City for the Future: Resilient, Equitable, and Regenerative

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Christa Daniels[1] and Michael Simpson[2]

[1] Christa Daniels, PhD, AICP; Program Manager, Center for Climate Preparedness and Community Resilience, Antioch University
[2] Michael Simpson, MS, MALS; Director Resource Management & Administration Graduate Program, Antioch University

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Executive Summary

The goal of this report is to imagine and propose a new urban settlement in the United States that is sustainable, resilient, equitable, and regenerative and can be used as a model for redeveloping existing cities.

According to the United States Census Bureau, the average population density for cities is 1,594 people per square mile. By 2050, it is projected that two thirds of us will live in cities. Cities that account for the use of over 75% of global natural resources currently produce over 50% of global waste and emit 80% of greenhouse gasses. This is a result of our linear take-and-make materials economic model, which is unsustainable and highly vulnerable to climate change. This model also produces significant inequalities among community members. The negative consequences of applying a fundamentally linear construct have resulted in an urgent need for us to rethink the urban pattern and metabolism. To create a city that is economically, socially and environmentally resilient, and sustainable, we need to consider a new regenerative circular model that encompasses a systems approach. The pattern needs to incorporate the tenets of all natural systems and be designed with humans in mind. While many urban settlement strategies have been applied to cities, there is no current example that represents a holistic systems approach that adequately characterizes a resilient, sustainable, circular, and equitable city.

A city's metabolism is the flow of all materials and associated energy in the urban system, but it is with a circular economy a city changes its focus from the managing flow to managing the stock. This paper will highlight current best practices in cities throughout the world and propose an innovative model city, which encompasses not only a circular pathway for products that keeps the highest and best use of materials for the longest duration possible but also strives to minimize the city's ecological footprint and loading of greenhouse gases.

In addition, a city must be truly inclusive and accessible to all individuals who are represented in the United States. In order to achieve this, a transparent participatory process is required at all stages of a city's formation: design, implementation, and ongoing maintenance. This will require a new way of thinking about stakeholder involvement because of the absence of an existing population to engage before groundbreaking. An

Current Landscape

A city is a large human settlement. It is a permanent, geographically defined area that contains a concentration of people, services, and government. For this report, we define cities as an incorporated area with governmental powers that are delegated by the state or county. As of 2018, there were 19,495 incorporated cities, towns, and villages in the United States. These range in size from those with populations below 5,000 to the largest, New York City, with over 8 million people.

Historically, the purpose of a city is to provide infrastructure and services to the population that lives within the city boundaries. This includes the streets, buildings, power, water, and necessary government. Cities have a significant influence on material inputs and outputs, including the directional pathway of how materials are consumed and discarded. Materials are defined in this paper as water, energy, human products and byproducts, people, and the components of natural ecological systems. In cities, food, water, energy, and consumer goods are constantly flowing in to support the needs of an urban population. These materials are typically discarded as waste after being consumed by the population. This is a predominant linear pathway of material flows that has resulted in unsustainable and inequitable societies.

All of the materials in our existing systems, including within our cities, are connected and interdependent. However, these connections and dependencies are not necessarily included in the current urban planning and design of cities. In addition, the city's geographic boundary typically defines the systems of materials that the city attempts to manage. However, a city itself is embedded within a set of larger systems that exist and extend beyond the city's actual footprint on the landscape (Wackernagel & Rees, 1996). Invariably, two phenomena are associated with city operations that seldom considered in a city's design. First, negative externalities are exported, which are then experienced by others, often far beyond the urban boundary. Second, cities are buffered by space and time from the natural regulating feedback loops that have emerged to avoid unsustainable pathways.

It is also important to note that cities are rarely, if ever, planned and built through a holistic process. Typically, city planning, and implementation is often balkanized by the

Daniels, 2018). This type of method allows for the coproduction of knowledge that can inform and establish a successful urban settlement that is influenced by the populations that will live, work, and play there (McCoy & Scully, 2002).

Because the purpose of this research is to conceptualize a new city, with no current residents, a new approach must be adopted to ensure a participatory process. Many recently built cities have suffered from underrepresentation of the populations they originally seek to serve. In fact, many of these cities have become White enclaves of privilege amidst a larger region that does not demographically represent the new city (Ellis, 2002; Grant, 2006; Trudeau and Malloy, 2011). A possible option for overcoming this failure, piloting a participatory process in a city that has yet to exist, will be further explored in the Way Forward chapter of this report. This process relies on an iterative Collaborative Planning Approach (Gruber, et al., 2015) that can be adapted for creating the model city.

To apply the proposed framework to the development of a new city, a systems approach is needed. This type of approach requires stakeholders to expand their focus from the individual parts of a city toward a holistic view that includes how all of the parts work and operate together through their interconnectivity and relationships. Now, before describing the key metrics to consider in planning a city for the future, it is important to first clarify the various definitions that are commonly used in this reflection.

Definitions

There are numerous definitions of what "sustainable" and climate resilient development encompasses in the current discourse. In order to clarify what we are proposing in this paper, the following definitions should be used as a baseline for the vision of a sustainable, resilient, equitable and regenerative city in the future.

Systems Thinking

A system is a set of parts that are interconnected that produce a pattern of behavior over time. The behavior of a system emerges from its components but is greater than just the sum of its parts (Meadows 2008, p. 2). Therefore, even with detailed master planning, a model city will eventually self-organize into a system that is hard to foresee at the point of its conception. This is because systems are embedded within other systems, both temporally essential function, identity, and structure, while also maintaining the capacity for adaptation, learning, and transformation. (IPCC, 2014b, p. 1772)

Many practitioners at the local level have used the terms "climate adaptation" and "climate resilience" interchangeably. However, there are important distinctions between the two that need to be reflected in the local decision-making discourse. Climate adaptation is one option of achieving climate resilience. Many municipal decision makers tend to think of climate change preparedness as engineering resilience (Davoudi et al., 2013). They strive to return to or "bounce back" to what the community looked like and how it functioned prior to a disaster (Davoudi et al., 2013). This prior state may have included social injustice, inadequate public infrastructure and housing, other hazard vulnerability, and a weak local economy (Glavovic & Smith, 2014).

Therefore, it is important to recognize the aspects of resilience that involve "transformative sociopolitical change" (Davoudi et al., 2013; Glavovic & Smith, 2014; McEvoy et al., 2013). In application, this translates to urban planning that improves a specific social system. For example, instead of expanding existing drainage systems in a public housing complex, increased green space could be installed for stormwater retention that also increases psychological well-being (Wolch et al., 2014). This paper will use the socioecological definition of resilience: "resilience is not conceived of as a return to normality, but rather as the ability of complex socio-ecological systems to change, adapt, and, crucially, transform in response to stresses and strains" (Davoudi et al., 2013, p. 309).

It should also be pointed the interdependency of the concepts of resilience and sustainability. Resilience could be considered a necessary, but not sufficient condition for sustainability (Derissen et al. 2011). Where sustainability is an ongoing process towards a goal, resilience is often framed within the context of a shorter temporal horizon based on the best future projections at any moment in time.

Circular Economy

Kirchherr (2017) posits that there are at least 114 different definitions that have been identified for describing a circular economy. The variability in the definition provides a barrier to operationalization and may eventually result in the collapse of the concept. This parallels the history of the use of the word "sustainability." Thus, one of the potential circularity should be applied in assessing, revisioning, and implementing urban and economic development and the associated policies, which continues to build the resilience of the city and enhance the traditional ecosystem services of the region.

Social Equity

Equitable sustainable development ensures that all residents of a community are empowered to have a voice in design, implementation, ongoing engagement, and economic and social benefits of urban development. In the field of urban planning, all stakeholders must acknowledge and recognize that past and current planning practices have a direct influence on who benefits and who is systematically excluded from any benefits in community planning. This paper will define social equity according to the definition used by the American Planning Association, which defines equity as "just and fair inclusion into a society in which all can participate, prosper, and reach their full potential" (APA, 2019, p. 3).

Social equity infused in a model city would allow for a complete community where everyone is included, has access to all resources, and feels safe and equally valued. It is important to distinguish the differences between focusing on *equity* versus *equality* in sustainable development. While equality connotes sameness, equity's focus is on mitigating historic systematic differences in order to actively address fairness and justice. Therefore, it is a necessary component to design and plan a city not to repeat the mistakes of the past.

Until recent years, equity was often overlooked in sustainability efforts due to a focus on natural systems at the exclusion of social systems. The work of many environmental justice activists and other leaders has resulted in a broader lens that embraces equity considerations. This is starting to change the work of municipal sustainability initiatives and departments. Equity is no longer the forgotten E in the three Es of sustainability (environment, economy, and equity) and has even been center stage in some recent efforts such as the work in the City of Providence, RI.

