Urban Resilience

and

Urban Sustainability

A Thesis Presented to the Faculty of Architecture and Planning

COLUMBIA UNIVERSITY

In Partial Fulfillment

of the Requirements for the Degree

Master of Science in Urban Planning

by

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May 2016

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Foreword

With every word I type on my laptop, I realize the many harmful metals it is made of and the unsafe mining conditions. Every bite into my morning apple, reminds me of the poor farmer who himself wakes up famished. My leather shoes scream with every step of the injustices done to production laborers and the packaged water I sip as I get to work tells a story of water reserves that have gone dry or been poisoned. And I know that the empty bottle will make its way to a now deranged landscape forcing juxtaposing communities to deal with the pollution. Similarly, everything we 'consume' reiterates this story. A story, that is not printed anywhere on the wrappers or packaging boxes; one which defines the full cost of what we consume, ignorance about hazardous contents, the breakdown of communities, a disregard for the future, political corruption and atrophy of more sustainable means by which we might provision ourselves.

Architects, engineers and planners across the world often look at problems regarding the natural world through their specialized objectives. However the issue at hand goes beyond polar bears or spotted owls. For every degree of rise in temperature, entire agronomy based communities are rendered jobless. For every drying lake and clogged stream, dependent societies are forced to relocate for survival. For every mine left abandoned, there are communities rendered unemployed with polluted air to breathe and poisonous land to live on. And somewhere we realize – the choices we make as inhabitants of this planet affects the manner and condition of our life. And for now, 'consumerism' is a choice we have made.

Acknowledgements

The apparent paradox of urban resilience within urban sustainability is a dedicated to the ecology and the beauty that is this planet – the hills, seas, rivers, oceans, mountains, rocks, sand and the endless bounty we inhabit.

I acknowledge Dr. Joyce Klein Rosenthal, the advisor of my thesis, for her endless support and guidance. Special thanks to Mr. Michael Fishman, the reader of my thesis, for his tremendous support and inspiration. Many thanks.

A special thanks to my family for always being there and supporting me through all the ups and downs and to my friends who have been invaluable in this process.

Abstract

The urban system has been a subject of much attention and inquiry, more so in the past two or so decades. The design of urban systems and juxtaposition of humans with nature has been scrutinized and critically examined by several means and modes. To replicate the natural systems' balance post human intervention on thus is what societies have strived for, for a long time now (Redman, 2010). The emergence of sustainability in the realm of urban living and more recently the attention imparted to the long known concept of resilient living have been a corollary of this quest. The trend in sustainable development and resilient systems planning of devising frameworks and drawing indicators to help define these vast concepts and help make their manifestation and measurement more tangible is evolving and developing more and more in academic circles and planning disciplines alike (see Alberti, 2012; Arup, 2015).

However, the lack of a definite norm and basic sustainability and resilience requirements worldwide has made it more and more difficult for built and planning manifestations to respond directly to these broad-ended goals. It is hypothesized thus that a required innovative framework that incorporates the concepts of sustainability, resilience, a balanced ecological living and an efficient urban system be coined so that these concepts are reflected in manifestations of urban living and not lost in translation. An analysis of existing indicators and frameworks created by both academics and practitioners that currently define sustainability and resilience in urban development are used in identifying gaps in the current methodology adopted by cities in planning for sustainable-resilient living. A new framework and approach is attempted by incorporating the missing links. It is expected that this integrative framework - measuring and defining a resilient, sustainable and more responsible urban systems living - is a paradigmatic shift in the way planning policies are ideated and manifested in cities.

Chapter I: Introducing Urban Systems

Over the past two decades or so, sustainability has emerged as a guiding framework to shape human and economic development and conserve the ecological balance of the planet (Slavin, 2011). Lack of understanding and a defined consensus on the specificities of the exact definition of sustainability has often led this concept to be a victim of critiques defining it as 'too broad', 'vague' or 'elusive' (Marshall & Toffel, 2005). The noticeable deterioration of urban conditions and the apparent need for alternative environments to sustain human life became evident to social reformers in the late nineteenth and early twentieth century (Wheeler & Beately, 2004). The European urban centers of the late twentieth century had enormous problems related to public health, sanitation, overly dense residential units and inadequate infrastructure (Wheeler & Beately, 2004). With polluted air, degraded water sources and deforestation increasing to all time new heights, observers realized that the balance between humans and the natural ecology that they inhabited was being tipped too far in one direction. With this understanding, a major planning theme centered on the balance between the urban and nature emerged in the nineteenth century as did the concept of 'sustainability', which was first used in German forestry circles by Hans Carl von Carlowitz in 1773 (Pisani, 2006) and later translated to urban systems and their development thereon. The concept of "sustained" development has been attributed to the field of human resource management (Wheeler & Beately, 2004). Since then it has been widely agreed to be a concept at the node of defining interconnections of ecology, economy and society, considering resource base – both global and local and being definitive of the long-term needs of the future generations (WCED report, Our Common Future, 1987). Since, a variety of indicators examine, quantify and measure progress towards sustainability of the urban system at multiple spatial and temporal scales. Organizations and governmental institutions, as depicted and summarized in New York City's 'ONENYC' are seen to be using more and more of these indicators, modified at a contextual scale, to track progress towards or away from sustainability of set policies aimed at thus - to make, what was once believed to be an abstract concept of sustainability, into a tangible and measureable objective (One New York: The Plan for a Strong and Just City, 2015).

As studies and theories continue to add more terms to the arena of social-ecological systems in a quest to better understand and hence better design human habitation within its context, the term 'resilience' has recently observed a major rise in its priority and application for thr design of cities (and urban policies) amongst governmental agencies and professionals (Zolli, 2012). From the symbol of perseverance that is the phoenix to the endless Arabian and Egyptian folklore on resilience, the word itself seems to have sprung to a new life in planning conversations and practice alike (Sehgal, 2015). Resilience as a concept to define the design of urban living system, has joined Sustainability in many major planning frameworks and investments of a region's financial and human capital and soon seems to be replacing it as the main concept in urban discourse (McPhearson, 2014). A lack of clarity in the linkages between resilience and sustainability is increasingly being seen as a rising concern towards losing specificity of these extremely influential and fundamental concepts (McPhearson, 2014) and therefore their application in better understanding and designing the juxtaposition of human life on the natural system.

The first section of this thesis reviews the background and theory of evolution of the concepts of sustainability and resilience into urban discourse. This thesis then begins to understand and draw links between urban sustainability and urban resilience, thus translating their interactions from what they appear to be to what they truly mean in urban development. From there - this thesis goes on to discuss the indicators that have been applied in the context of these concepts and the common critiques that have appeared in academics related to thus. The next section then offers an alternative perspective to the current frameworks applied for planning by lending an insight into the gaps and missing links according to the concepts of 'responsible urban development' also defined thus. This framework ultimately intends to exemplify how a truly resilient, sustainable, responsible, dynamic and efficient living system for human habitation can exist, not only theoretically but functionally. It concludes by identifying the implications, an innovation of such a framework can have on the planning realm and the way forward.

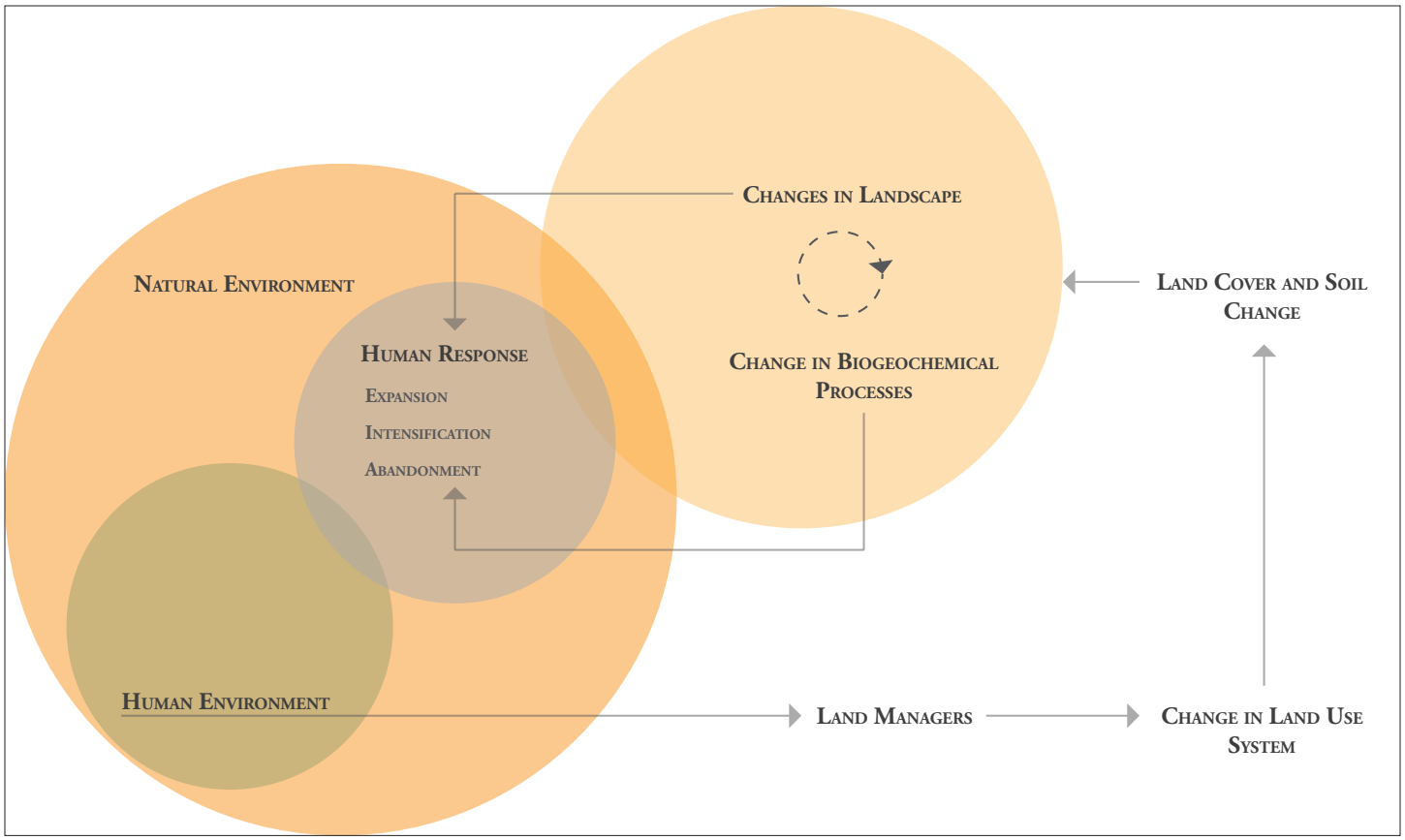


Figure (i): Understanding of our Natural and Urban Environment

As a precursor to this study, this diagram represents the understanding of the urban system in context with the natural environment, and where 'human response' and 'human environment' fit within the larger natural system. This also defines the changes that human responses are continuing to pose on the landscape.

Chapter II: Methodology and Background

Theoretical Perspective

The theoretical framework for this research is divided into three broad conceptual basis – *The sustainable communities' framework, the resilient communities' framework and the resilient and sustainable communities' framework.* These will be orderly explored to define an overall framework to inquire the research question –

Is there value in integrating resilience and sustainability indicators to environmental impact assessments to better understand and plan for Urban Systems?

In order to understand the integration of sustainability and resilience measures for social-ecological systems, there is a need to explore these individually first, incorporating the theory base extensively used currently. Through exploration of these extremely vast and crucial measures, appropriate nodes for exploring linkages are identified and the integrative theory is then tested.

Sustainable Urban Communities' Framework *(Derived from the Institute of Development Studies framework, 1998 and The Natural Step Framework for sustainable society)*

The measure of a sustainable community is important both from the perspective of the population that constitutes it and their livelihood and the ecological context on which the community depends. For a sustained livelihood of any human/household/community, the sustainable livelihood framework is considered as a base that defines characteristics of the poor and vulnerable of any community and the framework to help assess their livelihood. From there, the context is then considered through the natural step framework where natural resource management and a sustained dependence of humans in the ecological setting is considered. Together, this defines the sustainable urban communities' framework for this research.

The sustainable communities' framework consists of a number of basic elements. As described by Ian Scoones (1998) the key question to be asked in any analysis of a sustainable community is –

"Given a particular context (of policy setting, politics, history, agroecology and socio-economic conditions), what combination of livelihood resources (different types of 'capital') result in the ability to follow what combination of

livelihood strategies (agricultural intensification/extensification, livelihood diversification and migration) with what outcomes? Of particular interest in this framework are the institutional processes (embedded in a matrix of formal and informal institutions and organizations) which mediate the ability to carry out such strategies and achieve (or not) such outcomes." (Scoones, 1998 – pg.03)

This framework is applicable at a variety of different scales ranging from individual to household to society to region up to even nation, assessing sustainable outcomes at different level (Scoones, 1998 – pg.03). It is hence, extremely vital to specify the scale of analysis and thus the interaction between these different levels of context. This framework is adapted to the urban context and used in the research to understand the sustainability outcomes of urban living systems and the indicators that influence thus. Even though there is a basic similarity in the fundamental principles outlining the livelihood approach in rural (for which the framework was originally devised by the Institute of Development Studies, IDS) and urban areas, there are however stark contextual differences, namely – social, governmental, economic and ecological. It is critical hence to understand the nature of the urban context here when examining the intricacies of urban sustainable communities. These differences are then further translated into not only the characteristics of the neighborhood but also in implication for policy and other interventions.

