Stone Soup and the Catalytic Power of Participatory Practice

"Art does not reproduce the visible; rather, it makes visible." - Paul Klee, *Creative Credo,* 1920

"...the lovely puzzles, the enchanting beauty, and the excruciating complexity and intractability of actual organisms in real places." - Stephen Jay Gould, 2002

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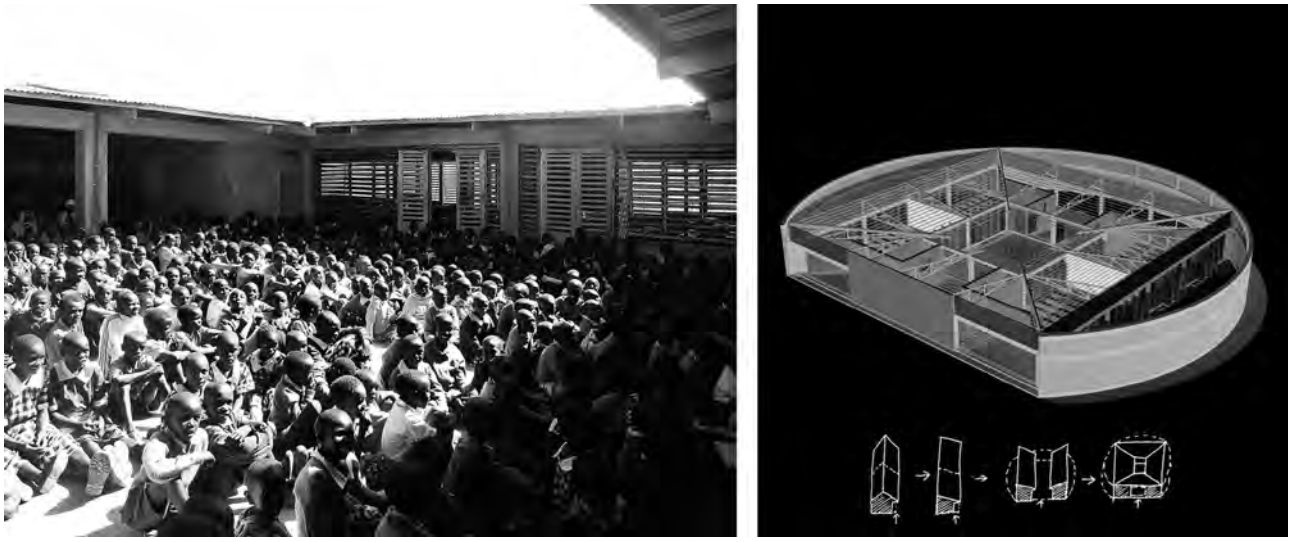
Contemporary architectural discourse about new modes of collaborative practice often focus on the production benefits of digital technology, parametric design, and rapid prototyping to the near exclusion of socio-economic considerations. Kenneth Frampton critiques this disjuncture in the edited volume *Building (in) the Future: Recasting Labor in Architecture.* He writes in this analysis of the current fascination with building cladding, "Thus we are confronted not only with a fetishistic emphasis on the membrane as an end in itself but also with the problematic displacement of the 'what' with the 'how.'"[1] In this post-critical climate, the architectural discipline has become increasingly preoccupied with the 'how' over the 'what, where, when and why.' Humanitarian aid projects for the global South often present the most troubling misalignment of socio-economic context and architectural technology when designers employ their normal mode of production with radically different collaborators and conditions. Such projects typically reject the value of participatory practice and incorporate building materials and advanced technologies that far exceed the acquisition, construction, and maintenance capacity of a particular social situation. For example, a federally funded adaptable pneumatic emergency housing project called *PNEUMO* uses a "self-activated building envelope regulation system" with an "integrated self-regulating hygrothermal and opto-mechanic membrane."[2] Lungi-clad Bangladeshis are photoshopped into these fragile "hygro-nanoreactive" homes. The challenging socio-economic, cultural, and physical realities of that place do not influence the parametrically generated form and technical diagrams that rationalize the object's parabolic profile and performance. One is left asking why and how this architecture was produced for this place at this moment in time. The *Divergent Modes of Engagement* call for papers poses two provocative questions in this regard. "What conflicts emerge when we collaborate with parties with different academic, cultural, professional, and disciplinary backgrounds and values? How might we capitalize on these conflicts to produce new social capacities and/or practice innovations?"[3] By examining the work of ATOPIA Research, this essay considers a mode of participatory practice emerging from an awareness of architecture's role in social justice challenges and the technical constraints of these contexts.