Permaculture

According to Bill Mollison permaculture is "a philosophy of working with, rather than against nature; of protracted and thoughtful observation rather than protracted and thoughtless labor; and of looking at plants and animals in all their functions, rather than settlement (Mang and Reed, 2012). We propose incorporating the concept of regenerative design to holistically build and support earth's natural systems while accommodating human needs. A regenerative approach to design and development of the built environment requires a systems approach. Regenerative approaches recognize the need to reverse the current degradation of natural systems while establishing new human-centered systems that can exist and evolve with natural ecosystems.

Background/Justification

We now begin this section with providing the historical context of urban planning for sustainability, starting from the time of the Industrial Revolution, in order to set the stage to describe the overarching frameworks for a city of the future.

Historical Context

The Industrial Revolution is an important period in the evolution of cities. For the purposes of this research, it serves as the starting point in our search for a sustainable city. In the last few centuries, urban design and development has evolved from focusing on layout to include functionality and other human-valued considerations. These changes have often been made to meet the needs of citizens that reside in the urban settlements.

Many notable urban planning movements have emerged in the last hundred years to create a sustainable city. This ranges from the self-sufficient Garden City movement that was inspired by Ebeneezer Howard to the New Urbanist principles, proposed by the Center for New Urbanism. New Urbanist principles were established to create alternative mixed-use communities versus the dominant single-use low-density urban form. Many of the recent movements, such as Principles for Better Cities, Biophilic Cities Network, Circular Cities, and the recent Smart Cities model by New Cities and Sidewalk Labs will be discussed with respect to our proposed conceptual new city. However, many of these examples lack the components that constitute a holistic systems approach. While many of the movements above include various aspects of sustainability and resilience, there is no example that represents an entire city system. This tends to result from the prevalent urban

It is also important to note the majority of New Urbanist projects in the United States consist of *infill* development projects versus *greenfield* development (Trudeau & Malloy, 2011); thus, there is a lack of new city examples to evaluate as opposed to the multiple examples of Smart Cities. We have included New Urbanist strategies to the degree that we can highlight lessons learned that can be applied to any new greenfield development.

A Framework for the City of the Future

This section introduces five overarching frames that we will use to consider a city of the future: climate change, material circularity, scale, equity in realizing social well-being, and natural systems

The increasing demand for human settlement worldwide creates an opportunity to imagine, plan, and design new cities from scratch. Thinking about a holistic approach to a new urban environment can guide models for retrofitting existing urban areas. Based on the research and findings we gathered in this report, it appears that new cities that have been built from "scratch" in the United States have faced significant problems in their goal to be sustainable, resilient, and equitable communities. These cities are typically developed based on the New Urbanist or Smart City model. As seen in the example below of an exemplar New Urbanist city (Seaside, FL), there are numerous critiques regarding the sustainability, equity, and social capital aspects of these developments (Ganapati, 2008; Luka, 2019; Shin & Shin, 2012; Talen, 1999).

This section will begin to conceptualize a model city that encompasses a materials pathway that is sustainable, resilient, equitable, and regenerative. It will be based on a systems approach to all materials with respect to the following aspects: land use, design, municipal infrastructure (gray, green, and blue), urban intelligence, social systems, public health, economy. and the natural environment. The framework we propose below (Figure 1) includes the following components: Climate Change, Material Flow/Pathways, Scale, Equity/Social Well-Being, and Natural Infrastructure. The various components of the framework have a set of critical questions to address when exploring each of the existing sustainable urban development strategies. A draft matrix table is presented in Appendix A that can be further refined and used to begin reimagining future urban settlements.

increase the climate resilience of its citizens. According to Folke et al. (2003), this would be evident in how well the city can live with disturbances and uncertainty, nurture diversity for reorganization and renewal, combine various knowledge types for learning, and create opportunities for self-organization.

The Stockholm Resilience Center proposes the following seven principles for applying climate resilience: maintain diversity and redundancy, manage connectivity, manage slow variables and feedback loops, foster complex adaptive systems thinking, encourage learning, broaden participation, and promote polycentric governance systems (Stockholm University, 2014). The following is an explanation of the principles above that need further clarification.

Feedback loops and variables are evident in all aspects of society. The management of slow variables and feedback loops is important to monitor because actions that are related to one variable can affect another variable in a reinforcing loop. Slow variables are factors that are harder to manage because they occur over a longer period and at larger scale and shifts may not be recognized until the process reaches a pivotal threshold for abrupt change. For example, if policies result in reductions in energy efficiency investments (the investment reductions constituting a slow variable), consumer energy costs are higher, resulting in lower profits, creating a reduction in further energy efficiency investments. It is important to identify these variables and feedback loops to disrupt the positive (reinforcing) trend that can occur to disrupt and change the outcome of the system, in the case above, energy efficient investment.

One aspect in building a city's adaptive capacity and mitigating risk to future disturbances, thus building resilience, is through a polycentric governance model (Carlisle & Gruby, 2019). This system of governance allows for multiple scales of governing bodies to collaborate for effective regulations and enforcement (Stockholm University, 2014). One main characteristic of polycentric governance is the acknowledgement of the inherent nestedness of different jurisdictional levels of government in order to create solutions that work holistically throughout all the levels of government (Ostrom, 2005).

An important aspect of effective polycentric governance is an adaptive management framework which begins with repeated monitoring of the components of resiliency of the system. The time horizon for such monitoring needs to consider the rate of change in the

Material flow analysis (MFA) determines the flow of materials through the city's metabolic pathways. In such an analysis, materials and energy are intimately linked. From extraction through processing and eventual product creation, energy is consumed. In short, the product is a reflection of this energy use, which has been characterized as a product's "embedded" energy (Simpson, 2020). From a life-cycle perspective, an MFA analysis recognizes existing, or potential material circularity, pathways that lead to less extraction of nonrenewable resources, which in turn reduces the sum total of embedded energy in the economy, which translates to a reduction in greenhouse gas emissions (Figure 2).

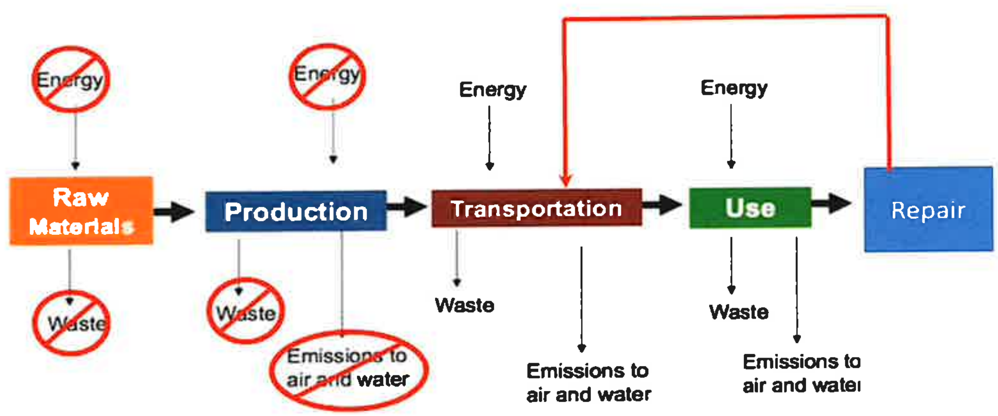

Figure 2. Avoiding Materials Extraction and Additional Energy Expenditures Through a Circular Pathway

Note. Simpson (2020).

MFA is a key component of industrial ecology that is often used in circular economy/city models. Every model of human settlement that is explored in this report will be evaluated for consideration of how material flow and pathways are managed and discussed.

Due to the historic lack (or perception) of the scarcity of materials, the flow of materials currently follows a linear pathway in the majority of human settlements. The traditional hierarchy in the United States of waste management has been to reduce, reuse, and finally recycle before disposing of materials. This still creates a "take-make-waste" linear model of pollution. Recycling, as conceptualized in the United States, has allowed for globe (Figure 3). These larger systems provide inputs into the city and receive products, and associated emissions, from the city. Managing the city boundary is a necessary condition for maximizing a community's resilience.

The perspective of scale should also be considered in the context of the capacity to "scale-up" from the initial groundbreaking to the city vision that was conceptualized. Some of the visions for a future model city that are explored in this paper may not be possible due to scalability, or may not create the appropriate synergies beyond a certain population size or geographic footprint. In order to better understand this issue of scale, we have identified case study examples of existing cities that have instituted or are experimenting with some of the model city-frameworks identified in this paper.

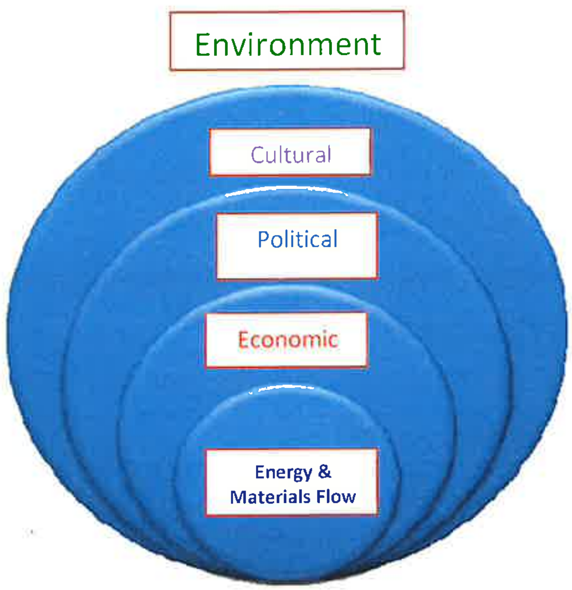

Figure 3. The City's Materials Flow is an Embedded System

Note. Simpson (2020).