The Approach

The sustainable livelihoods approach can be defined as a way dissecting development activities into objectives, scopes and priorities. It is based on the evolutionary thinking of the significance of policies and institutions and its implications on how the financially challenged and vulnerable population live their lives (Scoones, 1998). The sustainable livelihoods approach while facilitating the identification of practical priorities, makes the inherent connection between people and their environment that directly influences the outcomes of livelihood strategies. This framework organizes factors constraining or enhancing livelihood opportunities and displays the relationships amongst them (Scoones, 1998; Serrat, 2010). The central notion is that households have varied livelihood assets (human, social, physical, natural,

financial) amongst which the vulnerable and poor, must make trade-offs (Scoones, 1998; Serrat, 2010).

Included with this is the United Nations Sustainable Development Goals Framework which was formally initiated in June 2012 to pursue a focused global action on sustainable development. This resonated with the sustainable livelihoods at an inherent level as it focusses at the core of its agenda on the fulfilment of rights for the wellbeing of all people. The 17 goals and the 169 targets aim towards addressing climate change, renewable energy, food, health and water requirements amongst other factors under the larger social, economic and environmental umbrella. Though the goals have been defined, the metrics to measure progress towards the targets on local, national, regional and global levels and across sectors still need to be better developed and understood (Lu, Nakicenovic, Visbeck & Stevance, 2015). Owing to this, in the indicator study in this research, though the goals are used as a driving and framing force, the lack of a metrics makes it difficult to assess and incorporate the goals within the larger framework.

Adaptation to Urban Context

While generic, the assets as described in the frameworks, are similar for rural and urban models. However the urban context may require a different emphasis for each type of asset. To exemplify, financial capital gains more significance in an urban context than natural capital (Carney, 1998) when compared to a rural livelihood context. The correlation of asset types, as clearly depicted in the model drives users towards a more holistic understanding of the basis of livelihoods. Complex asset configurations with unclear definitions and often undetailed specificities are common to the urban poor and vulnerable populations of a community (Carney, 1998).

Sustainability Measurement Framework for Social-Ecological Systems

The major challenge in this research is an understanding of why and how some (if any) Social-Ecological Systems are sustainable while others fail to survive. The framework for analysis must also traverse multiple levels of complex systems across varied spatial and temporal scales. The complexity of such systems needs to be dissected and understood

individually and then brought together as a whole. However, most frameworks fail here as different variables of a system are explained by different models and theories and a common node to connect them all remains non-existent. Many frameworks and theories have sought to identify the nature-human interaction and nature resource utilization. The 'Environment Space' (Pg. 8, Opshoor, 1991) being one such was seminal in its definition of the variables of "pressure indicators" and "environmental effect indicators". This model measures the limitation of various resources available for human consumption and further to understand the amount of reduction in resource consumption necessary to guaranty long-term availability of resources. This model tends to draw connections between social aspects (mostly economic) and ecological capacity of the system and in the process tends to neglect the other nested systems which play a major role in defining this human-nature dependency.

As Holling et al. (Peterson, Allen & Holling, 1998) helped identify, the problems involving social and ecological structures are actually complex and nested system problems and can no longer be defined through linear solutions. These systemic problems demand solutions similar to their own inherent structure, one that traverses across multiple temporal and spatial scales.

With this understanding it was enormously essential to understand prominent examples across various organizations of sustainable indicators. Alberti's seminal study on various sustainability indicators provides with a sound basis for this research (Alberti, 1996). The many lists of urban indicators lists adopted by public agencies or academic bodies differ widely in their policy focus and in their scale of measurement or implementation (Alberti, 1996). Even though these indicators differ in their emphases on definition of what needs to be sustained and how, the enormous pool of work in this area could help define a framework for this study. Using five different frameworks and methodologies aimed at measuring sustainability of social-ecological systems, a framework for a workable indicator set for this study is defined. The indicator sets studied include – United Nations Commission on Sustainable Development (UNCSD, 1992), Environmental Sustainability Index (World Economic Forum's ESI, Siche et al., 2008), Ecological Footprint (Redefining Progress, 2002), OECD's Green Growth Indicators (OECD) and Boston Indicators Project (BIP.org,

2015). These sets of indicators are chosen to emphasize and reflect the variety of focal points and various scales at which different organizations place their concentration and priorities. Various approaches, technical and ideation-centric, are employed in the development of these measurement systems for sustainability. For example, OECD and the UNCSD indicators are aimed towards the national scale whereas UNCHS focusses on the urban scale. Within these too, the core area of focus varies from climate change (OECD) to socio-economic features (UNCHS) and to environmental concerns. There is inconsistency observed in units of analysis, temporal scales, terms and definition used and aggregation and selection of indicators, as they tend to be hugely contextual.

The most important factor in the definition of the indicators is the realization of the interaction between social and ecological systems and the recognition of devising solution for nested structures. As a starting point for analyzing any social-ecological system, a general framework is necessary to be defined consisting of the basic variables of a resource management system, resources themselves, and stakeholders of that system along with the governance structure of the system. Where generally the indicators are categorized as social, economic and ecological (International Urban Sustainability Indicators List), this framework tends towards traversing the harsh boundaries of systemic differentiation and aims towards cross-referencing sections to understand the complex systems better.

Resilience Measurement Framework

Resilience being a novel concept (owing to its recent re-birth) in the understanding and defining of social-ecological systems, not many frameworks for indicators to measure the resilience of a system exist currently. For this study, since the focus lies primarily on urban systems, the conceptual framework to measure resilience at that scale of human habitation, two frameworks have been used to derive the indicators/variables from. M. Bruneau et al. (2003) devised a framework to quantitatively assess the resilience of communities in the case of seismic disasters and is a useful framework to derive a theory for this study, from. More recently, Rockefeller foundation's City Resilience Index (Arup, 2015), succeeded in defining an extensive metrics to define resilience of communities in the urban context in the

face of constant change. Both these studies, provide insights into various aspects for this study and a methodology to measure resilience is thus defined. The linkage assessment of resilience of community and infrastructure (Bruneau et al., 2003) identify through a systems diagram the key steps to quantify resilience. It further goes on to indicate how the multitude of resilience measures can be integrated into a consistent and defensible method for evaluating both current and over-time improvement of resilience of a community. This study focusses on "robustness" and "rapidity" as being two ends of resilience (Pg. 737. Bruneau et al., 2003).

The City Resilience Index (Arup, 2015) broadly characterizes its indices into four categories of

1. Health and well-being,

2. Economy and society,

3. Infrastructure and environment and

4. Leadership and strategy.

Further intensive research led to definition of 12 indicators within these four dimensions and 58 sub-indicators within that. Their framework focusses on inclusiveness and integration as being the two most important characteristics for all systems unlike others that change with each sub-system characteristics.

Deriving from these frameworks for measurement of resilience for urban systems, most suited to the spatial scale of this study, it is realized that resilience is measured over a period of time, particularly a threshold defining a disturbance or disruption to the existing system (Bruneau et al., 2003). Unless resilience is measured before and after the event of disruption, it ceases to define the ability of the system to adapt or transform. Hence, key components and connections are visualized as being vital to the transformation; perturbations and drivers are assessed to cater to the change in local social-ecological system as are social systems to understand the constant exchange with the ecological system.

Research Problem

The research problem is based on a pragmatist worldview where the emphasis of the thesis is on the research problem

more and in the understanding of thus (Creswell, 2009). The hypothesis being studied in this study is as follows:

Current resilience and sustainability indicators effective in urban systems, need to intentionally and tangibly correspond to environmental impact assessments for projects, policies and programs.

This problems looks at the existing policy manifestations and implementations on environmental conservation in context with urban development (namely the Environmental Impact Assessments) and identify if in fact they reflect the two main concepts of resilience and sustainability, intentionally, either in ideation, implementation or manifestation. As existing theory indicates the growing opportunity to identify the link between resilient urban systems and long-term sustainability of urban systems, this study aims to understand whether existing policies and their manifestations capitalize on this opportunity at any level. This study further hopes to explore the value, if any, in integrating resilience indicators and sustainability indicators within the Environmental Impact Assessment requirements to manifest design of more sustainable, resilient and ecologically responsible urban communities. Through these measurements and inter-linking of concepts at an urban scale, the research follows a pragmatists' approach of defining or providing strength to an existing nascent theory by understanding and measuring already existing implications in the practical world.

The inter-relationship between the concepts of Urban Sustainability and Urban Resilience and their manifestation in planning projects