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ATOPIA Research is a critical practice that operates within the specific conditions of rural sub-Saharan Africa (dba PITCHAfrica). Principals Jane Harrison and David Turnbull have designed a series of smart and sustainable projects that advocate for "localized, decentralized and non-linear approaches to infrastructure design combined with direct community engagement in the management of resources and resource distribution."[4] They work in the central Kenyan highlands where deforestation and ongoing climate change produce increasingly erratic rain patterns of drought, torrential storms, and poor soil conditions. Access to clean drinking water is a major problem in the region. Rampant waterborne illness and associated malnutrition limit school attendance and long hours spent collecting water prevent many girls from attending school. ATOPIA clearly situates their work within these interconnected local challenges. "The population is rapidly growing, and current water usage trends are environmentally and economically unsustainable. To emerge from poverty, the region needs access to good quality water in sufficient quantity, water purification technology, and water availability and distribution systems."[5] Responding to these negative synergisms, they have developed a mode of participatory practice to design physical WATERBANKS with larger catalytic goals for disadvantaged communities.

WATERBANKS

This essay examines two recently completed WATERBANK schools that employ local labor, local materials, and local construction techniques. The form of each building was designed to collect, filter, and store large quantities of rainwater in a straightforward way. This approach critiques the normative Kenyan school type, which is a rectangular masonry barracks with small punched openings and a corrugated metal roof that deflects water. The Uaso Nyiro Waterbank School, located in Laikipia, Kenya and completed in 2012, is a sixteen-square, concrete grid structure that contains four classrooms around a central courtyard (fig. 1). An integral circular stone wall enclosing the square creates both protected open-air vegetable gardens and comfortable microclimates that provide natural ventilation and indirect daylight to the classrooms. Rough louvered wood doors modulate light and access between classrooms, perimeter gardens, and the central court. Water captured from the large roof is purified with ceramic filters and stored in a 150,000-litre cistern beneath the courtyard, while cooling the space for community gatherings. The strategic assemblage of simple local materials—stone, concrete, and wood—together create a sustainable and beautiful place for learning that harvests 350,000 liters of rainwater per year. The Uaso Nyiro Waterbank School was named The Greenest School on Earth in 2013 by the World Green Building Council and was selected for SUSTAINIA'S top 100 sustainable solutions for the Planet in 2013.

Figure 1: Uaso Nyiro Waterbank School, Laikipia, Kenya

The Endana Secondary School employs similar strategies to create a model WATERBANK campus with student dormitories, canteen, latrines, a PITCHKenya stadium, and five acres of conservation agriculture gardens. Like the Uaso Nyiro Waterbank School, each WATERBANK building on campus integrally harvests, filters, and stores large quantities of rainwater, while addressing other needs. In response to the problem of sexual assault for girls living away from their families, for instance, ATOPIA has designed a circular Girl's Dormitory inscribed with an equilateral triangle that provides a secure and comfortable central courtyard. This colorful building, twenty-four metres in diameter, has a playful array of tiny apertures that create dynamic light patterns and a sheltered environment for rest (fig. 2). The campus canteen and kitchen, a sixteen-square form that collects rainwater into a central courtyard cistern, also serves as a community center and place of worship. Latrine and ablution buildings use prominent solar chimneys to formally express and ventilate the solar dehydration composting toilets within. Conservation agricultural plots structure the landscape and will-provide food for the school children while restoring exhausted soil. The campus incorporates the first built version of ATOPIA's PITCHKenya stadium prototype (fig. 3). With seating for 1,500 spectators, integrated classrooms, and cisterns capable of collecting and storing 1.5 million litres of rainwater annually, the stadium develops a synergy between the need for water and the local love of football. "By placing Soccer and Water at the heart of the community, PITCHKenya is able to support integrated and sustainable community development by providing holistic community support in the areas of sport, clean water, education, health, food security, gender sensitivity and peace building."[6] These Kenyan projects exemplify why the architectural discipline must think critically about who is being sheltered, why and with 'what', in addition to the 'how' of technological innovation and gratuitous form.