A consideration of scale from planning through implementation needs to better balance the larger systems context of materials/product supply with the localized dynamic of human urban life (Berners-Lee, 2019). Historically the latter is often sacrificed by the former. The economy suffers from an idolatry of growth, which disenfranchises the value of the size of scale of human well-being. In short, a wholly new system based on attention to people, and not primarily goods, is required. The circular economy echoes this perspective of "production by the masses, rather than mass production" (Schumacher, 1973).

relates to urban development. Focusing on equity versus equality creates opportunities and ensures fairness in the planning and policies that are associated with urban development. It is important to recognize that sustainable urban development strategies can exacerbate issues of inequity in cities if they are not addressed throughout the entire process of planning, engagement, design, and implementation. Therefore, this framework will include an equity lens to examine how well the strategy addresses this factor.

Each urban strategy example will be evaluated based on the following factors to establish the degree to which equity and social well-being is evident:

- Does the planning and design of the urban development include active participation from the region's community wherein it is being sited?
- Does the strategy promote environmental justice with respect to an equitable share of environmental benefits for existing communities in the region in which the urban development is to be sited?
- Does the strategy promote and advance equitable economic opportunity?
- Does the strategy include policies or programs that allow anyone to live in the community (affordable housing, accessible transportation, healthy and accessible food, safe neighborhoods, and public health)?
- Does the strategy allow for meaningful engagement and participation of all community members?
- Does the strategy proactively address past city planning and design flaws that has shown to exacerbate inequality of the citizenry?

Natural Systems and Infrastructure

Providing food, energy, water, housing, and other goods and services while maintaining the ecosystem functions and biodiversity that underpin their sustainable supply is one of the great challenges for cities of the future. Worldwide, the UN states that the biosphere upon which we as a society depends is being "altered to an unparalleled degree across all spatial scales." Their projection is that one million plant and animal species will become extinct in the next few decades due to human-induced disruptions to their natural

- Does the spatial footprint for this urban development reflect the carrying capacity of the region in which it is being sited with respect to land, water, and energy use?
- Does the strategy integrate existing natural resources into the design and planning for this urban development to ensure ecosystem functions and services are maintained?
- Is there a commitment to regenerate lost or damaged natural systems?
- Does the design and planning of the city both replenish resources and maximize reuse of already extracted natural resources from the surrounding region?

Sustainable Urban Development Strategies

What follows is analysis of a selection of the most relevant current urban development strategies within the context of our proposed framework in regards to: a changing climate, material and associated energy circularity, the multiple scales of a city's footprint, the necessity of equity in realizing social well-being, and the ecological and physical laws that governs all natural, including human, systems. The urban development strategies that will be focused upon include examples of Biophilic cities, Biomimicry, Transition Towns, Smart Cities, Planned Communities (TND, Housing Trusts), Leadership in Energy and Environmental Design (LEED) and Green Buildings (Architecture and Design), New Urbanism, Circular Economy/Cities, Common Pool Land Ownership (Ostrom Model), Industrial Ecology, Ecovillages, and Cradle to Cradle.

From the list above, a limited number of strategies was selected for a deeper investigation into how the framework is applied in each setting. This is not an exhaustive list of model-city strategies, but these are the ones that are referenced most frequently in the literature as examples for new development. It is fair to say that the featured examples represent the spectrum of current thinking regarding urban development into the future.

Urban Development Examples

Below are the relevant urban development strategies and examples in practice that were selected for further analysis. Each of the strategies discussed are presented in the

Andres Duany and Elizabeth Plater-Zyberk for developer Robert Davis to create a resort beach town that would be differentiated from conventional master-planned communities often seen at that time.

The design of Seaside can be viewed as being based on neotraditional planning principles. Neotraditional planning, often called Traditional Neighborhood Development (TND), is a postmodern planning approach that draws inspiration from Ebenezar Howard's *Garden City Movement* (Howard, 1960) along with Frederick Law Olmstead's and John Nolan's work on landscape architecture. These principles focus on building architecture, pedestrian-oriented infrastructure, mixed use, and a variety of different types of housing for mixed incomes. TND is differentiated from New Urbanism in scale, as TND is usually smaller and limited to a neighborhood or town. One particular tool used by New Urbanist developments is the transect (Figure 4). This tool is used to envision the continuum of urban development from the rural to the urban to take a systems approach to urban planning wherein the whole (city) is greater than the sum of its parts (the individual pieces of a neighborhood).

Seaside is approximately 80 acres with 1,500 residents. The city was designed with the following goals: walkability, mixed-use development, vibrant street life and community spaces, inclusion of an urban village, natural sustainable landscaping, affordable housing, incremental development based on needs, and a form-based code approach to regulating development.

Seaside Florida is a good example that illustrates the pros and cons of applying New Urbanist principles to achieving a sustainable, resilient, circular, and equitable new city. However, as seen in the Background section of this report, there are no such specific requirements mandated in the charter for the New Urbanist movement.

systems based on the compact design of settlement. Waste management policies, with the hierarchy of reduction, circular economy incentives, and informed purchasing policies, are not included in the design or operating function of Seaside or any New Urbanist development.

Scale

Seaside is a small compact community of fewer than 2,000 individuals. There are also many examples of New Urbanist applicability to neighborhoods in large cities, such as Manhattan and Jersey City, NJ (Ellis, 2002). But there is no example to be found that demonstrates the efficacy of scaling up this approach, and many researchers question the successful upscaling of a New Urbanist small town or neighborhood to a large metropolitan city (Fulton, 1996). However, many of the basic principles of New Urbanism could certainly be applied to a model city, especially implemented at the neighborhood scale—for example, physically designing a city to include mixed use, mixed housing, walkability, and public spaces.

Equity

Seaside is not considered an affordable town to live in. Based on a recent real estate search for the costs of homes on Zillow, listings ranged from over $10 million for a Gulf-front home to $305,000 for a small inland condominium. High housing costs tend to characterize many New Urbanists towns, leading to homogeneous populations (Bookout 1992). These homogeneous populations can create privileged White enclaves that do not represent the larger regional demographics for an area (Ellis 2002; Grant 2006; Trudeau and Malloy 2011).

The Center for New Urbanism recommends using the *Charrette* format as a planning tool to include citizens, designers, and others to collaborate on a vision for development. However, there are no specific recommendations or strategies for ensuring that equitable representation is included when using the Charette design process. Seaside, as the first model new urbanist city, used the Charrette process, but it did not have significant public input. Robert Davis, one of the founders of Seaside, attributes this to the lack of zoning, building officials, and others that would normally participate in the Charrette process.

Natural Systems and Infrastructure

Seaside Florida was constructed on a greenfield. Any new development that is constructed in 2016. The certification was intended to be a new way forward for resilient, green, inclusive, and smart cities. The Arc performance platform allows a city to track and measure their progress across six LEED categories: natural systems and ecology, transportation and land use, water efficiency, energy and greenhouse gas emissions, materials and resources, and quality of life. This platform is a digital program that allows the user to benchmark, track, and measure improvements at any scale (from building to city) to meet LEED criteria. A city's score in Arc determines the city's certification level (Certified, Silver, Gold, or Platinum).

There are two guidebooks and scorecards for a city to use to achieve certification. One is designed for existing cities and the other for new or planned cities. The following will be in reference to the requirements and point system of the new and developing cities guidebook. The scorecard for obtaining LEED Cities and Communities certification requires acquiring 40 of a possible 110 points to receive LEED designation. There are criteria in each category that are prerequisites that any LEED city must meet, and then it remains up to the city to determine how they will create a cumulative score of additional points. Unfortunately, this approach falls short of a systemwide approach to achieving a model city based on the framework we propose. A city could achieve certification just by focusing on climate effects and social equity and addressing water quality, while giving scant attention to waste recovery or transforming to a low-carbon economy.

Thus, the point system creates a disintegrated approach to how materials are used and flow through the urban environment. The credit points have an indiscriminate weighting that results in projects being evaluated without incorporating externalities that are associated with ecological degradation. For example, installing a bike rack outside a building is weighted equally to bioremediation of a brownfield site. If a city pursues points in every category of the LEED certification, it is likely that it would be on track for approaching the ideal of a sustainable community as reflected by the intent of our proposed framework.

However, we believe there are a few considerations that first need to be addressed when considering the use of LEED for Cities to ensure the successful implementation of a sustainable plan. First, the scorecard for points should require the applicant to begin an integrative planning and design process before any construction of the new city begins. Second, the desired interactive process of continual improvement, which should be integral equity component of our proposed framework. Therefore, while it indirectly addressed climate change to a degree, it directly highlights an attempt by the city to address equity in their projects.