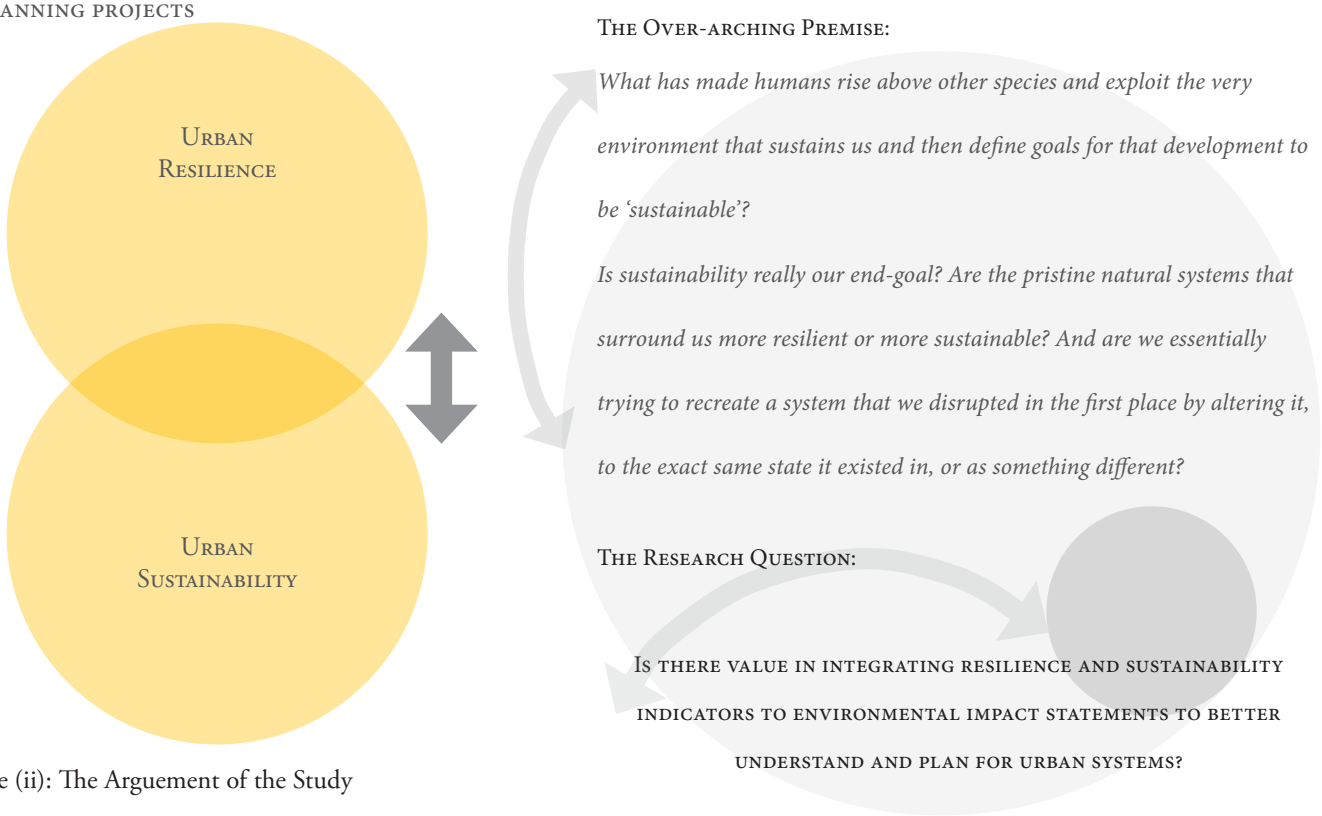


Figure (ii): The Arguement of the Study

Methodology

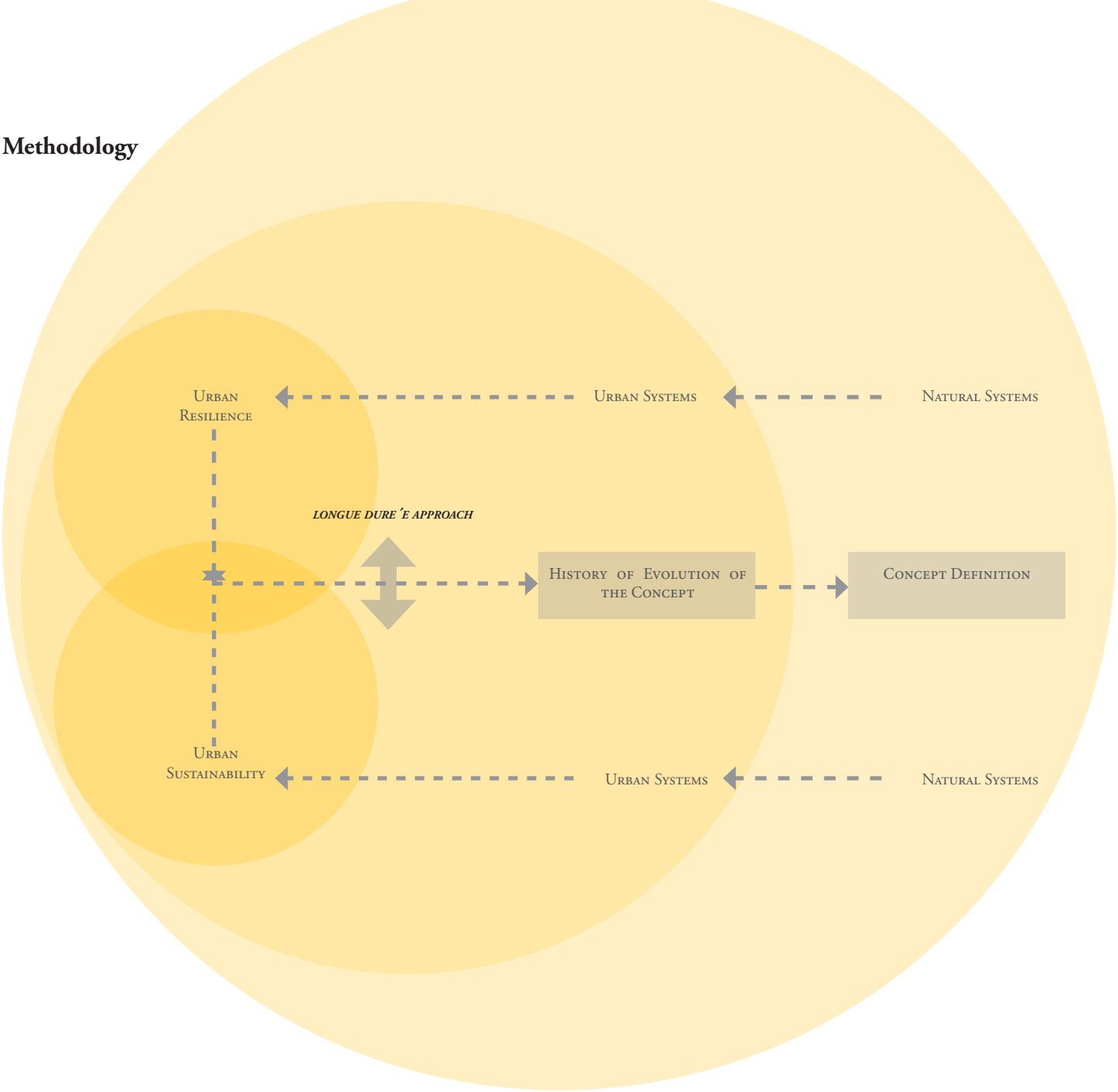


Figure (iii): The Methodology of the Study *(Part-I)*

The methodology followed in this inquiry is qualitative consisting of the Longue Duree Approach (see, e.g. Pisani 2006; Braudel 1980), Scale Analysis and Gap Analysis (derived. See eg. Bunse et al. 2011) leading thence to defining an alternative approach. Since the premise of this research is embedded in these widely researched and studied concepts of urban resilience and urban sustainability, it is important to define these concepts in the context of this study. Through a longue duree approach, traversing and studying the history of evolution of these concepts, these large concepts are first defined. The area or context of application of these concepts - the urban systems - is further established within the larger ecological framework and identified as the premise of this study. Establishing this base thus, the indicators and

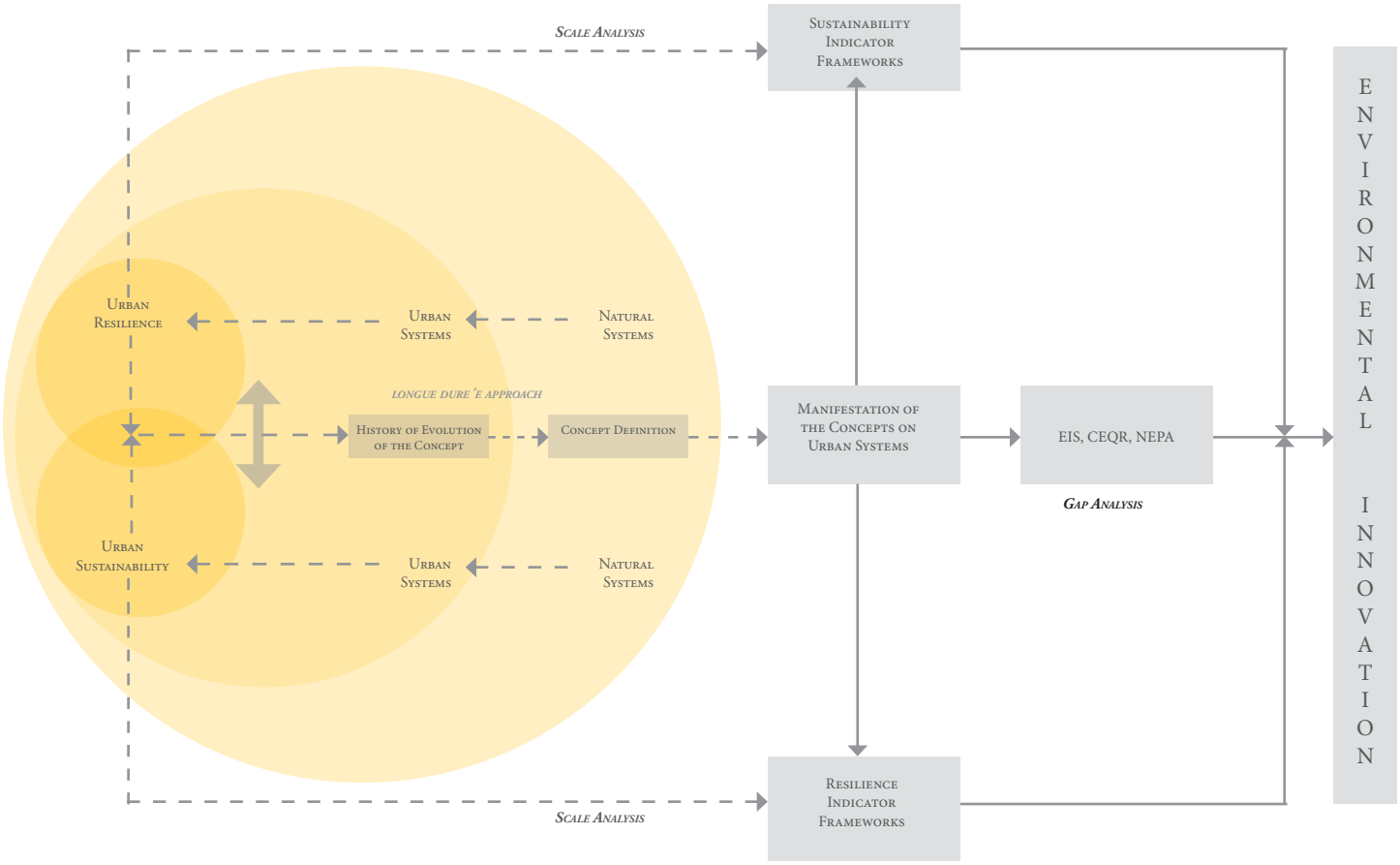


Figure (iv): The Methodology of the Study *(Part-II)*

measurement analysis is then studied.

After establishing the basis and premise of the study, a scale analysis of the existing indicator lists, both for sustainable urban systems and resilient urban systems is done. This analyzes the application and manifestation of existing indicator lists on various current scales of human habitation. However, since these frameworks are not mandatory at all levels of governance yet, a robust and practiced manifestation of a framework that aims to do the same, the Environmental Impact Assessments, is also analyzed. A scale analysis of its required indicators and a gap analysis of its current methodology is conducted to identify missing links where intervention would most make sense. A combination of these analyses then leads to an alternate approach and innovation statement that if further developed and implemented can have enormous impacts on the way urban planning policies are ideated and manifested.

Chapter III: Literature Review

Throughout time in history populations across the world have developed attitudes towards their surroundings (Redman, 2010). These have continued to change over time as societies developed and transformed from primarily agrarian societies to urban agglomerations through various forces that grew as societies grew (Redman, 2010). One of the biggest challenges facing humans for the last two decades has been for humans to live in harmony with their environment. It has been seen from time and again, that for people and societies to seek economic gains, manmade luxuries and enjoyment has sometimes been at odds with preserving the natural environment and more recently even ensuring continuity of life on Earth (Redman, 2010). To understand and decode the intensity of this environmental crisis that we seem to be facing, scientists and biologists have attempted to understand the natural systems of this planet in isolation from human interventions and have more commonly focused on the belief that the crisis is a result of modern technology and rising densification of people – but there is immense value in understanding how human impact on their surrounding has evolved through time and taught us more (Redman, 2010). Throughout history, humans individually and collectively in societies, have continually affected the surrounding environment by decisions that have resulted as physical manifestations on thus. The following figure attempts to reveal a basic framework for interpreting human transformations of the natural environment.

The quest to understand the basic interaction of humans with their natural environment has given rise to some very rudimentary but fundamental questions to human existence, which are also at the crux of this inquiry.

What has inherently made humans rise above other species and exploit the very environment that sustains us and then define goals for that development to be 'sustainable'?

Is sustainability really our end-goal? Are the natural systems that surround us more resilient or more sustainable? And are we essentially trying to recreate a system that we disrupt in the first place by altering it, to the exact same state that it existed in, or as something different?

Is what we are defining now as an environmental crisis really that or is it a natural process in life's trajectory when seen from a long-term perspective?

These questions are central to the on-going inquiry of how and when cities emerged as massive habitats for the human species, overlaying tangible and intangible interventions on the natural ecologies, and one that reveals much how from a naturally sustainable, enduring, productive and diverse ecosystem, our planet transformed into this seemingly balanced yet increasingly banal entity (Redman, 2010).

Understanding Urban Sustainability

It is evident that the population rate is a key variable in understanding the seriousness and intensity of human impacts. An infinite growth in the population can clearly not be supported by the readily available resources of this planet (WCED report, Our Common Future, 1987). Our modern concept of this word 'sustainable' which was used as 'sustainable development' for the first time in the UN's 1987 Brundtland Report, has surprisingly deep roots and a long, little-known tradition (Grober & Cunningham, 2012). Visualizing the history of sustainability as Gober and Cunningham mention in their groundbreaking record of the term, Sustainability: A Cultural history, gives us various insights with the most important being – "the new only develops from the womb of the old"; that in every renaissance, in transformation through each era, the basic concept of sustainability appears in new and different forms; that in their own words defines the future as "never the linear continuation of the present" (Pg. 34. Gober & Cunnigham, 2012). And that has been the most interesting premise of the evolution of the term sustainability through history and what also gives this term its flexibility. It has an inherent capacity to adapt its meaning to the dominant situation. Out of all the definitions and understandings of the term sustainability, the one that does most justice to it evolution till now and its current application too is given by nuclear physicist Hans-Peter Durr, in an interview with Gober and Cunningham in Sustainability: A cultural history:

"Sustainability is not a percept which tells us what to do in any possible situation. Ultimately what it does is to give us a realm in which to experiment without the risk of total failure, room to create new combinations in order to learn from them and to make further new combinations. Sustainability is desirable in the sense that we don't want to be

eliminated from the evolution of living things." (Pg.195, Grober & Cunningham, 2012)

In the recent history of this term, 'sustainable development' has been widely applied as a concept to urban planning and architecture only since the 1990s. Although, as discussed, the factors that led to its development – the recognition of modern urban development patterns and their lack of sustainability have a history rooted much longer in time. In the nineteenth century, cities consisting of agglomerated populations were virtually unknown. The dawn of industrialization brought with it workers from the countryside, attracted to labor-demanding industries and privatization of formerly held rural land couple with centralization of rural landownership pushed hinterland dwellers further away from their traditional communities. It was then for the first time that populations chose to densify smaller physical geographies more accessible to industries and formed urban environments far from the countryside. Though technological advances lead to resolution of infrastructural needs of the large number of people clustered together, enormous problems related to public health, overcrowding, sanitation and such came to the forefront (Wheeler & Beately, 2004). Other heightened conditions induced by the new-found lifestyle like deforestation of the countryside and deploring air and water due to pollution, induced in social reformers and other observers the awareness that the nature-human balance was now irreversible.

Social reformers in the early twentieth century, Howard Ebenezer and Lewis Mumford, being the most influential of them, called attention to problems in sanitation, services and pollution on being the vices of extreme overcrowding of early industrial cities. Though their ideas of decentralization of population and such proved to be premature, since they did not foresee the advent of automobiles and the scale of thus which happened subsequently, they succeeded in drawing public attention to clear negligence of sustainability of urban development trends of that time and the subsequent need for awareness and planning for better alternatives.

A number of major planning themes emerged to the forefront in the nineteenth century. The first glaring one was the juxtaposition of human habitation with nature – the resonance and strife of such. Through the century the theme from nature-human sustainability broadened to include the second other major challenge of promoting equity. In the post-

World War II period, there was an increased awareness of the widening gap between the rich and the poor and between different regional and ethnic groups (Wheeler & Beately, 2004). Soon, the twentieth century development practices, both within cities and worldwide, were recognized as worsening inequities instead of helping improve them. The third important theme was that of economic growth and its inadequacy to regulate the natural and human systems as a concept by itself. Sustainable development, since then, came to be recognized as the three 'E's – Ecology, Equity and Economy, with advocates trying to maximize and balance all these at once, rather than following suit with traditional development policies of pitching these against each other (Wheeler & Beately, 2004).