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Figure 2: Girl's Dormitory, Endana Secondary School, Laikipia, Kenya

THEORETICAL FRAMEWORKS

In this essay the WATERBANK projects are investigated through several concepts—some articulated by the designers and others proposed by the author. Rather than attempt to formulate a unified theoretical framework, a series of seven interrelated ideas are each examined to provide insight into these projects and inspiration for future humanitarian work. The first idea developed from the *Stone Soup* folktale, which ATOPIA reframed to argue for the value of many small, incremental, and adaptable catalytic actions with local residents. This type of participatory process inherently refuses to subordinate human agency and experience to scientific knowledge. Thus, a cultural understanding of technology emerges. A third idea is about physically revealing the vital connection between visible forms and invisible flows, in order to reduce natural resource consumption by buildings and their inhabitants.

Fourthly, the social, environmental, and economic impact of material usage, construction methods, and labor practices are important considerations for architects that want to create more sustainable and participatory processes. The current debate about whether architects are responsible for construction worker deaths in Qatar is an example of this issue. The fifth concept, the "poetics of economy," generates architecture inspired by limited access to refined materials and craft traditions, as well as the process of physically building with the local community. This approach values decentralized human agency and social innovations over more centralized technological solutions. Finally, ecosophic awareness is examined as a useful theory for architects. Rather than regretting our inability to control complex systems and design for a precise future, this acknowledgement of limitation in a connected holarchic world can stimulate creativity and catalyze community.

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Figure 3: Samuel Eto'o Laikipia Unity Football Academy, School & Environmental Training Centre based on PITCHKenya prototype

PARTICIPATORY DESIGN AND CATALYTIC ACTIONS

ATOPIA has written about how the *Stone Soup,* a ubiquitous allegory about cooperation, inspires their approach to participatory design: "In a straightforward way we design 'Soup Stones,' the 'things' that will stimulate individual and collection action."[7] Depending on the situation, these things may or may not be buildings. While this folktale may be read as a celebration of the social skills of a clever traveler or even as an act of deceit, it may also be understood as a magical participatory process combining creativity and limited resources. In a WATERBANK school, for example, a cistern does far more than store water. Girls are encouraged to attend school by providing drinking water that they can take home to their families each day. Harrison explains how water collection duties prevent girls from attending school. There may be as few as two girls enrolled for every ten boys in the Laikipia region. The WATERBANKS concept intervenes in this vicious cycle of positive feedback loops between education, health, population growth, economic stability, and gender. As a shared resource for the community, a WATERBANK school becomes a significant gathering place that offers social, health, economic, and educational benefits. Much like the metaphor of the pebble in the pond, the catalytic power of WATERBANKS far outweigh the material conditions of these stones. This decentralized water infrastructure approach recalls the economic concept of smallness developed by economist E.F. Schumacher. "There is a wisdom in smallness if only on account of the smallness and patchiness of human knowledge, which relies on experiment far more than on understanding. The greatest danger invariably arises from the ruthless application, on a vast scale, of partial knowledge."[8] Each WATERBANK School addresses immediate problems in a community with a concept that may be adapted and replicated across the region through many small and incremental catalytic actions by local residents.

A CULTURAL UNDERSTANDING OF TECHNOLOGY

The role of technology is a crucial question for architects engaging in humanitarian aid work. Too often contemporary practices reduce technology to instrumental rationality and a seemingly value-free notion of progress. For example, dEEP Architects describe their DE_PLO disaster relief shelter as a "deployable 3D structure generated from a flat surface, able to arrive directly from the factory to the site, perfectly packaged and ready for easy and quick assembly" and wrapped by a "multilayered membrane intelligent system."[9] Human agency and experience is subordinated to scientific knowledge. Philosopher Andrew Feenberg has written about the history of this imbalance.

