should mean a reduction in energy use. Third, an ecological worldview goes beyond the construction process and includes water harvesting and urban agriculture, something all five interviewees did. Respondents used the words "start living green" regularly to express their commitment to an ecological worldview. One said, "People can grow their vegetables; you cannot separate eco-building from growing vegetables and all that". Fourth, it also creates opportunities for inter-generational learning. Two respondents proclaimed that it provided an opportunity to teach children "how to help the environment" by not "just [throwing] anything around" and that they should know "that you can recycle it". Another said: "When you say to a child, 'Look here, don't throw your sweet papers away, put them in a bottle, you are cleaning the environment', the child will not throw the papers away."

4.3. User Control, Human Development and Healing

Turner used his "dweller control" concept mainly in respect of building processes [10]. Our findings show that user control can lead to human development and healing. We highlight six findings from our interviews.

First, self-help work articulates the value of self-build and supports Turner's view that engagement in the construction process increases the user value of a house. One of the interviewees observed that people saw no need to live in a shack anymore, when they could "use their own hands to build their own house". Another said he felt happy because he had never thought he would "end up having this experience of building my own house", and added that that was why he liked the house so much. More than four decades ago, Turner argued that being able to make decisions about the construction process of a house created what he termed "dweller control". Using waste materials means that, in addition to dweller control, the builders develop a sense of ecological responsibility and attachment to place. It creates a more profound feeling of self-value, as we observed during the interviews.

Second, the project contributed to creative thinking and imagination, an essential element of Nussbaum's capabilities [42]. Many of the participating projects had an art component, which required some form of imagination. Beautifying the building was a vital element of the building process. A respondent said: "You sometimes think, maybe it was supposed to be like this; then the project helps you become innovative." Another suggested that "you need to shift the mindset—create something that the person will love; create a career out of it". This interviewee's reflection on a house someone would love indicates a deeper sense of attachment, substantially more than Turner's idea of "user value". The ability to imagine is a deeply rooted human capability [41] and was expressed as follows: "Look, it's just beautiful. It was not like this before. I can imagine. It is beautiful." These comments show that the project not only inspired artistic innovation, but also brought an acknowledgement that the project required a shift in mindset and a shift from uniform housing construction to creating something for which there is appreciation. The emphasis on beautifying houses through eco-building also stands in stark contrast to the mono-typology of the government-constructed houses in South Africa.

Third, the human development component was apparent in the social cohesion generated by the project. Both eco-building and capabilities emphasise attachment to other people. The ability to live for others is one of the main capabilities mentioned by Nussbaum [42]. One respondent said: "I have never been in an environment that I'm in now since . . . I'm feeling better because of this, because of *ubuntu*, because you're still in the same place you grew up but at the same time, you're at a different place." The term *ubuntu* refers to the notion of humane treatment but also to the feeling of being together or helping others. A respondent expressed it like this: "Working with people and helping people come through the building process; I love helping people." Another indication of social cohesion was the acknowledgement of the value of teamwork: "We are enjoying [ourselves] a lot because we are not working together every day—so when we meet, sometimes we become one family again—yes, we feel connected." The interviews revealed much caring at a community level.

Fourth, respondents agreed that the projects were empowering. Concerning the prolonged alternative of waiting for the government to provide houses, they often made comments like, "It empowers me" and "I could create change". They liked the idea of bringing about change without the assistance of the government. To them, eco-building was a way to empower communities, while one emphasised self-empowerment and not needing to rely on the government to provide houses. One of them expressed disappointment with the nature and scale of delivery of government houses as follows: "The time the government is taking to build and provide houses to these people. It means it's quite pathetic. They are busy with the RDP houses for how long. It's the 21st century and there are still shacks." Some interviewees also advised the government to stop building houses and to provide soil so that people could do the building themselves.

Fifth, the project also helped to heal physical and mental health problems, both central to capabilities and occupational value. One of the respondents, who had survived a stroke, said: "Everything that came to my mind [when he had the stroke] was that I was going to die. Before the sickness, I was just working; so, I'm happy because, if it weren't for this sickness, I wouldn't have gained this." He added that the eco-building project "brought back some of the pieces that I've lost; it gave me the idea of things that I thought I would never do or be able to do. I am me again and I see lots of the positive attitude from my side." Another respondent echoed these sentiments,

saying that because of being part of the project, "my body became better and better—I recovered—my body was weak but I am getting stronger." We also found evidence of mental health improvements. Respondents often referred to the building process as a form of therapy, as something that provided a sense of purpose, created joy (an important capability identified by Nussbaum), and fostered emotional involvement and the desire to do something.

Sixth, the regenerative development approach is committed to knowledge transfer and we found evidence of this. One respondent summarised it as follows: "I believe that the contemporary knowledge and skills that we acquire can be a key to the future." Knowledge sharing also took place for the university students who helped at the project and received training from the community members involved in the training process.

Despite the value explained above, the construction process was incremental and the builders did not apply for approval of the building plans. While some respondents did note that, eventually, legal recognition was required, the incremental nature of the building process was more suited for work outside formal building code applications, according to Turner's original view of the formal building processes.

5. Conclusions

Most commonly, governments regard informal settlement upgrading as a technical exercise. This originated from the World Bank's views of the 1970s. Apartheid and post-apartheid housing and informal settlement upgrading policies continued in line with this technical approach. Currently, South Africa has a progressive informal settlement policy, but implementation is slow and still dominated by technical approaches. We emphasised three aspects of regenerative development in this paper: waste building materials, the development of an ecological worldview, and the role of informal settlement upgrading and construction in human development and healing.

Our findings suggest that using waste material for building is a good source of regenerative development. The builders used substantial amounts of waste material in the construction process. Despite the small scale of their endeavours, the value of their efforts lies in the acceptance of eco-building and the development of an ecological worldview. The five interviewees all showed evidence of human development in the form of a changing worldview and the health, environmental and psychological benefits they said they were experiencing through self-build construction processes. Our findings show that those who were involved had developed an attachment to conserving the physical environment, a vital requirement of both regenerative development and human development. We drew comparisons between regenerative development, self-help concepts of housing as a process, Nussbaum's capabilities approach [41] and occupational therapy concepts of well-being.

Regenerative development mainly supports user value as identified by Turner and his peers. The findings point to increased user value through arts and self-build. Regenerative development goes beyond issues of user value. Our findings demonstrate the value of turning housing construction into art, and how that helps to stimulate the imagination, promote social empowerment, and offer enjoyment and physical and mental health benefits. Regenerative development also provides shelter, which it does better than informal houses constructed with corrugated iron. The training yielded results, and five of the seven initial trainees engaged in incremental, informal self-build processes based on the training they had received. Lastly, the research highlighted the enabling role that academia and capacitation grants play when engaging in regenerative development programmes that run over some years.

The eco-building projects continue despite a current lack of funding. Further research will expand the body of knowledge, but also should focus on aligning building codes with the eco-building approach. This requires a long-term engagement in challenging existing knowledge and practice.

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