It is clear that the relationships between human societies and the environment are highly adaptive given the fact that civilizations continue to exist till today and spread far and wide throughout the world. In some very real sense equilibrium at a new level has been attained and perhaps it has a promise of continuing well into the future. This survival has emanated from the two basic elements of availability of sufficient energy and resources and the effective self-regulating processes that imbibe balance in the comprising systems. The notion that the energy and resources of the planet we inhabit are limitless, is perhaps the first of the many problems that has lead us to the systemic imbalance that is our world today. In the face of potential risks from this erupting imbalance societies have shaped their culture to buffer themselves against these threats to their continued existence (Redman, 2010). Institutions and governing organizations thinking that the we are on the brink of disaster, has led to the idea of 'sustainable development', in an attempt to continue to make humans as a species and civilizations continue to thrive on this planet well into the future.

Understanding Urban Resilience

Today, with increasing imbalance and rising socio-ecological challenges in the world, the sustainability regime is no longer thought of as a self-sufficient, effective tool (McPhearson, 2014), more so because it "requires sustaining" which in its own self as a concept is not how natural systems tend to function (Holling, 1973). Scientists, innovators, governments and organizations are all challenging the broad spectrum of sustainability (Zolli, 2012) and is increasingly

impressed with a relatively new emergent concept in the context of urban systems of resilience. Where sustainability propagates a closed loop system in resource management and consumption, with an aim to realize minimum change to enhance stability (Zolli, 2012), resilience being much less utopian in its ideology and more focused towards adaptability (Holling, 1973), assumes changes in systems as commonplace and from there defines the ways of resisting and thriving in the face of these unforeseeable disruptions (Zolli, 2012). Even though these concepts appear to be conflicting in the world they aim to achieve, they aim to resolve the same issues that torment this generation with a different approach on scales and priorities. Understanding resilience from its emergence to its current rise in importance, gives insights that help resolve these subtly blurry lines of concept definition and manifestation.

The resilience perspective emerged in the 1960s and early 1970s from the field of ecology (Folke, 2006). In his seminal paper on resilience and stability in ecological systems, ecologist C.S. Holling explained the existence of multiple basins of attraction in all systems of nature and how they respond to 'heterogeneity of temporal and spatial' scales (Brown, 2014). He defined resilience as the persistence of a system or the capacity to do so, in the face of change and further elaborated as it being a measure of the ability of these systems to absorb changes (Holling, 1973). The concept of resilience further developed in context to complex systems (Folke, 2006). Scholars' theories of complex systems were organic and process-dependent, rather than predictable and deterministic (Levin, 1999), which allows systems to self-organize at multiple scales. (Levin, 1999) Levin explains how through the study of complex adaptive systems, patterns of interaction emerge from disorder through rules that guide these changes – the rules being sustained diversity, localized interaction among components and the individuality of these components.

Resilience of complex systems is not just about conservation of original structures and resistance to change, which attributes to their dynamic and multi-scale interplay. Resilience has come to be defined now as the "capacity of a system" to absorb external disturbances and "re-organize while continuing to undergo change so as to essentially retain the same function, structure and identity" (Pg. 6. Walker et. al., 2004). This has also been extrapolated to social change where, to exemplify, Adger(2000) defined social resilience as the innate ability of communities to absorb and

withstand external shocks to their social context and structure such as social, economic and political disruption. As the concept developed further it was again realized that resilience is not just about being persistent to disturbance. It goes beyond to also capture the opportunities and avenues that disturbance opens up in the form of renewal of systems and emergence of new trajectories (Folke et al. 2010). In this sense of the term, resilience goes on to provide adaptive capacity (Smit and Wandel, 2006) that allows for developing while also continuously changing. Resilience hence, is an approach that offers a perspective for organizing thought and in this broader sense, provides a valuable context for the analysis of socio-ecological systems, an area of explorative research undergoing incessant development with direct implication on sustainable development from a policy standpoint. This approach creates an arena for generating interdisciplinary collaboration with an integrative science basis, in order to govern and manage a transition towards a more sustainable development for the world (Folke et.al. 2002).

The dynamics of the ecosystem and the resilience of social and ecological resilience must hence be understood in the context of change, both slow and fast. This gives us clues on expanding this analysis at a broader spatial and temporal scale (Folke, 2006). The differentiation between sub-concepts within resilience – adaptability and transformability – is very important. Where adaptability refers to the "capacity of people in a socio-ecological system, to build resilience through collective actions", transformability defines the "capacity to recreate a new socio-ecological system when social or ecological conditions make the existing system indefensible" (Pg. 3. Walker et al., 2004). This research focusses on the socio-ecological aspect of the urban systems to clearly understand the interplay of society and adaptability of an ecosystem in the light of resilience indicators (Folke, 2006). This framework hence relies critically on a diverse set of indicators and their effects at different scales of the social and ecological ecosystems (Folke, 2006).

Translating the Interaction between Urban Sustainability and Urban Resilience

Through the discussion of concepts we understand that sustainable development or sustainability is more of a process, than an end-result. It is a process that assumes stability and explains change for social and ecological systems and in

resource-management within these structures. It seems now, though, that resilience as a concept is more realistic where in the process adaptive capacity if encouraged within societal structures to adapt and deal with. Where "sustainability implies maintaining the capacity of ecological systems to support social and economic systems" (Pg. 2. Berkes, Colding & Folke, 2003) through the pretext of growth, resilience defines the capacity of reorganization in the event of halted growth and unforeseeable unpredictability (Walker et al. 2004).

The major concept of adaptability defines the key change between resilience and sustainability – where resilience takes adaptability as an inevitability, sustainability tends to shun it for its lack of explorative subjectivity on what change is actually necessary and favorable. Since sustainability seeks to define the prevention as a better strategy than adaptation, this ideal concept needs to be viewed and explored in a real-world scenario. In today's highly vulnerable and fast-changing world, people are constantly being affected by disruption and they need practical measures now, which is the pretext of resilience. Advocates of sustainability over the decades, have not succeeded in refuting the popular misunderstanding associated with the concept that the perfect equilibrium of the world is achievable (Zolli, 2012). Contrary to that belief we observe today, that social-ecological systems exist in a constant state of flux, something that resilience caters to since the beginning of its usage in context of urban systems and in fact defines as a given (Zolli, 2012). It is also not necessarily true that either resilience or sustainability are concepts that define our future, especially when the ideas are different in terms of their scales of implementation and layers of manifestation (McPhearson, 2014). Rather, an approach that integrates both and uses one to reach the other, is the need of the hour. Integrating social-ecological resilience and sustainable development, hence indicates towards planning discipline to design new paradigms for a more desirable transformation of urban living systems (McPhearson, 2014).

Significance of this Study

With the incorporation of such concepts, as discussed, of urban sustainability and socio-ecological resilience, in the context of urban living systems, as a few academic studies have indicated, like that of G.A. Tobin (Tobin, 1999),

there is a rapid rise in incorporation of new paradigms with a core focus on “community sustainability and societal resilience” (Pg. 13. Tobin, 1999). The new aim for nations and at a global platform too, is to devise policies for the creation of communities that remain resilient to short-term hazards while also being sustainable over the longer term (Tobin, 1999). A context of globalization, interconnectedness and industrial complexities has further complicated contextual issues in local planning (Tobin, 1999). Extrapolating the question thus, that Tobin indicates towards, is at the core of this inquiry: Is there value in measuring the success of urban policies from a sustainable and resilient lens? And if so, how can short-term immediate resilience lead to a long-term sustained urban living system? (Tobin, 1999)

This paper focusses on answering just that and in examining the role of existing policies like the Environmental Impact Assessments aimed towards the conservation of the ecological balance and towards creation of urban communities in harmony with nature. It further examines the role sustainability and resilience indicator frameworks can play in strengthening the Environmental Impact Statements, for it to be more pro-active than reactive in the creation of sustainable, resilient and ecologically responsible urban communities. “Sustainable and resilient communities are defined as societies which are structurally organized to minimize the effects of disasters, and, at the same time, have the ability to recover quickly by restoring the socio-economic vitality of the community” (Pg. 13. Tobin, 1999). This research further addresses the value of creation of such communities alongside them being ecologically responsible, where the impact statements not only measure the impact of a manifestation on its surrounding environment and provide options of mitigation but in fact encourage development to be innovative in defining a solution that propagates these core concepts of sustainability and resilience of urban living systems.

Chapter IV: Designing Urban Systems in the face of Climate Change

Urban Sustainability Indicators

As discussed, sustainability has emerged as a major concept for planning of urban living systems and in assessing urban development. Over time, various methods and techniques have emerged, including indicator-based approaches to help conserve the environment while still steering towards development (Hiremath, Balachandra, Kumar, Bansode & Murali, 2013). Through time, in instances, organizations and communities have taken initiatives to coin sustainability indicators, to provide a more tangible and measurable base for decision-making. It has been a prevalent school of thought from academics and planning professionals alike, since 1990s (Allen, 2009) that propagates the development of long-term sustainability of urban agglomerations by introducing tangible long-term indicators. Even though the systems and sub-systems within the functioning of a city seem tangible like economic activity, population growth, infrastructure and services, air pollution, noise pollution and waste management and there is clear understanding that an internal balance within these needs to be achieved to limit the cumulative impact on the environment, a consensus on a defined methodology to implement the same has not yet been reached (Hiremath, Balachandra, Kumar, Bansode & Murali, 2013). Reviewing these various approaches developed over time, give us an insight into the methodology of selection of indicators, the techniques of using these indicators and the policy assessments that can be made from following these different techniques and approaches.

"We cannot regulate our interaction with any aspect of reality that our model of reality does not include because we cannot by definition be conscious if it." (Pg. 123. Aina, 1992). It follows that to be able to measure and tangibly assess the progress towards or away from urban sustainability can be truly done by reporting indicators and the observations. If chosen properly, indicators have the capability to convey data that can further help to engage in conversations that can result in tangible discussions and policy

implications and can help convey the trend of movement of a region towards the overall sustainability aim (Hiremath, Balachandra, Kumar, Bansode & Murali, 2013). The studies that have been resulted in developing sustainability indicators have done so in the context of a geography and through stakeholder participation at some level of the development or other (Hiremath, Balachandra, Kumar, Bansode & Murali, 2013). A study through all or many of these indicator-development studies, it is apparent that these studies though vary in approaches, indicator-selections, frameworks and such, there is no one method that is appropriate for all applications (Hiremath, Balachandra, Kumar, Bansode & Murali, 2013). The relevance of any indicator matrix is only relevant when it is intended towards a particular set of goals in a particular geographical context (Hiremath, Balachandra, Kumar, Bansode & Murali, 2013).

The study and framework development of urban indicators, found most inclusive and relevant to this study was that done by Marina Alberti in 1996, where the conceptual base chosen for the study was the ecology. Building on the base set in this paper of sustainability being at its core a concept in natural resource base, he too argued through his framework that unless indicators are situated within clear linkages of urban patterns and the state of the natural resource base, they will not be effective (Alberti, 1996). One of the important things highlighted also in the study is the idea of scales and their relevance in understanding and planning for a sustainable living. The interdependence of cities to the global environment, though not apparent, is immense in the context of sustainability. Cities achieving acceptable local environmental conditions in the short term is not acceptable for the global scale in the longer term (Alberti, 1996). Though the links between global sustainability and local conditions become visible only in the long term, the effects at the global scale trickle down sooner to the city-scale (Alberti, 1996). Today, the systems notion of "city sink and city sources" have extended beyond the hinterlands and any city sustains itself by drawing resources from a much larger extended region (Pg. 383, Alberti, 1996). The figure below begins to define the ecological system on the city and the various energy flows.