> "In modern times…the world split into two incommensurable spheres: a rational but meaningless nature and a human environment still rich in meaning but without rational foundation. In the centuries since the scientific revolution, no persuasive way has been found to validate experience or to reunite the worlds despite the repeated attempts of philosophers from Hegel to Heidegger. This is not just a theoretical problem. Experience teaches caution and respect for people and things. Experience brings recognition that the Other has its own powers, limits, and goals."[10]

ATOPIA seeks a cultural understanding of technology that is embedded in specific societal conditions and collaborative processes. Their value-laden, human-centered approach is committed to creating more sustainable social, environmental, and economic conditions in Kenya. By rejecting technological instrumentalism, they acknowledge the interdependence of human experience with scientific knowledge and technical rationality. Feenberg argues that this interdependence is essential for democracy to intervene in technology and thereby democratize the technological realm. While this essay does not claim that these WATERBANK schools are 'democratic,' the designers undoubtedly engaged the culture and experiences of the local community. Architectural design and construction, however, is inherently somewhat top-down since it requires planning and coordination due to its complex nature. Architects that acknowledge and seek to shift this power imbalance are more likely to create thoughtful processes that creatively engage the potential risks of a more democratic process.

MAKING FLOWS VISIBLE

Because there is minimal public or private water infrastructure in the rural highlands of Kenya, most drinking water comes from streams contaminated with eroded soil from deforestation, and animal and human waste. Many humanitarian aid projects in the region drill deep wells and install pumps and taps that deplete aquifers, create a false sense of water security, and produce water that regularly contains dangerous levels of naturally occurring fluoride.[11] Seasonal rains can provide adequate water for area residents if collected, filtered, and stored effectively. Yet, rainwater harvesting is rarely used by pastoralist communities and has not been widely adopted by humanitarian aid groups. WATERBANKS offer a viable alternative to the unsustainable practices of drilling boreholes or importing water by truck. The big, water-collecting roofs intentionally make material flows visible and understandable to occupants, thereby increasing environmental awareness and responsibility. Essentially WATERBANKS become an integral part of the hydrological cycle. In a similar way, the latrine's solar chimneys make the composting process and larger waste cycle visible and linked to the conservation gardens. Thus, they seek to counteract the problem of essentially invisible water and energy infrastructure that generates "a cultural perception which disconnects the consumption of natural resources from its natural context and environmental impact."[12] While this idea is not new to architects, the current architectural focus on surface often masks increasingly complex and abstract building systems. An enriched engagement with natural systems is an important way to connect people with the objects in their midst.

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Figure 4. Handmade tools and rough construction site in Laikipia, Kenya

MATERIAL, MAKING AND FORM

There is an increasing disconnect between material, making, and form in architectural design. In his essay "Valuing Material Comprehension," James Carpenter describes how "a concern for materiality has been replaced by a preference for the pure abstraction provided by computer software: a building, instead of revealing its materiality, more clearly reveals the algorithms and parametric formulas used to conceive and create it. This fundamental shift suggests that the role of materials has been reduced to solving the problem of how to wrap surfaces over forms."[13] The local stone and rudimentary construction tools and techniques available in this area are integral to the WATERBANK designs. For instance, roughly cut local stone forms the simple load-bearing wall of the Girl's Dormitory. The circular shape reduces the area of expensive perimeter wall and calls attention to the new presence of female students at this secondary school, thereby challenging the notion of efficiency promoted under colonial rule and perpetuated in the ubiquitous rectangular barracks. Instead, the one-story circular shape recalls the low, oblong or circular forms of Maasai dwellings, livestock enclosures, and the enkang—a larger circular village enclosure or family compound (fig. 2). Traditionally Maasai women weave leleshwa or acacia tree branches, twigs, and grasses into structures that they plaster with wet mud and cow dung.[14] ATOPIA's circular design for the SATUBO Womens' Beading & Traditional Crafts Workshop references the continuous wall to roof form of many Maasai dwellings. At a time when complicated architecture is generated to reflect the complexity of our world, the clarity of ATOPIA's direct forms is refreshing.