Material Flow

LEED for Cities and Communities version 4.1 included material circularity in the certification system. It provides points based on the material usage, life cycle, and transparency of materials used. The system evaluates waste, water, and energy based on a hierarchy of reduction, reuse, and recycling. LEED for Cities and Communities encourages cities to move toward achieving a zero-waste city through recycling, reuse, and reduction of waste generation as stated above. In the optional materials: Recycling Infrastructure category, the LEED 4.1 guidebook states that the intent of this possible credit is to "To encourage waste diversion of inorganic matter away from landfill and move towards 100% diversion from landfill." The guidebook further elaborates on the reasoning behind the stated intent above. It is in this section that the guidebook discusses the benefits of a circular economy and connects the credit to a city's pathway toward advancing the circular economy through recovery and restoration of materials.

While LEED does provide a framework for making informed decisions about material circularity, it still does not require a systems approach to the application of a circular material flow path. For example, in each category that deals with materials, one can find a stated intent to be zero water, zero energy, zero waste, and zero carbon. In addition, on further evaluation of the options to gain additional certification points, there still seems to be no clear framing for achieving a true circular material flow path. Specifically, the LEED framework does not address local policies that target the flow of desirable materials and products into the city, create incentives to ensure synergistic business relationships, emphasize economic development that target product-as-service business sectors, or establish accessible circular pathways that are as common as one sees for waste management pathways.

Washington DC does recycle materials, but well below the national average, and there is no evidence of a concerted effort to improve the circularity of materials because there are no other materials pathways being proactively developed by the District. In addition, the City provides subsidies to private waste haulers through the use of their trash

The District has an ambitious plan to attain a 40% tree-canopy cover, aligned with creating access to all parkland and natural space within a 10-minute walk of all residents. The city has numerous commitments and plans to conserve natural resources in various plans and programs.

Unfortunately, tree planting alone is not considered an effective strategy if there is no socioecological integration with respect to distribution and ongoing maintenance. A recent study in neighboring Baltimore, MD, showed that the effects of summer heat were disproportionately higher in areas with higher poverty rates. This difference was attributed, in part, to the lack of tree planting and shading in these low-income neighborhoods (Huang et al., 2011). This phenomenon may exist in Washington DC; a study inventorying trees in DC showed that low-density, higher-income, residential neighborhoods saw a tree density of 50.5 trees/acre, whereas the poorer medium- to high-density neighborhoods showed more than a 50% reduction in the associated tree density (Nowak et al., 2006). More recent research for Washington indicates that low-income neighborhoods in the District have a faster loss rate of preexisting trees versus new plantings and growth (Chuang et al., 2017). This leads to concern that the LEED certification point strategies may need deeper analysis in order to achieve multiple goals with a single policy initiative. In this example, urban forests can not only address the need to support ecosystem services and build resilience to climate-mediated urban heat-island effects but also do it in a manner that is just.

Ecovillages: Auroville, India

An ecovillage is an intentional community of any size that is created by a group of people who are consciously collaborating toward a shared vision on supporting ecosystem services. In most cases, a participatory process is used to design and construct the envisioned community, and the resulting physical space is a representation of the shared principles of the individuals involved.

population of 50,000 residents. Over the 50 years of its evolution, Auroville has received the support of the Indian ministry and institutions like UNESCO.

Climate Change

Auroville is considered a model city as it relates to reducing the effects of climate change in a specific location. When Auroville was initially conceived in the 1960s, climate change was not at the forefront of urban development considerations. When founded, the area was a barren wasteland that was the result of grazing, deforestation, and land-use practices that degraded and eroded the soil. Since 1968, efforts have been underway to restore the vegetative cover and manage stormwater, and the efforts have been extremely successful. Initially intended as a means of improving living conditions in the immediate vicinity, the successful and ongoing reforestation project has since gained both local and national attention. Starting at the turn of the last century, climate change has taken a pronounced role in the development of ecovillages. According to the Global Ecovillage Network, ecovillages are designed to help implement the UN's Sustainable Development Goals and Climate Agreements on local levels.

Such a regenerative initiative highlights the benefits of forest cover in ameliorating the disruptions that can be exacerbated by a changing climate such as mediating excessive heat, sequestering carbon, capturing and storing runoff, reducing erosion, and cleaning the air of specific pollutants. The added benefit is an increase in biodiversity in the region.

Some renewable energy systems have also been developed and are in place, and multimodal transportation alternatives have been embraced by many residents. However, with a significant international population and summer temperatures that soar, large numbers of residents leave the community for part of the year to escape the heat, visit family, and earn additional income. This surely has social, economic, and environmental effects.

Auroville is an exemplary model for climate resilience with respect to disaster management and response. After the tsunami of 2004, Auroville created a Rehabilitation Center, a Knowledge and Coordination Center, and Palaam Community Groups to help with trauma counseling, livelihood projects, and ecological restoration (Wheeler, n.d.). Community member suggestions for resettlement patterns included open and shaded areas, For the future city, the ecovillage model provides elements of community building and collaboration that should be considered at the neighborhood or street level during design of any new urban development. This is also the case with the Transition Town model (addressed below), as these two approaches are very much aligned.

Geographically, it appears that the ecovillage model can fit in a very small and densely populated footprint or be spread out over a large rural area, as one sees with Auroville. However, the intent and initiatives found across the many ecovillage examples worldwide should serve as inspiration and should inform the design framework for a model city.

Equity

Ecovillages, and Auroville in particular, provide good examples of meaningful engagement of all community members, equitable economic opportunity, and affordable and accessible housing options. Human well-being, interconnection, and happiness are typically goals driving the creation of ecovillages. Because these communities are designed and developed using a systems perspective, the environmental benefits are shared within and often beyond the limits of the community. Most ecovillage examples also emphasize the production or sourcing of affordable healthy food for all of its citizens. Also, innovative transportation options are shared and promoted among community members, and the sharing economy is modeled on initiatives in many of the older ecovillages.

Income level is often touted as not being a barrier to becoming a member of an ecovillage. However, there seems to be a notable difference between the ecovillages of the developing South and those to the developed North. For the former, the intentionality of the ecovillage is often related to poverty alleviation and the isolation of dispersed rural populations. For the latter, even though there are often expressions of having a diverse community population, in looking at the existing communities' profiles they are often composed of homogeneous, mostly middle- and upper-class citizens (Dias et al. 2017).

Natural Systems and Infrastructure

Often in rural locations, ecovillages may have a greater opportunity for integrating natural resources and ensuring that ecosystem functions and services are maintained into the future. The same could also be said for a model city that is being planned in a greenfield location. Often the landscapes that are selected for Ecovillages are degraded and require reduction of greenhouse gas emissions. To do so, these initiatives focus on new approaches to transportation, the local economy, and energy production.

An aspect of this is the decision to purposefully transition to a future that is more local and less reliant on outside inputs that have large energy and emissions inputs—the goal being communities that consume fewer energy inputs and emit less emissions. In the case of Transition Towns, this work is largely focused on retrofitting existing communities. The model city presents an opportunity to avoid the many barriers that Transition Towns encounter by redirecting existing institutional structures and decisions related to moving from fossil-fuel-driven infrastructure and food consumption and one-time use of energy-intensive products.

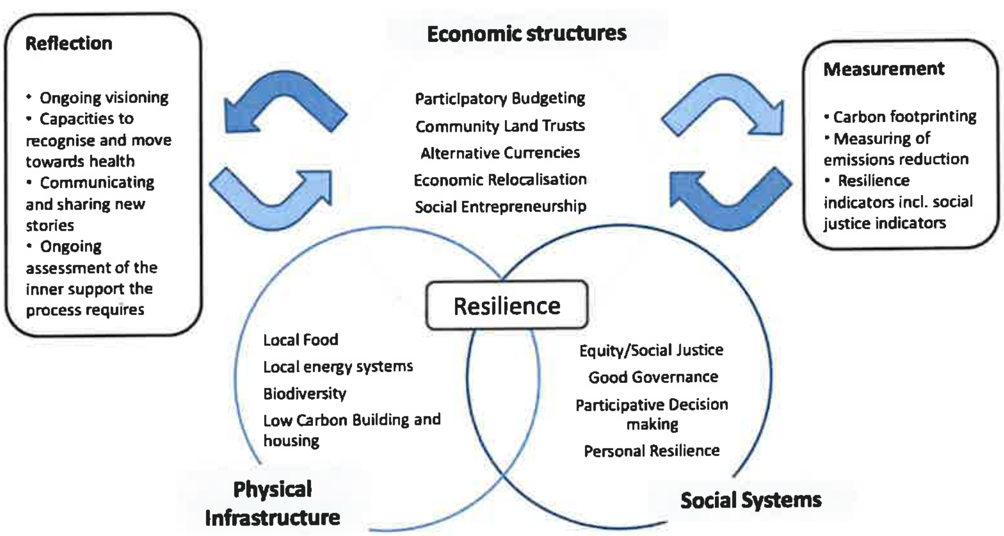

Figure 6. Community Scale Resilience in Practice for Transition Towns
Note: Banks, et al. (n.d.).