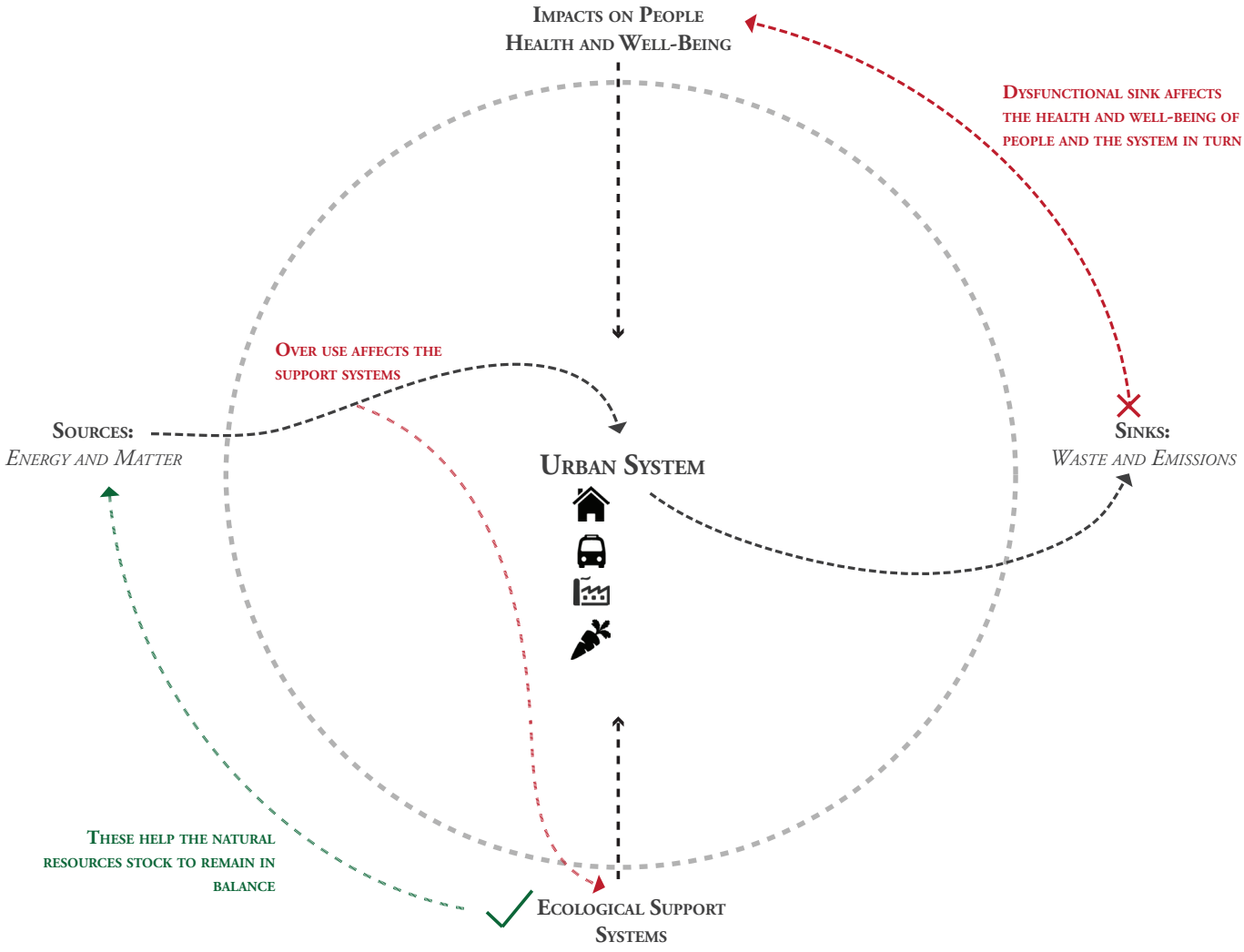


Figure (v): Sources and Sinks in an Urban System *(Created from the understanding of Pg. 386. Alberti, 1996)*

To define and accept a base for calculating urban analysis, the following aspects are considered as defined by Alberti (Pg. 386, Alberti, 1996):

a. Transformation of the physical structure

b. Natural resources and its renewability

c. Release of emissions and waste

d. Human health

As it is becoming clearer that there are in fact biophysical limits to the carrying capacity and economic growth on this planet and the method of measuring thus is gaining popularity. The sources and sinks as seen in the diagram, link the various systems and susb-systems if the city in this context.

Translating this to actual dimensions that can be considered to measure urban sustainability are:

a. Urban quality

b. Urban flows

c. Urban patterns (Pg. 388, Alberti, 1996)

As Alberti concluded in her study of various indicator sets that for indicators to actually determine the environmental stress that human activities are generating, they should also directly inform whether or not the environment can absorb this stress in the longer term or not (Alberti, 1996). The four categories that hence become inevitable to be covered in this research for defining urban sustainability dimensions are:

a. Energy source indicators

b. Energy sink indicators

c. Ecological support system indicators

d. Human impact and welfare indicators (Pg. 389. Alberti, 1996)

Combining, linking and overlapping variables from five international indicator studies of United Nations Commission on Sustainable Development (UNCSD, 1992), Environmental Sustainability Index (World Economic Forum's ESI, Siche et al., 2008), Ecological Footprint (Redefining Progress, 2002), OECD's Green Growth Indicators (OECD) and Boston Indicators Project (BIP.org, 2015) and applying the base of study as provided by Alberti, a cumulative indicator list to measure and define sustainability for this study is derived. This is as follows:

Sustainability Indicators

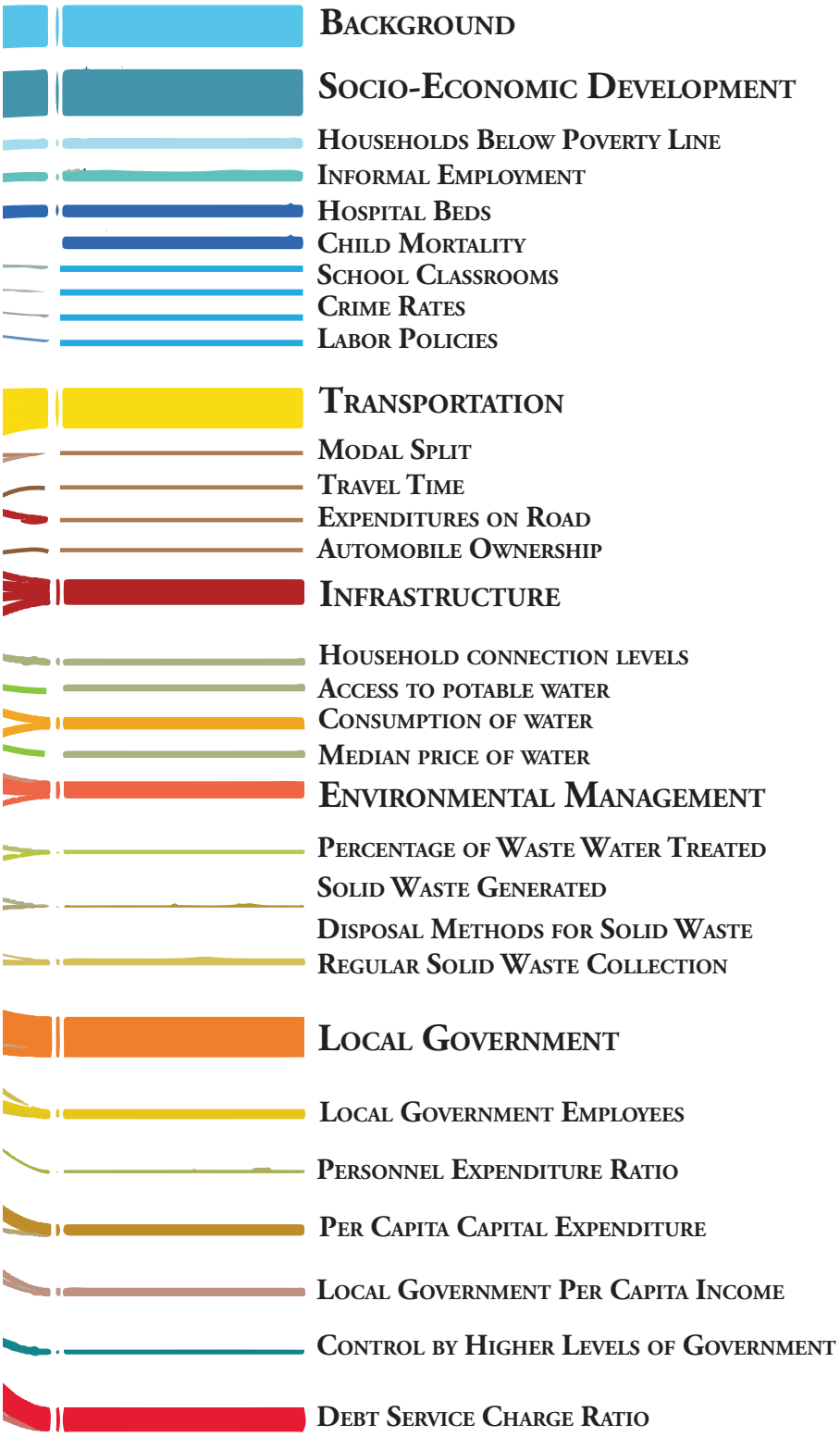


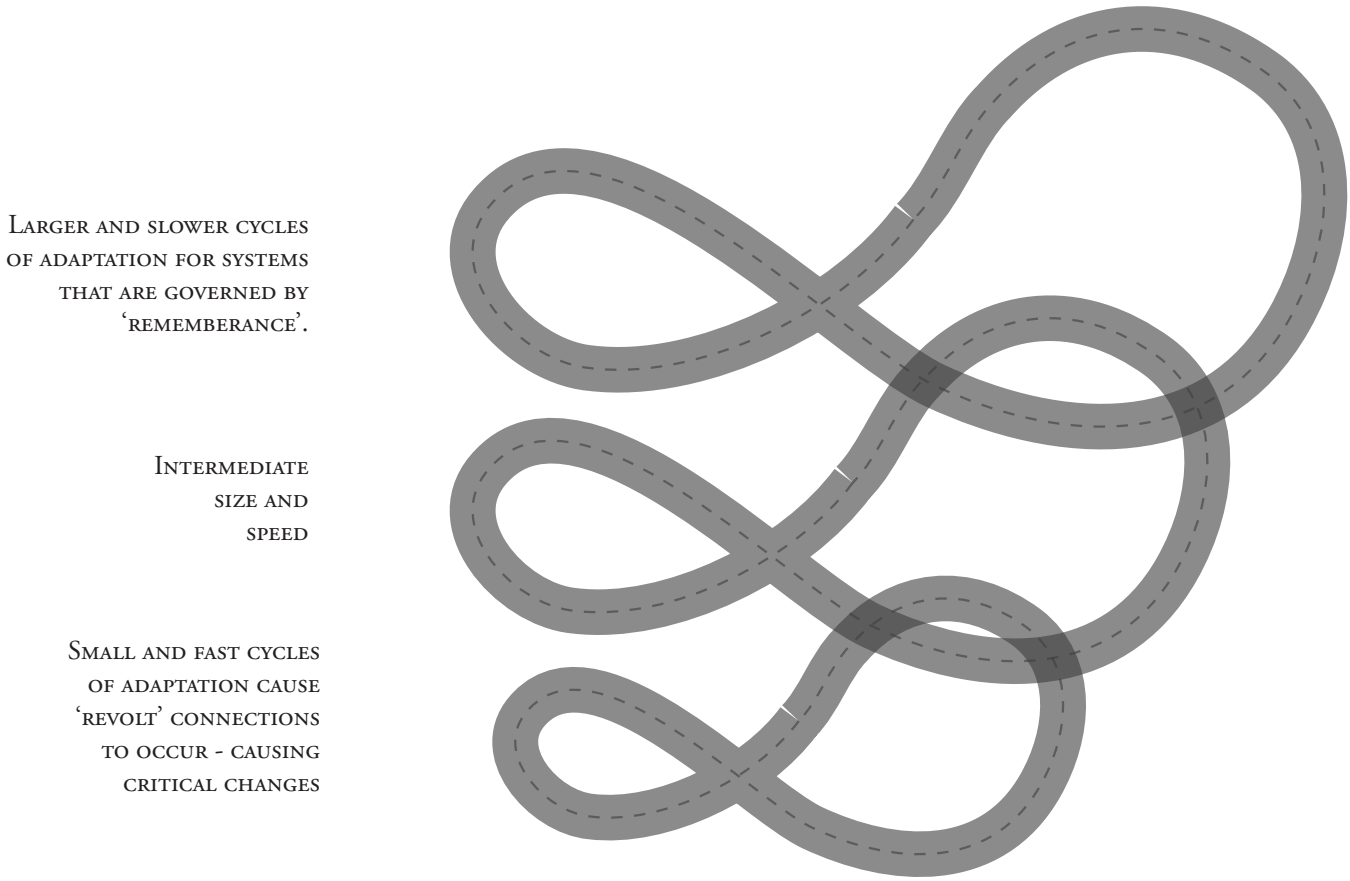
Figure (vi): Derived List of Urban Sustainability Indicators

Urban Resilience Indicators

The development of resilience indicators has been in the context of understanding urban risk to facilitate risk management options for urban city centers. The value of these indicators and relevant studies has been in informing decision-makers and public officials on important information about natural hazard risk and resilience in the urban environment facilitating policy development and risk management. Though there have been attempts to design the resilience indicators framework, these have been fewer and newer attempts than for sustainability indicators, some of them being Urban Disaster Risk Index (UDRI), Risk Management Index (RMI) and Disaster Resilience Index (DRI) (Khazai et.al., 2015). A more recent framework which is not as dependent on the context of external disaster threats has been developed by Arup in collaboration with the Rockefeller foundation, called the City Resilience Index (CRI) which will be discussed later in this chapter (Arup publications, 2015).