According to Harrison, "The principles of the Waterbank School are quite simple; invest more in the size of the roof, design it to help collect, rather than deflect rainwater, and detach the traditional building enclosure, usually stone or concrete, from the school itself to form a perimeter enclosure creating a more protective world within the bounds of the school."[15] The enclosure blocks wind, creates a pleasant microclimate, and registers a connection with the vernacular architecture of the region. Much is achieved with the strong geometry of circles, squares, and triangles. ATOPIA writes about how we need to use resources more effectively than we do, and the WATERBANKS projects abound with examples of efficient material use achieved through spatial configuration and form. For instance, the sloped stadium seating incorporates inhabitable classroom spaces within (fig. 3). The judicious use of materials and construction methods in these projects manifests an ecological agenda related to James Nash's concept of the "ecological value of frugality." Frugality is "'sparing' in production and consumption—literally sparing of the resources necessary for human communities and sparing of the other species that are both values for themselves and instrumental values for human needs. Frugality minimizes harm to humans and other lifeforms, enabling thereby a greater thriving of all life."[16]

THE POETICS OF ECONOMY

In addition to their intentional frugality, these buildings embrace the roughness inherent in the local material extraction and building processes. Although Kenya is quite different than Brazil, the architecture of Arquitectura Nova and Lina Bo Bardi offer a useful comparison. Sérgio Ferro's politicized work in the 1960s with Arquitectura Nova sought a "poetics of economy" and an "aesthetics of poverty" that could democratize the process of design and construction in Brazilian architecture. An "aesthetics of poverty," as described by James Williams, is "the acceptance of the impact that limited availability of materials might have on form, or to put it another way, the futility of trying to approximate the finish of the cultural products of the developed world when the materials to make them may be absent."[17] In Lina Bo Bardi's proposals for a "poor architecture" (not an architecture for the poor), she attempted "to acknowledge the reality of those excluded from consumer society's luxuriously created finishes, and offered 'pre-craftsmanship' as a non-Eurocentric alternative, 'inciting Brazilians to adapt the industrial revolution to their own needs and to reinvent consumer culture to fit their desires.'"[18] Her conception of "pre-craftsmanship" referred to the lack of guilds and other social structures that supported skilled craft production. The building trades of rural Kenya also exist in this condition of pre-craftsmanship. A lack of access to both materials and tools limits the possibilities for low-cost, highly crafted buildings. The long-term demands of building maintenance and operations are a challenge as well.

ATOPIA acknowledged existing conditions and designed accordingly, rather than taking a utopian approach that imported prefabricated components from abroad or inappropriately employed high-tech materials and processes in the rural Kenyan context. Because they design with local materials and simple construction techniques, they were able to organize the Uaso Nyiro Waterbanks School construction as a community process. Local residents with little or no building experience built the school and they were empowered through its creation (figs. 4, 5). While the multi-building scope of the Endana Secondary School campus required assistance from a local builder, the process provided translatable skills and employment for residents. It is crucial to note that this participatory work is not opposed to contemporary technology. When working in rural Kenya, digital communication technology is essential to support collaboration across continents. ATOPIA has written about the vital role of their digitally-facilitated collaborative process. "An important part of our design and research work is the construction of networks of collaborators, supporters, sponsors and partners in the affected regions, ensuring the effective delivery of the project, and the monitoring in use of project elements. In this way the collective intelligence of the network can be applied to the project and the knowledge acquired used in other contexts, establishing continual feedback as a principle."[19] A cultural understanding of technology generates a combination of high and low tech.

DECENTRALIZED LOW-TECH INFRASTRUCTURE

While humanitarian aid efforts often propose costly and overly technical water, sanitation, and energy infrastructure projects out of scale with a community, it is important to understand how this approach to technology is part of a larger societal conundrum. Brian Wynne, Professor of Science Studies, has examined how science and technology influence policy decision-making and risk assessment in environmental issues.