Material Flow

Transition Towns emphasize education and collaboration to reclaim the local economy, inspire entrepreneurship, reimagine work, and reskill the population over time. When fossil fuels are intentionally phased out and the community shifts to making and repairing the products needed to support the local population, material flow becomes an overarching consideration in decision making. Specifically for Totnes, forums, workshops, Transition initiatives have also modeled more comprehensive stakeholder engagement. These efforts recognize that individuals and organizations in all sectors have access to networks or people, funding sources, and different solutions. When they are invited to collaborate, new ideas and actions are possible.

Natural Systems and Infrastructure

Given that Transition Towns have largely been used as a redevelopment tool, this model acknowledges and respects the resource limits that are related to natural resources, both locally and globally. The Transition movement also advocates for creating more resilient communities with healthy natural systems. While regenerative approaches may not appear to be a major focus of the Transition Town efforts reviewed, there are isolated examples that illustrate the potential for more emphasis on this work.

Blue-Green Infrastructure: Vancouver, Canada

With the increased threat of climate change due to extreme weather events, maximizing the resilience of water infrastructures is necessary to reduce the vulnerability of cities. Even though the current (gray) water-conveyance infrastructure of existing cities already has embedded investments of materials, energy, and associated dollars, such a system has resulted in the increase of impervious surfaces on the landscape, which in turn reduces water infiltration.

This vulnerability of increased runoff due to increased impervious surfaces is particularly relevant in the current reality of urbanization in the context of more frequent extreme weather events (Kaluarachchi, 2020). The World Bank (2019) has highlighted the fact that current investment in gray infrastructure lacks the flexibility to respond to a rapidly changing climate, and the unavoidable investments into the future must look to integration of green infrastructure.

Blue-green infrastructure (BGI) is a needed component for achieving the model city. BGI is the interconnected system among designed and natural water bodies and associated green spaces (Lamond & Everett, 2019). Blue infrastructure refers to water elements such as rivers, wetlands, floodplains, marshes, and water treatment facilities. Green infrastructure includes trees, forests, fields, parks, and other green spaces.

The Rain City Strategy was born out of the city's concern of how to manage their stormwater which is expected to increase in runoff volume due to changing climate. The strategy specifically focuses on implementing blue-green infrastructure projects that will increase the climate resilience of Vancouver.

The city has various environmental plans and strategies under the Green Vancouver Initiative. This includes climate change mitigation and adaptation, zero waste, renewable energy, and a vision for a strong local economy and inclusive neighborhoods. By having a strong focus on implementing green infrastructure, the city has addressed many of the principles of climate resilience. As you will see below, this reinforces the importance of including blue-green infrastructure into your urban design, nonetheless still requires other synergistic urban development strategies to be implemented to create a model sustainable city.

Material Flow

Blue-green infrastructure examples in an urban settlement include items such as green roofs, constructed wetlands, bio-retention ponds, green vertical walls, bioswales, trees, and parks. Materials, such as water and heat (energy) are delayed in entering and exiting the urban system green-infrastructure. Instead of stormwater directed into rivers and gray sewer systems, a constructed wetland can capture and hold the water for an extended amount of time while recirculating part of the material (water) back into the vegetation. In effect, such closed loops for water (and associated heat) can be more efficient, and thus less costly, than using more traditional linear flow systems (Houle et al., 2011). This water can also be stored as a reservoir for those seasonal times that rainfall amounts are lowest.

Blue-Green Infrastructure projects in the city of Vancouver provide a modicum of circularity of material flow in the system; a stormwater mitigation framework does not specifically apply to the majority of materials circulating in North American cities. However, implementation of BGI throughout the city will obviate the need to utilize more materials to dig up and up-size the City's stormwater piping infrastructure (Simpson 2017). As an aside, in developing economies, there is a close link between storm and wastewater runoff and the ultimate disposition of materials associated with production of goods and services bought and consumed by community members (Ngoc & Schnitzer 2009).

conservation of urban ecosystems is a necessary component of achieving a model urban settlement.

Biophilic Cities: Singapore

E.O.Wilson defines biophilia as "the innately emotional affiliation of human beings to other living organisms. Innate means hereditary and hence part of ultimate human nature" (Wilson 1984, 31). There has long been a history of notable urban development planners to emphasize the vital importance to integrate nature and parks into urban settlements. This is evident in the work of Olmstead and McHarg (Linehan & Gross, 1998). Furthering this work are examples from Ulrich (1981) and Kaplan and Kaplan (1989) to Kellert (2005) and the European Union (2015) that showcase the psychological and physical healing power of integrating nature into our built environment.

Biophilic cities have come to represent a city that prioritizes nature in its design, planning, and management while recognizing and allowing for daily human contact with nature. Timothy Beatley is the founder and director of the Biophilic Cities Network. He reinforces the integration of nature and the city by explaining how a biophilic city is no longer a park in a city, but the city itself as a park.

The biophilic cities model is closely related to regenerative design. It includes many of the principles of permaculture, and a recognition of ecosystem services that are considered in blue-green infrastructure. Biophilic cities also focus on the importance of the human connection to nature. However, it never specifically talks about building the capacity of our ecosystem services beyond what is needed. The strategy also never explicitly considers the design flow of materials into and through an urban settlement.

Singapore has shown how it is possible to incorporate biophilic urbanism in a dense city setting. Since 2013, Singapore has been a Biophilic Cities member and has changed its motto from Singapore, Garden City to *Singapore, A City in a Garden*. The city has installed a comprehensive network of trails and pathways that connect to each other and the population. The city has also incorporated nature into various built infrastructure throughout the city.

Material Flow

The biophilic cities strategy does not directly discuss material flow and pathways in the urban environment outside of the benefits of green infrastructure projects. As discussed in a previous example, green infrastructure projects are geared toward changing the linear flow path of materials such as water and the related use of energy. However, the biophilic-city concept does not address other areas in the linear input and output production cycle of materials used by community members.

One would assume that a city that puts vegetated space at a premium would also need to consider the flow of required water, nutrients, and soil amendments and the circularity of biomass and the associated carbon. For the latter, the prevalence of the growth and consumption of the organic material can be converted to local bioenergy or recycled to create soil amendment products that can be used to provide food to the city. Concurrently, this mediates the need for as much import of organic material that has a substantial reservoir of embodied energy from having been produced in a more energy-intensive manner, if for no other reason than that it must be delivered from a distance. The co-benefits of closing the loop locally are that the captured biomass provides a carbon sink, improves the city's soil structure, enhances the water-holding capacity of the natural landscape, and delivers macronutrients that create a reinforcing feedback to the greening of the city.

Scale

Biophilic cities are not limited to geographic or population size for applicability. The biophilic strategy could be implemented at any size or geographic location for a model city.

Equity

It has been shown that populations with greater exposure to green space experience lower mortality, a reduction of health inequalities, and improvements in psychological health and cognitive performances (Wang & Tassinary, 2019). However, biophilic cities do not lay out a governance structure to ensure equal access to the benefits of natural resources (Beatley, 2017).

Natural Systems and Infrastructure

The biophilic city strategy integrates existing natural resources into the built environment, ensuring some ecosystem functions and services. In many instances, this application can lead to regenerating lost or damaged natural systems. The intentional

The city of Kalundborg in Denmark is an often-touted example of an industrial ecology strategy applied at the community scale. The Kalundborg Symbiosis project (Figure 8) is based on an industrial circular economy model from the perspective that the by-product of one company becomes the raw material of another company. Such industrial symbiosis is not happenstance, it is the result of proactive planning to institute an industrial eco-park that improves the resilience and economic health of the surrounding city and agricultural region (Boix et al., 2015).

The Kalundborg project involves several businesses including a power station, oil refinery, biotech, plasterboard, and supports both agricultural initiatives and soil remediation. The initiative was scaled to a level that did not include the whole town, but a portion of the surrounding community benefits from industrial-sourced excess heat providing residential district-heating. It is important to note water scarcity contributed to the initiation of the project and did not initially take into consideration a multi-systems approach that included climate change and social equity.