The Urban Disaster Risk Index (UDRI) is based on the premise of risk identification and quantification which was understood to be the "result of interactions in time, space and exposure of vulnerable assets of the social and environmental context of the city "(Pg. 17. Khazai et.al. 2015). Based on the theoretical framework for a holistic approach to disaster risk assessment and management, the UDRI framework was a comprehensive perspective on the physical vulnerability, potential physical damage and the vulnerability factors of the context in question (Khazai et.al. 2015). It is also very flexible in terms of scales and its definition depends on the context and the hazard in question. The Risk Management Index (RMI) on the other hand, keeps time scale as variable while determining the management scale at an earlier stage (Khazai et.al. 2015). The third indicator in question, the Disaster Risk Index (DRI) was focused more on realizing opportunities along the existing development policies to mainstream the risk reduction and to increase resilience (Khazai et.al. 2015). Unlike the other three indicator frameworks discussed above, the City Resilience Index (CRI) by Arup, was developed in the context of challenges on the outside world, including but not restricted to climate related disasters, like rapid urbanization, climate change, terrorism and such. This resonates more with the definition of resilience as used and defined in this study, where resilience is not only restricted to climate related disturbances

on systems but also other natural and man-induced changes that may occur (Arup publications, 2015). This framework is structured around four dimensions and twelve indicators building on the holistic definition of urban resilience, including health and well-being, economy and society, infrastructure and environment and leadership and strategy. As is immediately visible, there are marked overlaps between the urban sustainability indicators centered down in this study based on Alberti's structure. As with sustainability, Arup also recognizes in the framework that the twelve indicators, though all relevant in all contexts, the true weights and importance of any or all of these indicators will actually depend on the context of study. Within these twelve indicators there are seven sub-indicators in each that contribute towards identifying the critical factors contributing towards the resilience of urban systems (Arup publications, 2015). The figure below depicts all these indicators and sub-indicators within each category derived from this study since it defines it in the closest possible manner to the definition of resilience as we use here also defined in the figure below.



The Resilience Panarchy

Figure (vii): The "Resilience Panarchy" (Redrawn from Gunderson, Lance H.and C. S. Hollings [eds]. 2002)

Resilience Indicators (derived from Arup)

Figure (viii): Derived List of Urban Resilience Indicators (Arup, 2015)

Issues with Indicators

In the context of sustainability today, the debate has largely shifted from the problem of a lack of a coherent definition to that of measurement (Redclift, 2005). As studied in the discussion of indicators above, it is realized that a single indicator framework has failed to emerge as a clear winner and significant governmental energy at all scales of governance continues to go into this problem-definition and subsequent solution. Even though there continues to be increasing amounts of data given the information technology age of today, the usable information from it is surprisingly little (Redclift, 2005). The social, economic and physical structure of the city has a wide indicator range of raw data but a defined manner and framework in which these can be converted to usable information is the need of the hour, not to say that the flipside of this is not possible – where a holistic framework with a well-designed index to simplify the measurement of this humungous concept in the context of a city can in turn influence specific and accurate data collection for a specific set of indicators. The problem with using the readily available data is that the true indicators corresponding to sustainability may or may not need that exact variable, but the sheer availability makes developers change the indicators to reflect that even though that might not be fully accurate and representative. Another problem with sustainability indicators is that these indicators are seldom selected based on local concerns and cultural diversity. There is also a growing concern of redundant and sometimes repetitive research in developing sustainability indicators thus, where studies rarely depend on the previously conducted studies and start anew instead (Redclift, 2005). It is also argued that designing a good indicator is difficult enough when the concept is understood in depth and with clarity, but it becomes more and more challenging if the concept it as large and wide like that of sustainability. The other criticism that the indicator sets have also suffered is the idea of 'reductionism' or over-simplifying the complex system that is this planet and our intervention on thus (Bell & Morse, 2008). As studies reveal more about this complex system, we realize that while understanding this complexity in manageable bits is not the ideal methodology, to attempt as far as the scientific knowledge measurable data leads us, is the obvious step to take (Bell & Morse, 2008).

These are some of the reasons why sustainability indicators have mostly remained a part of the academic documents and have not been explored as tangible frameworks being used in organizations as requirements to inform policy decisions to design and govern more sustainable and environmentally responsible living centers. This study attempts to first define the term sustainability and then narrow down on a specific framework which can influence urban policies to inspire designing of urban agglomerations with lesser overall impact on the environment. Another important aspect to consider while defining sustainability indicators is understanding the issues of the context not just locally but also globally. The traversing between scales is a concept that is most important in sustainability conversations and is yet hardly visible while designing these frameworks. The first step is to define a clear objective of the program and match it to the scales of the context in question (Redclift, 2005).

Chapter V: Lost from Translation to Manifestation

Process and manifestation of 'Sustainable/Resilient Development'

Overwhelming complexities continue to surround as we approach a more developed, more technologically advanced era within the second millennium. Sustainable development, out of many other concepts, is rising up to the challenge of manifesting a base to potentially overcome these socio-ecological complexities. Scott Campbell's seminal work in explaining what 'sustainable development' really means for the planning discipline, continues to hold true in its essence that the vagueness and the potential of the concept to attract complementarity of interests romanticizes it to an extent of hampering its modern applicability (Campbell, 1996). While, since its inception, sustainability has encouraged numerous initiatives at the local, national and global scales, the concept's impact in creating a consistent solution is minimal when pitched against the complexity and enormity of global environmental issues. This has been a major cause of increasing frustration, even amongst the advocates of sustainability, and calls for an interdisciplinary yet more focused approach to understand and promote more tangible, approachable goals leading to a sustainable future. Even as it continues to increase significantly in policy development and its implications, making it an important element of policy documents of governments, business organizations and international agencies, its breadth and intangibility could lead to it remaining an 'elusive' concept (Marshall & Toffel, 2005).

Sustainable development in its manifestation and definition has struggled to establish a definition where all facets contributing in its creation be consolidated and included (Osorio, Lobato & Castillo, 2005). Debates on sustainable development and its achievement have been all "conceptual, contextual, academic and geopolitical" (Pg. 501. Osorio, Lobato & Castillo, 2005). Where the conceptual debate centers on the generality and ambiguity of the relationship between development and sustainability it goes on to identify the major value of understanding that words and phrases like these cannot be homogenous in all cultures (Osorio, Lobato & Castillo, 2005). This debate recognizes the fact that the foremost thing to consider for sustainable development to occur is to "overcome the chaos surrounding definitions" – which encourages us to identify our "social, economic, political, cultural and environmental reality from a cohesive point of view but molded within our historical background" (Pg. 506. Osorio, Lobato & Castillo, 2005).

As we begin to understand the origin and the wide array of the sustainable development ideology it is interesting to see where and in what areas do major thoughts/views occur. Building on to the original mappings of O'Riordan and the more recent by Hopwood, Mellor and O'brien, we begin to understand the distinction between the environmental and socio-economic views regarding sustainable development, and the school of thought giving more emphasis to human well-being, equality and the environment, respectively (Hopwood, Mellor & O'brien, 2005).

From this map it is evident, that there are three main areas through which sustainable development is believed to occur – by retaining the structure of human-nature relationships, by adaptation and reforming of the existing system and the complete transformation of the structure of the relationship which is at the core of the imbalance (Hopwood, Mellor & O'brien, 2005).

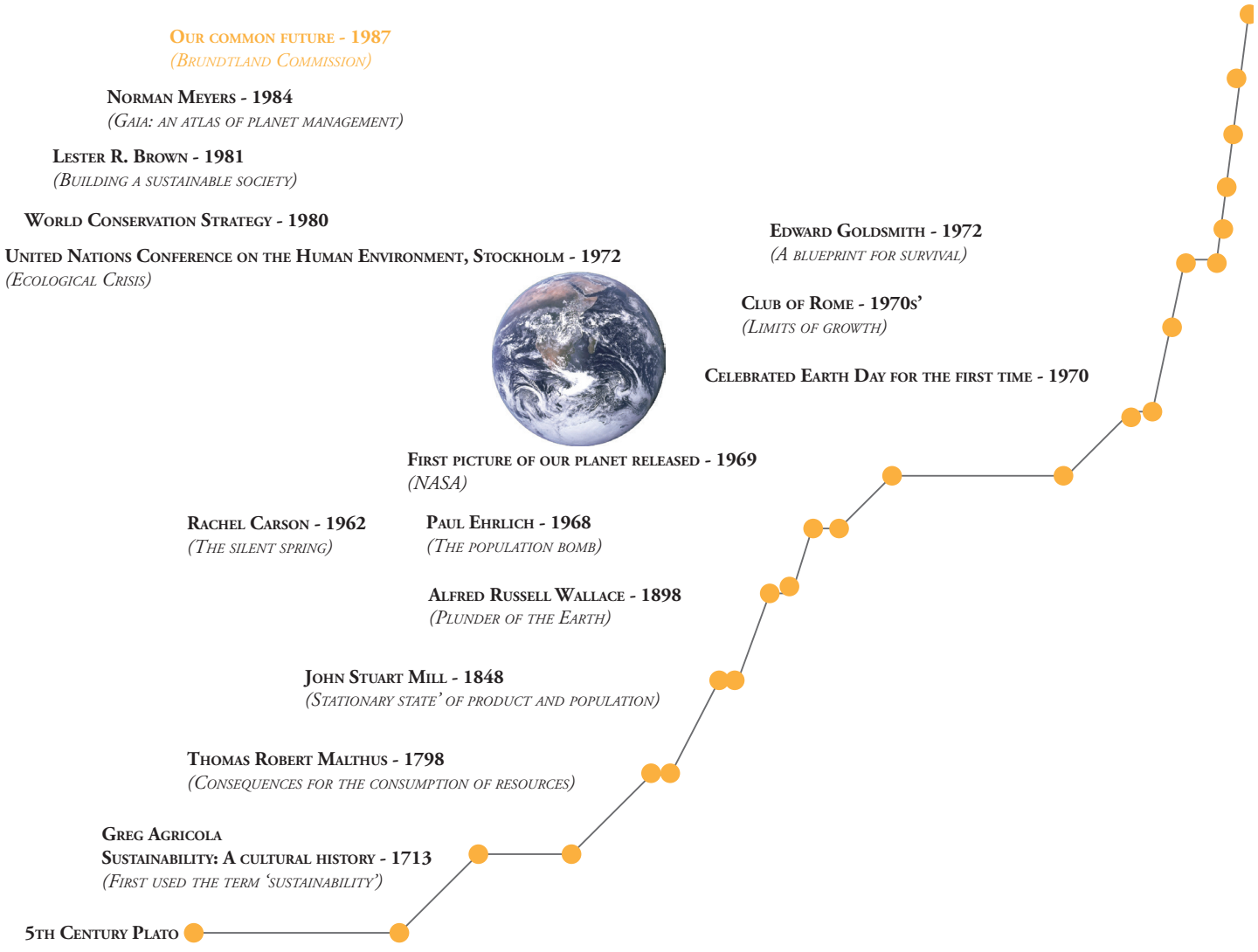


Figure (ix): Sustainability Origins (Hopwood, Mellor & O'brien, 2005)

The model of sustainable development as simplified by the Venn diagram it is most often depicted in, defining it as interconnected rings of economy, environment and society is also often seen as an over-simplified model distorting the true relationships (Giddings, Hopwood & O'brien, 2002). Such an approach that defines different sections for each concept assumes a misconstrued segregation in these concepts which further underplays the important connections. This often prevents the fundamental connections at the core of sustainable development which need to be understood and sought to come up (Giddings, Hopwood & O'brien, 2002).

However, a much more accurate representation of these concepts is nesting them rather than segregating them – economy within society, which in turn is nested within the larger environment (Giddings, Hopwood & O'brien, 2002). The first step towards understanding "the concept of sustainable development is the integration of different actions and sections", holistically viewing the disciplines (Pg. Giddings, Hopwood & O'brien, 2002). And to have a long-lasting impact of sustainable development that is tangible, an integrated approach based on human life and the planet we inhabit will have to be devised (below - an adaptation of what this study views this system as).

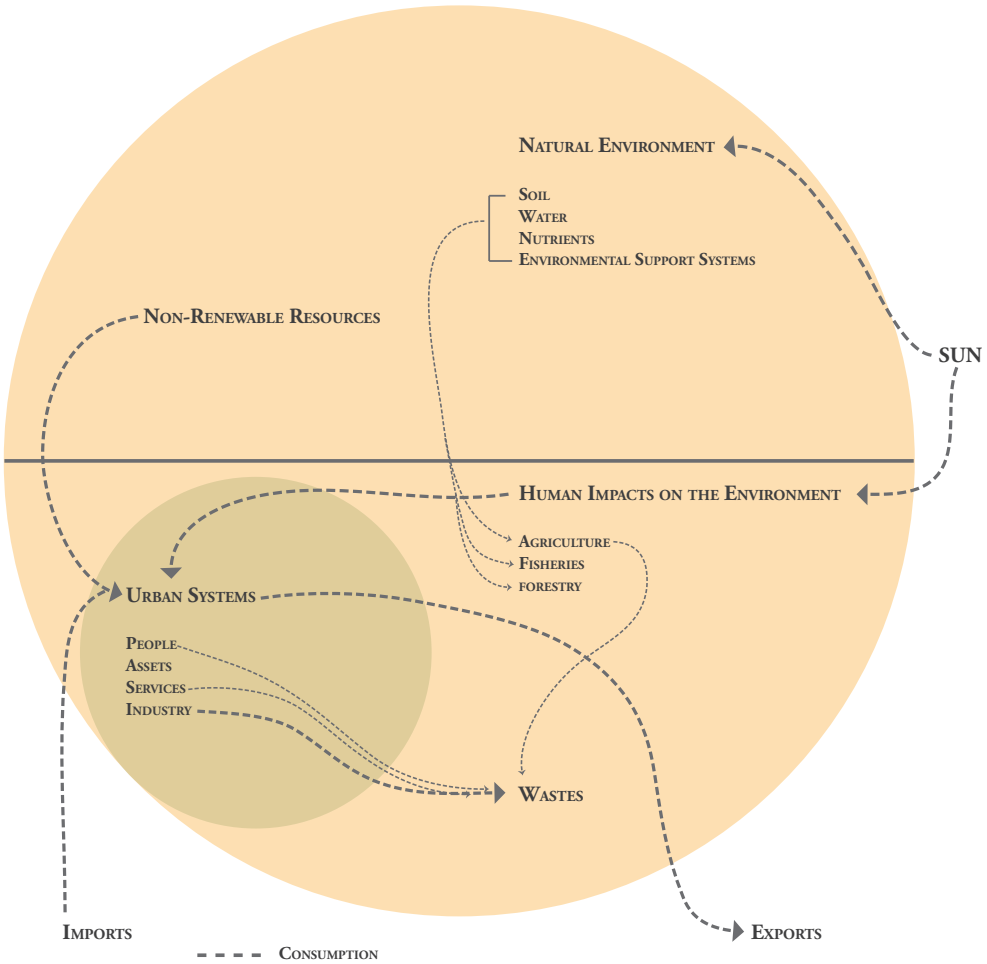


Figure (x): Understanding Socio-Ecological Systems (I)