> "Even where serious environmental challenges are recognized for what they are, the persuasive technological-scientific obsession tends strongly to distort the imagination of societal responses in the direction only of (sophisticated) technological innovations. This often also means a selective focus on only big-technology, concentrated science-intensive responses; which often itself means production-side, as distinct from 'demand-side' thoroughly social (or social-led technical) innovations… Human and social innovations

ENDNOTES

1. Kenneth Frampton, "Intention, Craft, and Rationality," in *Building (in) the Future: Recasting Labor in Architecture.* eds. Peggy Deamer and Phillip Bernstein (New York: Princeton Architectural Press, 2010): 33.
2. See BIOMS website (Bio Input onto Material Systems) for details: http://www.bioms.info/
3. Caryn Brause and Joseph Krupczynski, "Divergent Modes of Engagement: Exploring the Spectrum of Collaborative & Participatory Practices," *ACSA Conference Call for Papers* (2015).
4. See WORLDSBANK website: http://theworldsbank.org/#!?page_id=18. Accessed 1/2/2016.
5. Ibid.
6. See WATERBANKS website, http://waterbanks.org Accessed 1/2/2016.
7. *ATOPIA_Research Stories: Stone Soup* (Princeton, 2012): 4. http://issuu.com/atopia/docs/atopia_research_stonesoupstories?e=4322582/2187768 Accessed 1/2/2016.
8. E.F. Schumacher, *Small is Beautiful: Economics As If People Mattered* (Blond & Briggs, 1973): 22.
9. http://www.archdaily.com/120301/de_plo-deep-architects/ Accessed 1/2/2016.
10. Andrew Feenberg, *Between Reason and Experience: Essays in Technology and Modernity* (Cambridge: MIT Press, 2010): 181. Also see Chris Salter, *Entangled: Technology and the Transformation of Performance* (Cambridge: MIT Press, 2010).
11. For more on water issues in Kenya, see Elizabeth Were, et.al. "Water, women, and Local Social Organizations in the Western Kenya Highlands," *Collective Action and Property Rights Working Paper. No. 51* (July 2005). Also Samantha Marshall, "The Water Crisis in Kenya: Causes, Effects and Solutions," *Global Majority E-Journal,* V.2, N.1, (June 2011): 31-45.
12. Elisabeth Heindenreich, "Spaces of Flow as Technical and Cultural Mediators Between Society and Nature," *Environment, Development and Sustainability* 11 (2009): 1147.

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that might reduce turnover and processing of nature, while bringing positive environmental and cultural consequences, are increasingly excluded from dominant societal imaginaries, in favor of only concentrating technological 'solutions.' Smashing this deep trajectory and instigating in its place distributed and diversely grounded, pluralistic and hybrid reason-informed innovation cultures would be an alternative democratic modernity."[20]

By designing schools that also harvest, filter, and store large quantities of water, ATOPIA is able to create a decentralized relationship between fresh water provision and governmental or corporate techno-political forces. Critical of high-tech approaches in socio-economic conditions that cannot support them, Harrison explains: "We are interested in low-tech things and processes and in innovating at this level because of course together, many such things in fact can behave in very sophisticated ways."[21] Their sustainable approach recalls environmental activist Wendell Berry's observation, "great problems call for many small solutions."[22] The idea of many small, decentralized, and innovative efforts coming together to produce a large effect is evident in all their work—ranging from the Endana campus plan to the small-scale, Rainchutes rainwater harvesting solution for domestic situations. Using decommissioned military parachutes supported by locally sourced poles, Rainchutes are capable of collecting approximately 70 litres of water per day in Kenya using a 7.5-meter diameter parachute. This direct, low cost solution could be shared by several households and even used to recharge dry wells. Going beyond functionality, Harrison explained: "I particularly like the directness of this proposition, turning military equipment on its head to create a peace building initiative. Access to water is a cornerstone in building peace."[23] This process of turning a situation "on its head" emphasizes the power of individual agency.

AGENCY

While this short essay does not permit a discussion of agency and Bruno Latour's actor-network theory, it is helpful to locate ATOPIA's work in relation to political philosopher Jane Bennett's sustainability-focused "thing-power materialism." Bennett developed this theory to foster "greater recognition of the agential powers of natural and artifactual things, greater

13. James Carpenter, "Valuing Material Comprehension," in *Building (in) the Future: Recasting Labor in Architecture.* Peggy Deamer and Phillip Bernstein (New York: Princeton Architectural Press, 2010): 64.