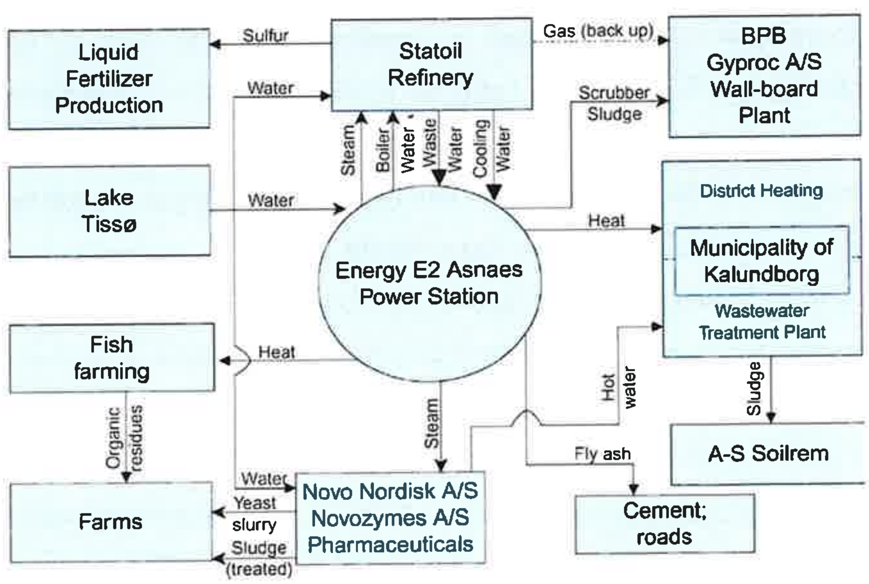

Figure 8. Industrial Symbiosis in Kalundborg

Note. Chertow et al. (2008).

Climate Change

The goal of the Kalundborg symbiosis is to reduce the environmental impact of industrial systems, which necessarily would include reduction of greenhouse gas emissions surrounding region. But it should be noted that such examples typically consist of business-to-business cooperation agreements and are not part of an overall economic-development vision by a city. Therefore, many examples of industrial ecology have been limited to specific industry mixes or single business park initiatives within a community (Vevela et al., 2016).

Equity

The strategy does not specifically address or mention issues of equity or social well-being. However, it could be expanded to include these considerations. In Kalundborg, heat from the power plant is diverted to district heating of homes. As such, industrial symbiosis design can lend itself well to sharing benefits of such by-products. With the appropriate planning intervention, this low-cost heat output could be directed to serving low-income or vulnerable residential populations. It is not unreasonable to expect that the social justice/equity needs can be part of the initial design and subsequent management of such a symbiotic partnership, not only between businesses but also including the local government.

Natural Systems and Infrastructure

The strategy does attempt to mimic the larger ecosystem system by mimicking how materials and energy flow through a natural system. However, there is no specific tie-in to using natural resources for providing ecosystem services or a commitment to regenerate lost or damaged natural systems.

Circular Cities: Brussels, Belgium

A circular city is rooted in the principles and practices of a circular economy, which shifts the value of the economic model from the material supply chain to one that puts the product use foremost. This would apply to both any goods manufactured within the city environs and products imported to support the city's infrastructure and citizenry.

In order to move to a circular city that is both resilient and equitable, the vision of focusing on extending the life of all products to minimize the extraction of additional materials and to avoid additional greenhouse gas emissions needs to be a foundational tenet of the urban planning, design, and implementation of how materials flow. This necessarily requires that the culture, and related social institutions, follow a path so that consumer behavior can adapt to new circular business models that can drive the circular transition.

products at their highest value, thus valuing labor over raw materials as the essential input to the economy (Stahl, 2010).

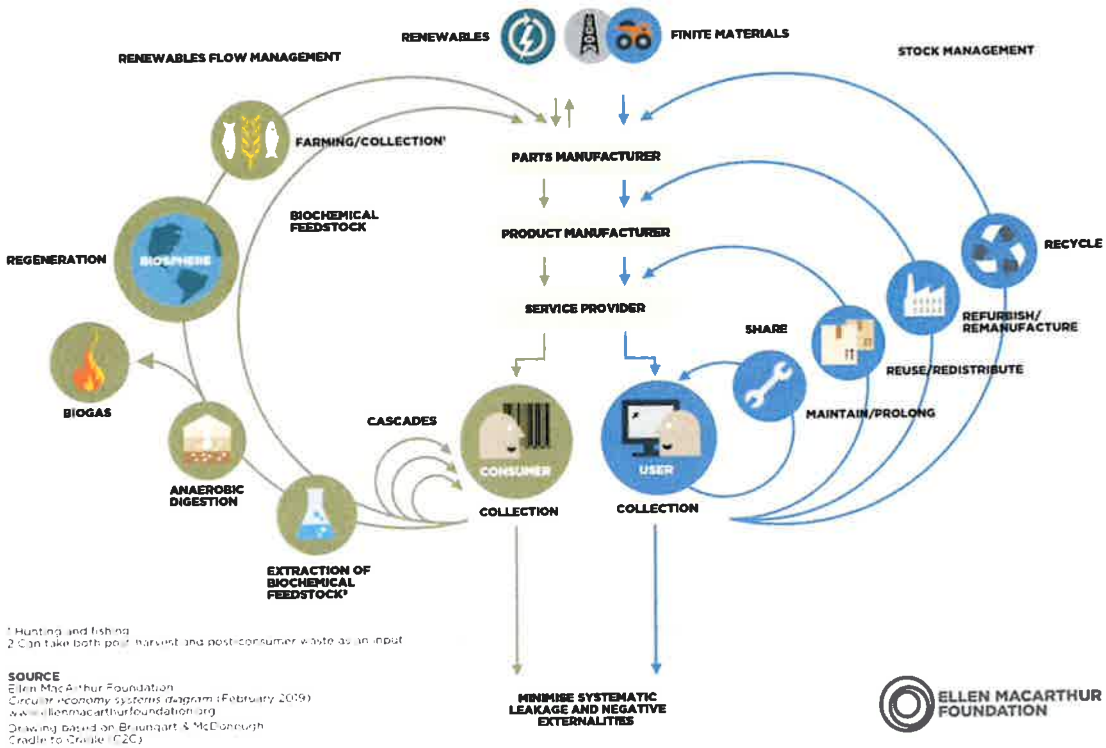

Figure 9. Circular Economy Systems

Note. Ellen MacArthur Foundation (2019).

While no circular city exists in the world, there are examples of aspects of circularity that are manifested within cities (Prendeville et al., 2017). However, there is still no consensus on what constitutes a circular city nor specifics on how to create, or retrofit, a city into a living example. Brussels is an example of implementing numerous concepts and principles of a circular city. The Brussels Regional Programme for a Circular Economy (BRCPE), commonly referred to as *Be Circular*, is Brussels's central circular economy initiative. The Brussels initiative focuses on six economic sectors: retail, logistics, waste and resources, food, construction, and the built environment.

circularity and develop sustainable collaborations within the larger region to enhance an external circularity.

Equity

The vision of the circular city from the Ellen MacArthur Foundation does not specifically address equity through any specific framework or guidance in the design, planning, and operations of a city. In many city examples, it is the major businesses, economic development organizations, or the solid-waste-management sector that frame a circular approach rather than the inclusion of citizen-stakeholder participants. To realize the vision of a sustainable, resilient, and equitable new city, a diversity of community members will need to be included in the design, creation, and maintenance of the model city (Prendeville et al., 2018).

Natural Systems and Infrastructure

In a circular city, valuable land previously dedicated to roads and car parking is freed up for green spaces, commerce, offices, houses, and recreation, thus helping to preserve natural systems. In the literature on circular cities, the words "restoration" and "regeneration" are often used. This is due to the embedded emphasis on reuse, repair, refurbishment, remanufacturing, and maintenance for products in the circular economy but not necessarily applied to natural systems and the ecosystem services provided (Morseletto, 2020). Because the term "regeneration" does not align with our definition of regeneration of natural systems used in this report, Brussels's Be Circular initiative would need to be amended so that the regeneration of ecosystems would be given a priority.

Smart Cities: Lessons Learned from Various Examples

The Smart City initiative is included in this report because of its applicability to obtaining a sustainable, equitable, and climate-resilient city. In addition, many recent examples of planned new city development were initiated and promoted based on the Smart City lens. The Smart City movement has seen more promising results with respect to achieving model-city status.

However, the Smart City does not lend itself as well to an analysis similar to that which we presented for the previously reviewed strategies. There is a limitation of privileged information about these developments for the public to access. Many of these are exploring various examples of smart cities across the globe, this section will need to address components of the framework throughout each specific example.

Shenzhen, China is often referred to as a successful, well-planned, instant city. However, if one researches the origins of the city, the initial purpose of the city was to spur market-led economic growth for a failing national-planned economy (Hu, 2019). As discussed in the beginning of this report, aligning the purpose of a city with a sustainable urban development vision is vital to ensure that a model city is implemented. New town projects in China are often marketed with sustainable urban concepts such as ecocity, low-carbon city, and Smart City to justify (or label) their creation. Unfortunately, if you examine the reasons why scholars or the Chinese government would classify these planned cities as successful, like Shenzhen, they will not align with the principles that are needed for our proposed sustainable urban development model. In addition, because the Smart City concept is applied to a "new city" without existing residents, the design of the city is lacking input from an already-present population that can add diversity and complexity into city formation. While many Asian cities have incorporated aspects of designing nature into the city, the overall material pathways for these cities remain traditional linear take-make-waste flows.