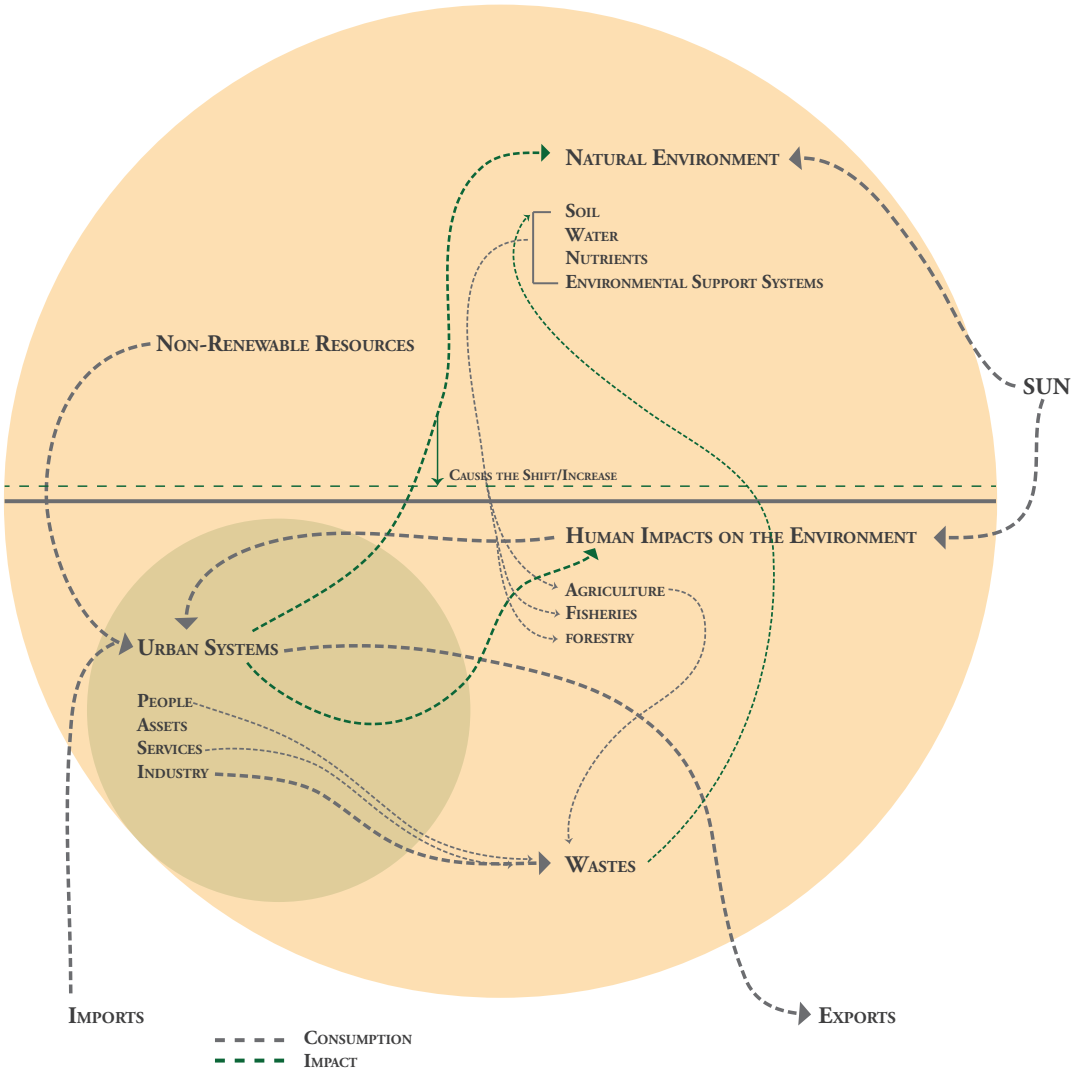
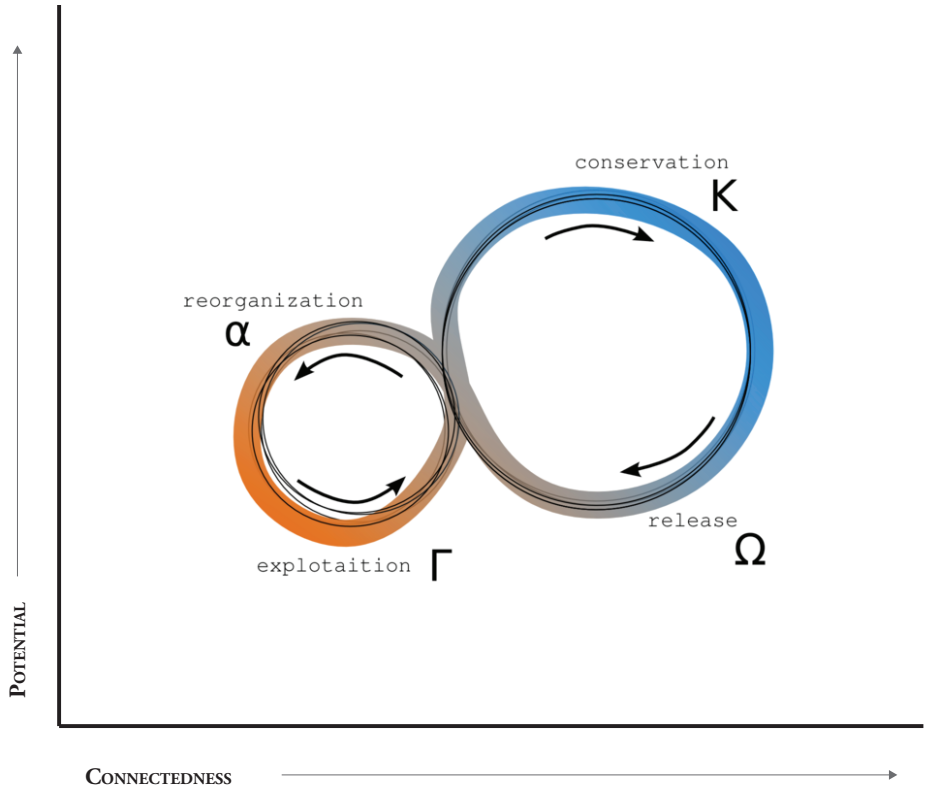


Figure (xi): Understanding Socio-Ecological Systems (II)

In the recent decade, it has become increasingly evident that the prevailing worldview in resource management and environmental conservation of systems and their balance, have been at odds with the observations from socio-ecological systems, and their glaring complexity (above - socio-ecological systems as defined for this study). With the indicators to measure sustainability and the scales to do thus being ambiguous and extremely subjective, it has become increasingly important to develop new frameworks, to complement those existing, to understand these dynamics. In this era of growing scientific understanding of ecosystems and the context of our habitation, the development of sophisticated tools and technology and awareness about intra and inter-system mechanisms, it is often thought that humans are at the apex of their problem-solving abilities. However, in the last few decades, a gap is becoming glaringly visible between environmental problems and our lagging ability to solve it. Many environmental problems are proving resistant and resource management is at a challenging point with new issues occurring every moment, adding to the existing pool of unsolved ones (Redman, 2010).

As Holling suggested, part of the problem exists in the preoccupation with the stability of systems and not in their adaptation (Holling, 1973). Paying more attention to a system's resilience properties gives more insight into the richness and diversity of natural and man-systems in a changing world. As Holling further elaborated that rather than defining a future limited to a set of notions, designing institutions to react and respond to the future changes and making them work to an advantage could lead to a better investment (Holling, 1973). As is obvious, the changes in the ecosystem, the modifying climate patterns, extinction of biodiversity and irreversible alterations to landscapes are all driven by human activities with changes magnifying in occurrence with a pace unprecedented in the history of human habitation on this planet. Thus, there is an emerging awareness regarding a need for multi-disciplinary approaches and solutions examining the environmental, resource management and societal issues under the same lens (below - integrating this adaptation into the socio-ecological system definition devised above).



Adaptive Cycle

Figure (xii): Adaptive Cycle in Resilience Systems (Redrawn from Gunderson, Lance H.and C. S. Hollings [eds]. 2002)

NEPA, CEQR, EIS

Understanding the environment and the human impact on the ecology at large, has been a long-drawn process in the history of civilizations. From academics, to media, to scientific papers to international, national, regional and local organizations, everyone has a concept and a theory to attach. In is interesting to note however, the concepts that eventually lead fruition. These concepts don't only assess the problem and the state of current events, but pose tangible solutions to help solve them. The environmental considerations that actually manifest in reality are also diverse and contextual. Each nation, each region within the nation and hence each city, comes forth with a contextual analysis and methodology to help reduce the impact of human habitation on the surrounding environment. This task however difficult due to the lack of understanding and tangible calculations relating to the exact considerations at play, has resulted in many methods, laws and regulations to minimize the impact of the physical requirements for human life to foster which tend to alter the ecosystem that we inhabit. However, the efficiency, effectiveness and implementation ability of these policies and programs remains contended. The gap between the true magnitude of the definition of the problem and the portion that gets resolved with these programs continues to be analyzed because the fact remains that unless these missing links are understood and designed for, the problem will only become more grave.

Tracking the history in the context of United States, a concrete path of environmental policies come to be discovered, translating from the national to the state to the city scale. One of the first laws ever written in the United States that established the national framework for protecting and conserving the environment was the National Environmental Policy Act (NEPA). It governs the federal actions that could significantly affect the environment and helps assure that due consideration is given to such actions prior to it occurring by all branches of the government (United States Environmental Protection Agency). The most visible and tangible manners in which NEPA translates to projects at various different levels of the government are Environmental Assessments (EAs) and Environmental Impact Statements (EISs) - which are essentially written and studied assessments of the probability and intensity of impacts from different alternative courses of action (United States Environmental Protection Agency).

In summary, NEPA has been instrumental in bringing about a major change in the way the government deals with environmental issues with the model being used and derived from as is or in parts in all states of the country. The National Environmental Policy Act (NEPA) was enacted in 1970 and has proved to be distinct and starkly different from some of the other policies that came to be in that decade (United States Environmental Protection Agency). Where NEPA was known for its succinct and comprehensive dealings, the Clean Air Act also passed in 1970, became more and more prescriptive and stringent. NEPA being the national policy created a sub-organization at the State level called the Council on Environmental Quality (CEQ) under which Environment Impact Statements (EISs) came to be prepared for all major federal projects. Subsequently, CEQ came to develop broad guidelines for the EIS process. As it later turned out, this development came to be the biggest revolution that occurred under CEQ and subsequently under NEPA. In essence, the CEQ became the major policy and educational caretaker of the environmental impact process (United States Environmental Protection Agency). Where NEPA and CEQ continue to hold an important role in the environmental conservation ground on the policy end, it has a somewhat diminished role than what it has begun with initially (United States Environmental Protection Agency).