14. Robert Rukwaro, "Architecture of Societies in Transition—the Case of the Maasai of Kenya," *The Habitat International Journal,* V.25 (2001): 81-97.

15. Jane Harrison quoted by Wycliff Muga, "The Fit between Football and Rainwater Harvesting," *EA Flyer* (August 2012): 29.

16. James A. Nash, "On the Subversive Virtue: Frugality" in *Ethics of Consumption: The Good Life, Justice, and Global Stewardship.* eds. D. Cricker and T. Linden (Lanham, MD: Rowman & Littlefield, 1997): 427.

17. Richard J. Williams, "Towards an Aesthetics of Poverty: Architecture and the Neo-Avant-Garde in 1960s Brazil," in *Neo-Avant-Garde.* ed. David Hopkins (Amsterdam: Rodopi, 2006): 198.

Figure 5. Laikipia residents building the Uaso Nyiro Waterbank School

awarenesss of the dense web of their connections with each other and with human bodies, and finally, a more cautious, intelligent approach to our interventions in that ecology."[24] Essentially, a stronger ecological understanding could be prompted by an awareness of material things (not only humans) as agents. Bennett's argument for the power of inanimate things to interact with other things to produce effects helps to explain the potency of ATOPIA's work and architecture in general. We can understand the WATERBANK school as an 'actant' that does something in the community—that has "sufficient coherence to perform actions, produce effects, and alter situations."[25] For instance, since the Uaso Nyiro Waterbank School opening, school attendance has risen from 70 to 90 percent and instances of waterborne disease have dropped to zero. As a public supply of clean drinking water, the school acts and interacts with people in complex ways not always anticipated by the designers. This 'soup stone' stimulates cooperation and resilience amidst scarcity of all sorts.

ECOSOPHIC AWARENESS

Operating within a world of complex nested systems, ATOPIA's participatory practice may be understood through the concept of "ecosophic awareness" as developed by political philosopher Leslie Thiele. "Ecosophic awareness is not only a humbling acknowledgement of limitation. It is also a stimulant of creativity, a provocation of freedom, and a catalyst for community. It strips from us the illusion that we could ever master life and control the future. But it does not, for that reason, discount efforts to improve our lot. Rather, it constitutes an attunement to the responsibilities and opportunities that a connected world presents."[26] These self-sustaining humanitarian aid projects creatively align technology with socio-economic context and community in the rural central highlands of Kenya. They reject technological solutions such as the extensive drilling of deep boreholes that generate quick fixes and often generate problems that far outweigh their benefits. Instead, they directly involve the community in the management of water resources and distribution through locally built, decentralized infrastructure and resilient processes.

18. Styliane Philippou, "The Primitive as an Instrument of Subversion in Twentieth-Century Brazilian Cultural Practice," *ARQ 8,* N.3-4 (2004): 294. Philippou cites Zueler Lima and S. Vivanco, "Culture Translated and Devoured: Two Brazilian Museums by Lina Bo Bardi," *Journal of Romance Studies,* V.2, N.3 (Winter 2002): 57.

19. ATOPIA Research website: http://atopia-research.org/#!?page_id=9. Accessed 1/2/2016.

20. Feenberg: xii.

21. Muga*:* 30.

22. Wendell Berry, "The Way of Ignorance," in *The Virtues of Ignorance: Complexity, Sustainability, and the Limits of Knowledge,* eds. B. Vitek and W. Jackson (Lexington: Univ. of Kentucky, 2010): 47.

23. Muga*:* 31.

24. Jane Bennett, "The Force of Things: Steps Toward an Ecology of Matter," *Political Theory,* V.32, N.3 (June 2004): 349.

25. Ibid., 355. Bennett draws from Bruno Latour, *Pandora's Hope: Essays on the Reality of Science Studies* (Cambridge: Harvard Univ. Press, 1999).

26. Leslie Paul Thiele, I*ndra's Net and the Midas Touch: Living Sustainably in a Connected World* (Cambridge: MIT Press, 2011): 278.