Other examples of a touted Smart Cities include Songdo, South Korea, which was envisioned as a "weapon for fighting trade wars" and was also intended to attract multinational companies with "lower taxes and less regulation" (Kasarda & Lindsay, 2012), and Belmont, AZ, which is the brainchild of Bill Gates, intended to be a forward-thinking community that embraces cutting-edge technology with real-time data accessibility, autonomous vehicles, and logistics hubs (Cooke, 2020). Although Bluetech Park, NV incorporates energy-generating sidewalks, net-zero buildings, "super trees," workforce housing, and other green technologies, the driving purpose of the development by the developers is still unknown according to recent newspaper articles in the Architects Newspaper, Las Vegas Review Journal, and Miami Herald. All these examples of using ICT/IoT data-driven logistics can contribute to city resilience but is in no way a panacea for sustainability. The examples being proposed still beg the questions of how these new experiments will be governed, where the food that is needed by residents will be grown, and

2008 global financial crisis and other economic constraints, the original plan was scaled back to a goal of "low carbon" along with less ambitious waste-reduction goals (Griffiths & Sovacool, 2020). While there are many aspects in the initial design and vision of the project to apply to our proposed model city, there are still two vital issues with replicating the Masdar City project. First, the economic mandate of Mubadala prioritizes economic returns over environmental returns, causing a conflict with realizing the original vision of a zero-waste city (Griffiths & Sovacool, 2020). Second, a significant concern of Masdar City is the physical location selected for the city. Masdar City will be constructed in the desert, with significantly limited freshwater resources and extreme sandstorm events. The latter has curtailed the ability to tap solar power to drive the energy intensity that is demanded by the City's design (Prior, 2010)—a cautionary tale that any model city needs to take a systems approach in the location, creation, operations, governance, and maintenance.

We propose that the incorporation of the technology and ideals of Smart Cities needs to be a part of the model city. However, it is important to take the lessons learned in many of the examples above to avoid the same barriers for development of a robust model city. First, the issue of data and privacy access must be addressed and resolved. Second, the conceptualization, planning, and design of such new urban development must consider the projected effects from a changing climate. Third, a new city needs to be planned and envisioned in anticipation of the community members that will live, work, and recreate there. This could be accomplished with representative samples of future resident populations. It would be an iterative process, where aspects of the new city would be refined over time as new residents migrate into the city.

While there is no silver-bullet answer for overcoming the issues associated with Smart Cities, there are many opportunities to ensure trust and transparency in Smart City development. In addition, there must be thought given to what information is collected in a Smart City and how it will be given meaning. Different interpretations of how the data is interpreted will change the outcome of who benefits from the information. Possibly even more important, is the importance of place-based, cultural information that cannot be collected through technology. This type of information, for example traditional ecological knowledge, can increase the climate resilience of a community and cannot be collected and analyzed by computers or tech. In addition, it is imperative that any new urban development investigating the previously explored sustainable urban settlement strategies and taking them to a higher level of systems thinking and material flow.

To achieve the model city for the future, a new way of thinking is needed for urban development. This can be achieved through restructuring and reconnecting people with the limitations and opportunities that are associated with natural systems and our physical environment. Leuphana University faculty (Abson et al., 2016) have engaged in relevant research to transform our systems and achieve true sustainability by addressing higher-level leverage points for system change. Their work is premised on Meadows's *leverage points*, which range from relatively easy interventions that change the amount or extent of a system's dynamics to more significant paradigmatic change that shifts a system toward sustainability (Meadows, 2010).

In today's society, changing numbers are typical intervention points for creating behavioral change. For example, increasing the miles per gallon of a car will reduce greenhouse gas emissions to a certain extent. This is because individuals primarily live in places where they need a car or another form of vehicular transportation to get to work, buy groceries, or just have fun. But economists have seen that such an energy-efficiency change may lead to more miles driven per car, obviating the benefit of lower mileage per gallon. This is often characterized as *Jevons Paradox* (Blake, 2005; Freir-Gonzales, 2015). However, eliminating the need to own a car because of the physical (re)development of a city has a much more profound effect on emissions.

Changes in the system's goal, organization, or structure are considered to be deeper and highly influential leverage points that can shift the overarching framework. Such leverage points are also considered the hardest to implement. For example, it is much easier to recycle waste through a solid waste system versus reengineering the design of all products to maximize reuse, refurbishment, or repair, a foundational attribute of a true circular economy. Historically, it seems evident that there has been a disproportionate focus and reliance on the easier-to-influence leverage points such as numbers, stocks, and flows. The structure of stocks and flows are viewed as having minimal influence for creating substantial changes because of the amount of time and resources needed to change physical infrastructure. You can see this evident in the time it takes for contaminants to be washed out of aquifers. The structure of the system would need to be completely changed to avoid being. Finally, we must always consider future generations and how to ensure that our decisions today do not limit their decisions in the future.

Purpose and Vision of the City

The goal and purpose of the city must be rethought to include a holistic systems approach for providing the infrastructure and materials that are necessary for people to live and work. We must necessarily include that the purpose of the city is to create equitable, meaningful, and fulfilling lives for the inhabitants. Beyond building resilience, equity, and social wellbeing and happiness, the purpose of the city should include a goal of supporting and regenerating the capacity of earth's natural systems.

Concurrently, we must acknowledge and explore how all materials and energy in our cities are produced and used. How do we envision our materials flow? Are products designed so that consumers have one-time use, which in turns reinforces a flow rate of the supply chains that hastens the limits to the carrying capacity of the very systems in which the city is embedded? It is time for us to rethink the linear flow path of materials, envisioning a culture where materials management is not just a waste management responsibility.

To begin this process, a community-driven design form of urban planning is necessary (Wilson, 2018). Such a design approach creates a space where power is equally redistributed for decision making, creativity is encouraged through deliberative processes, shared goals are highlighted and prioritized, and participation is honored and rewarded.

This type of participatory approach would be located at the highest rung of Arnstein's Ladder, which is "citizen control" (Arnstein, 1969). Arnstein's ladder was created as a guide to highlight who holds the power when making important decisions that affect the community. Environmental and resilience planning and design typically depend upon experts for crucial decisions on the outcome of urban development. However, in the model city we are envisioning, this information would be dependent on citizen participation for shared values and solutions to enhance the expert knowledge for an equitable, resilient, sustainable city.

To do this successfully, we propose adapting the iterative Collaborative Planning Approach (Gruber, et al., 2017) to gain stakeholder values, beliefs, attitudes, and knowledge

Sense of Place

For this resilient and circular model to be implemented, we must rethink different aspects of urban development. This begins with reconceptualizing the purpose of the city by acknowledging the "sense of place" within which the urban development is located or proposed to be sited. Such an approach values the preservation of the historical, cultural, and ethical mores of a region and its people. It also acknowledges the specific natural systems on the landscape that the city is supplanting.

In addition to creating opportunities for authentic citizen participation, we must also rethink the scale at which we envision, design, plan, create, and operate the new model city. To frame the model city to maximize its resilience in face of the global challenges we see, there must be a balance between thinking globally and recognizing that the proposed urban footprint is cognizant of, and respects, an already existing landscape.

"Sense of place" transcends various disciplines and has foundations in both urban design and sociopsychological sciences. It is necessary to incorporate and foster a sense of place for an urban settlement to be a vibrant and livable, as well high quality with respect to the built environment (McMillan & Chavis, 1986; Puddifoot, 1995; Hu & Chen, 2018;). The subsequent planning and design of such a model city should develop in a manner to maintain already-existing natural assets and culture while concurrently developing an economy that contributes and enhances the quality of life of not only the urban inhabitants but also of the greater region's citizens (National Academies of Sciences, Engineering, and Medicine, 2016).

Such a sense of place encourages stakeholders in the urban development process to be cognizant of the shift of the larger climate systems and the associated projection of climate effects in a particular region. The specificity, frequency, and intensity of such effects vary with locale. Therefore, the design, planning, and implementation will vary with respect to what makes the community resilient. Failing to consider this shift in the climate system results in a flawed design, which will not only constrain the sustainable economic growth of a city but also possibly lead to inequalities within the citizenry, and may actually result in fatalities.

in organizations and communities. Additionally, there must be restructuring of the production cycle and the associated flow pathways so as to maximize the useful life of already extracted materials and expended energy.

Balkanization and Decision-Making Hierarchy

The resilient and circular model city needs to develop an approach that allows both top-down framing, planning and design by producers that reflects bottom-up buy-in by the consumer, who ultimately makes the decision of how to handle a product once their use of it has passed. Top-down change is institutionally driven (in this case by the municipal/local government), such as economic-development decisions facilitating public-private partnerships that maximize material circularity. Alternatively, bottom-up change describes company collaborations (supply chains, product design), social movements, social innovation, and community/neighborhood based implementation (Prendeville et al., 2017).

A crucial factor of flattening and integrating the traditional hierarchy of decision making is to address the common "balkanization" of professional disciplines and material production. The process of developing a model city that uses a circular economy approach requires multiple disciplines including urban planning; economic development planning; architecture; engineering; water and energy resource expertise; and the professional disciplines within the transportation, public safety, education, and environmental protection domains, just to name a few. As has been seen in existing cities, the expertise that is required to operate the various city services are often separated into different departments, and collaboration among these different city operations is lacking a true transdisciplinary approach (Patel, 2015).

This has more recently been revealed as a barrier to effectively responding to the potential effects of a changing climate (Leiren and Jacobson, 2018; Uittenbroek et al., 2013). Thus, it is incumbent upon those who are championing the development of a new model city that during the initial phase of conceptualization, the visioning should be informed and refined by an inclusive process that brings the different professional perspectives into a common forum (Ekstrom & Moser, 2014). This would allow proposed ideas to be debated, critiqued, and refined so that subsequent planning, design, and implementation has a *shared vision* that emerges from the process. An additional necessary

Creating, or redeveloping, for a resilient and circular city will also require a transformation in the physical design of our cities. If we have the option for designing a new planned urban settlement, we recommend using the five steps of permaculture design to envision the physical structure and placement of the city. These include observation, envisioning, plan, develop, and implement. The observation of a landscape is the most important first step for the physical design of an urban settlement in the permaculture approach. Individuals are needed to understand and watch the landscape to be cognizant of the solar gain of the area, how and where the water flows, what the various soil types are, climate, wind patterns, and all existing ecosystems and their services. This will help minimize and recirculate materials that are needed to heat and cool structures, obtain water and food efficiently, generate distributed energy, acquire natural resources onsite to be used in production, and determine how to manage precipitation and stormwater.

During the envisioning step, a structured and facilitated process is used to build community collaboration on how best to locate residential, commercial, and recreational city forms, along with municipal spaces that can enhance industrial ecology and mimic natural systems. Once such thoughtful systems-oriented envisioning is underway, the next crucial step is to restructure existing land use policies and regulations to support and incentivize the circular economy of the urban settlement. Nontraditional and innovative land-use planners with experience in form-based code, performance zoning, development impact fees, power purchase agreements, land banks, tax credits, transfer of development rights, and more will be necessary to achieve this circular flow path of materials.

Reconnect

For this resilient and circular model city to be actualized, we must foster interactions between people along with their relationships with nature. This can be accomplished by building social capital through governance structures and other forms of authentic community participation. In addition, we must ensure there are opportunities in the design of the urban landscape for all members of the community to have access to experience nature.

example, a few leading cities around the world are attempting to change the current paradigm of developing isolated green spaces in a city where people must travel to experience nature to developing a city where nature is integrated into all aspects of urban design.

This type of integration has multiple benefits for urban development in addition to improved public health. These benefits include mitigating and adapting to climate change, building climate resilience, fostering "sense of place" among residents, increasing social capital, reducing energy demands, and lowering infrastructure costs. As we have recently seen through the current pandemic, green spaces and access to nature are a valuable, privileged resource. By incorporating nature into all aspects of urban design, the associated benefits are equitable and accessible to all community members.

A Few Closing Thoughts . . .

This conclusion begins with addressing some reflection on aspects of this thesis that should be mentioned in considering any conceptualization of a new model city. It closes with a proposed tool that could serve those who are initially conceptualizing any new urban (re)development.

Premises

Our analysis is framed from two overarching paradigms. The first is that we are imagining developing a new resilient and circular model city where, heretofore, there was no development. From a circular economy perspective, considering the investment in products and infrastructure of existing cities, our framework would be more apropos for re-urbanization. This would maintain the usefulness of materials that have been extracted and the related energy already expended. Also, there is the consequence of siting any new city footprint on the landscape in that it further reduces the natural ecosystem services on which society is dependent.

But with this said, if population growth and in-migration to cities from rural environs continue to increase, new city footprints may be unavoidable and as has been demonstrated

A recent research report showed that a small group of resilient companies outperformed their competitors during the 2008 financial crisis. Although their revenue loss was on par with that sector's industry-average loss, by 2009 the earnings of the most resilient companies had risen 10%, whereas the non-resilient companies had gone down 15%. In this context, resilience was characterized in the frame of preparation for possible futures by mapping supply-chain possibilities and developing alternative strategies to just-in-time procurement and access to capital (Sneader & Sighasl, 2020).

This lesson in resilience can be also seen at the city scale. After Hurricane Katrina hit New Orleans, an analysis of what went wrong with respect to city/regional planning was released by a review panel. This study concluded that with respect to a changing climate, there was a clear lack of thinking globally in order to act locally. The report went on to say the city failed to build resilience into their systems and lacked the necessary redundancy that was required to reduce the city's vulnerability (ACSE, 2007). An important implication of this report may be that efficiency can translate to more product and service output for the same input, but this will be a moot if a systematic shift outstrips the resiliency that the efficiency has compromised.

Another lens on the same dynamic has been developed by the Federal Emergency Management Agency (FEMA) regarding extreme events that are mediated by the changing climate. It has been found that after natural disasters many businesses within communities, especially small businesses, are not resilient to such disturbances. FEMA has seen that 40% of small businesses never reopen after a disaster and another 25% that do reopen fail within a year (McKay 2018).

Building resilience is important not only to a business's bottom line but also to the city's economic health and the well-being of the city's workforce. This is particularly important for a city that strives for a circular economy—one which focuses on highly skilled workers in a multiplicity of smaller business enterprises that maintain the usefulness of products.

AI: the Good and the Bad

With respect to efficiency, there is large potential for artificial intelligence (AI) to play a significant role in supporting a circular economy within our model city. This is at the business). Once the consumer has made use of the product, the decision to follow a circular path or a disposal path lies with them (Stahel, 2019).

To follow circular pathways, there needs to be system options for circularity as easily accessible as there are for a disposal pathway. It is in this role that the city must be a significant driver, not only through its urban and economic development but also through messaging, education, and collaboration with its citizenry. From the urban development side, circular paths for products, both spatially and temporally, must be equally accessible for all. From the economic-development perspective, the responsibility needs to start with facilitating the location of businesses that have shown to minimize inputs of materials and energy. It is also important for businesses to move proactively from a design of planned obsolescence to maximizing use. Businesses need to avoid designing a product's linked goods that are specialized and should consider establishing universal standards for component and accessory use. The design phase should envision component replacement and eventual disassembly, establish universal coding to recognize component parts to facilitate materials tracking, and support a more efficient marketplace for the sale and acquisition of such components.

Synthesizing a New City Model

As identified through our research, not one of the current urban development strategies reviewed represents a holistic approach to a sustainable development. Each of the strategies has essential characteristics and principles that need to be coalesced and synthesized into an all-inclusive new city model. To help move our assessment framing to application, the table (Appendix B) below is a first iteration of a guide to inform consideration of any future (re)urbanization. This approach should help guide envisioning, planning, and designing a model urban settlement.

The matrix uses the climate change, material flow, equity, scale, and natural-resource lens and has associated questions that can be applied to assess past urban development efforts or used to help conceptualize new urban development. Our ideal model city will score a 5 in every question to approach the goals of a resilient, equitable, and circular-material-flow city. The matrix, along with a systems approach in participatory planning, will foster the way forward to a new paradigm for a successful vision toward a new city model.

Appendix B: Framework Matrix

Climate Change	
Questions	**Rating (1–5)**
How well does the example incorporate current and future effects of climate change to that specific location?	
How well does the example address mitigation of greenhouse gas emissions?	
Does the strategy incorporate the climate-resilience principle, maintain diversity and redundancy?	
Does the strategy incorporate the climate-resilience principle, manage connectivity?	
Does the strategy incorporate the climate-resilience principle, manage slow variables and feedback loops?	
Does the strategy incorporate the climate-resilience principle, foster complex adaptive systems thinking?	
Does the strategy incorporate the climate-resilience principle, encourage learning?	
Does the strategy incorporate the climate-resilience principle, promote polycentric governance systems?	
Material Flow/Pathways	
Questions	**Rating (1–5)**
Are there easily accessible options for the consumer to direct materials to a reuse, repair, and refurbish economic pathways?	
Are there local policies (being) proposed to target specific materials/products flowing into the city that maximize circularity.	
Has the waste management system been altered to maximize circularity?	

Does the strategy promote environmental justice with respect to an equitable share of environmental benefits for existing communities in the region in which this urban development is to be sited?	
Does the strategy promote and advance equitable economic opportunity?	
Does the strategy include policies or programs that allow anyone to live in the community (affordable housing, accessible transportation, healthy and accessible food, safe neighborhoods, and public health)?	
Does the strategy allow for meaningful engagement and participation of all community members?	
Does the strategy address overall human well-being and happiness in the design?	
Natural Systems/Infrastructure	
Questions	**Rating (1–5)**
Does the spatial footprint for this urban development reflect the carrying capacity of the region in which it is being sited with respect to land, water, and energy use?	
Does the strategy integrate existing natural resources into the design and planning for this urban development to ensure that ecosystem functions and services are maintained?	
Is there a commitment to regenerate lost or damaged natural systems?	
Does the design and planning of the city both replenish resources and maximize reuse of already-extracted natural resources from the surrounding region?	

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