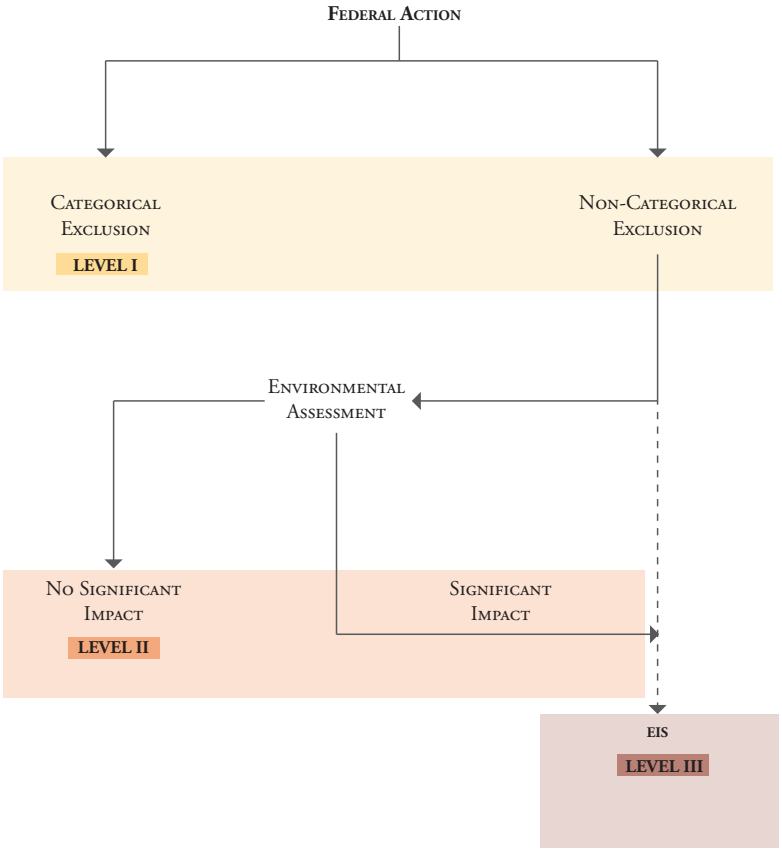


Figure (xiii): Levels of Analysis in EIA (Redrawn from Canter, 1982)

The figure depicting the levels of analysis in the EIA process, begin to identify and define the levels of analysis in the CEQ regulations: Categorical exclusion determination, preparation of an environmental assessment and finding of no significant impact (Canter, 1982). In defining these three levels, do CEQ regulations become subjective perhaps even leaving some scope for manipulation? These levels all depend on the 'significance' of impact of the proposed action on the environment. NEPA defined 'significantly' as requiring considerations of both context and intensity which refers both to the society on which the proposed action is inflicted and the severity with which the changes are going to impact it (Canter, 1982). The EIS hence, as defined by the NEPA is a detailed written statement serving as a discussion of environmental impacts in forming about all the alternatives that could potentially avoid, or minimize those impacts (Canter, 1982). It can hence be understood as a 'disclosure document' that can and theoretically is supposed to be used as a document to inform planning decisions. The entire process of the EIA along with the levels of public participation catered, are depicted in the figure.

Critiques:

Early in the process when EISs were first introduced, criticisms surrounding the methods of impact predictions were made (Canter, 1982). It was argued that formalized, repeatable methods with predefined relationships, measurable equations and more structured approaches were required to accurately and tangibly assess the true impact of the project (Pg. 7. Canter, 1982). With time and more scientific know-how, these criticisms have significantly diminished and better quantitative techniques in environmental impact studies have been coined (Council on Environmental Quality, 1993). Other issues that have been identified through the years of applying this process include issues related to cumulative impacts, risk assessment, addressing impacts on biodiversity (Council on Environmental Quality, 1993) and other global long-term issues like climate change (Canter, 1982). These are being resolved with more and more scientific discoveries in the field of environmental assessment and overall the process is observed to be maturing. The process is centrally technical and continues to rely on the application of scientific approaches and its subsequent effective implementation (Canter, 1982).

Chapter VI: From Sustainable to Resilient to… Responsible

Integrated Assessments – A precedent study

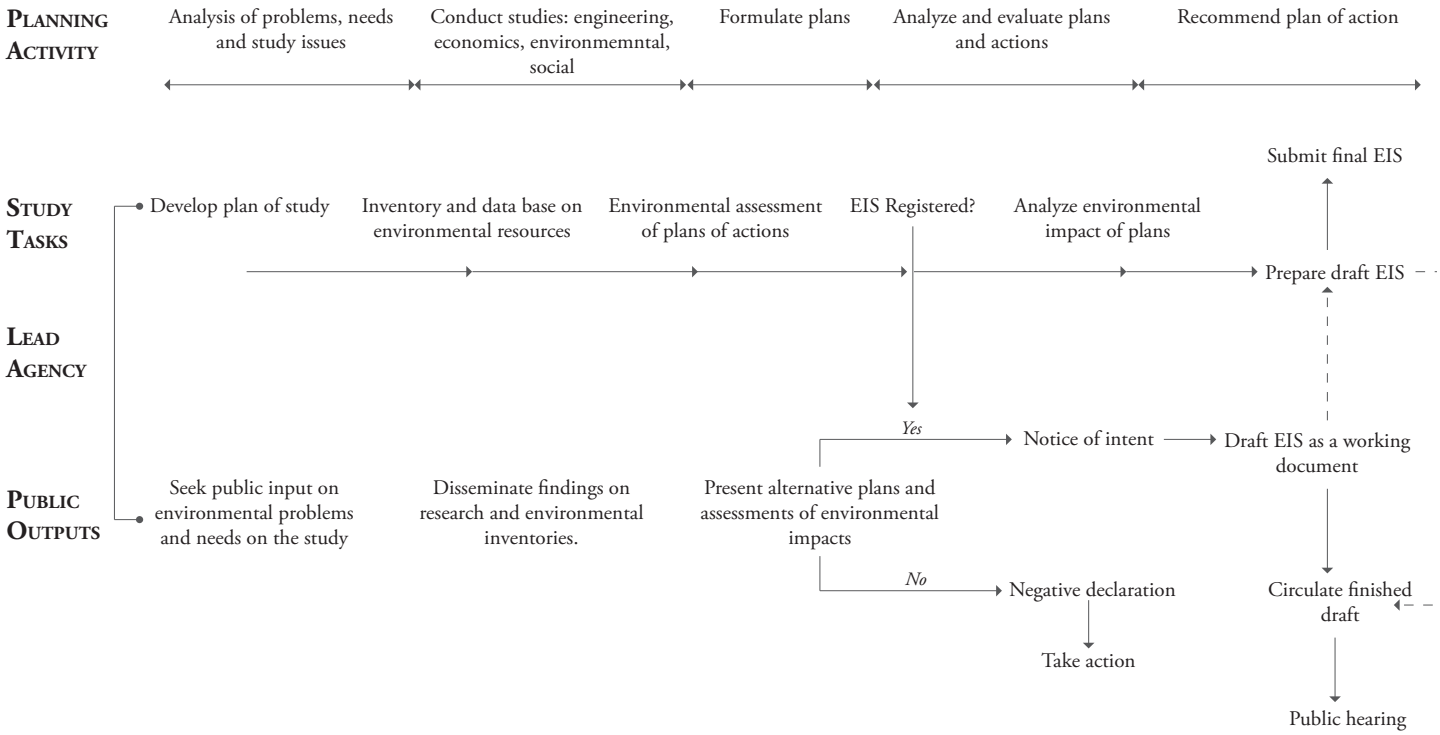
With the discussion on sustainability, resilience, their indicator sets (mostly developed in academic forums) and the practical framework actually applied in planning policies, projects and programs by organizations, the EIA, it is indicative that there is a growing need for the use of a more inclusive assessment framework at different governmental levels and scales of context. This new framework is expected to be applicable to all policies, plans and programs that apply in an urban setting. The indicators studied earlier measuring sustainability, resilience and the ecological balance of urban systems, which are extremely important in today's context, along with the existing EIA structure, is the core of this inclusive framework. The core assumption here hence, is that economic, environmental and social impacts are all assessed in relation to sustainable development, ecological balance and the resilience of urban systems. All stages of the project/policy are considered while devising the framework – the approval and implementation. Where the Environmental Impact Assessment is considered in itself to have a great value in assessing impacts of the proposed projects/policies, this framework building off on that is seen to resolve the other holistic issues of lack of tangible sustainability and resilience indicators that, as we have studied earlier, have a great potential in being implemented practically. Also, the current state of conditions in our urban centers requires this enhanced framework now that not only informs of the negative impacts that a project may have and provides remediation strategies, but in fact inspires to design them in a manner that improves our physical and natural world and that makes manifestation of such projects and policies more profitable and harmonious for everyone. In this section the EIA structure is analyzed in the context of other sustainability and resilience indicators, and then a 'gap analysis' is conducted to assess the methods and applications in all of them that either overlap or complement one another. Subsequently, a novel framework outline, by 'bridging the gap' involving a linkage consideration into a common framework is devised, detailing the context of assessment, the process and the methods for thus.

In the last decade or so, sustainability assessment has emerged as an important tool to aid in the shift of planning manifestations towards sustainability. Sustainability assessment is a concept through which the implications of an

initiative on sustainability are evaluated (Pope, Annandale &Morrison-Saunders, 2004). We start with a few examples of frameworks developed as being forms of sustainability assessments and evaluate them on the basis of their effectiveness to sustainability. Many of these have in fact been derived from Environmental Impact Assessments (EIA), while including economic, social and environmental considerations as a holistic approach towards sustainability. The study of these integrated assessments give us an insight into what objectives of sustainability are being met and to learn from in forming the new approach. Even though environmental impact assessments have existed for quite some time now, scholars are proposing newer procedures to include sustainable development procedures to contribute towards a more sustainable society (Pope, Annandale &Morrison-Saunders, 2004). The theory of sustainability assessments hence, has been evolved from studies of EIAs and Strategic Environmental Assessments (SEA, for policies) which all fall under the larger umbrella of policy analysis techniques (Sheate et al., 2001, 2003). The EIA-driven integrated assessments like the traditional EIA, are developed to be applied after the new project/policy has been conceptualized (Pope, Annandale &Morrison-Saunders, 2004). This assessment framework too, aims at identifying mitigation measures to minimize or avoid the adverse impacts that the project may inflict. The overall aim of this approach is to ensure that these impacts do not lead to a less sustainable state than the one existing prior to the project. Theoretically at the least, this does allow for a more transparent analysis of the social and economic impact of the proposal (Pope, Annandale &Morrison-Saunders, 2004). The integration of these however has its own limitation where the combination of the positives and the negatives of the sets of measure, must consider the combination effects (Lee & Kirkpatrick, 2001). Another study, realized a major limitation where the environmental 'trade-offs' between economy and environment, though seen as extremely relevant for a sustainable development, were overridden and the economic ones were not. This was seen as a major limitation in the sustainability assessment approach, as it was seen to be favoring or over-estimating the economic agenda and that it turn would lead to more projects being approved than with the traditional EIA. On the contrary the strength of the SA over the EIA was the transparent disclosure of social and economic implications of the proposal to the public and the decision-makers (Pope, Annandale &Morrison-Saunders, 2004).

Towards a Responsible Innovative Approach

Gap Analysis:



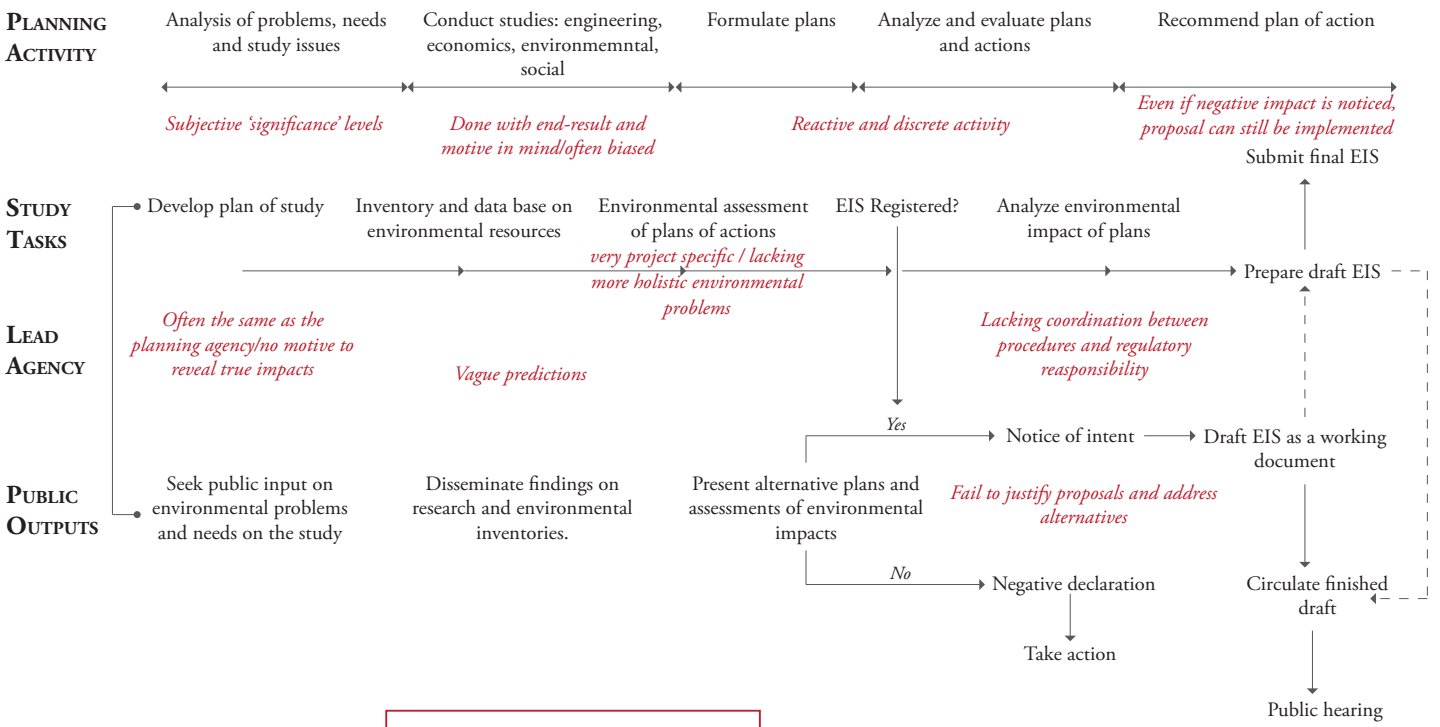


Figure (xiv): Gap Analysis EIA (Canter, 1982)

Spatial Scale Analysis:

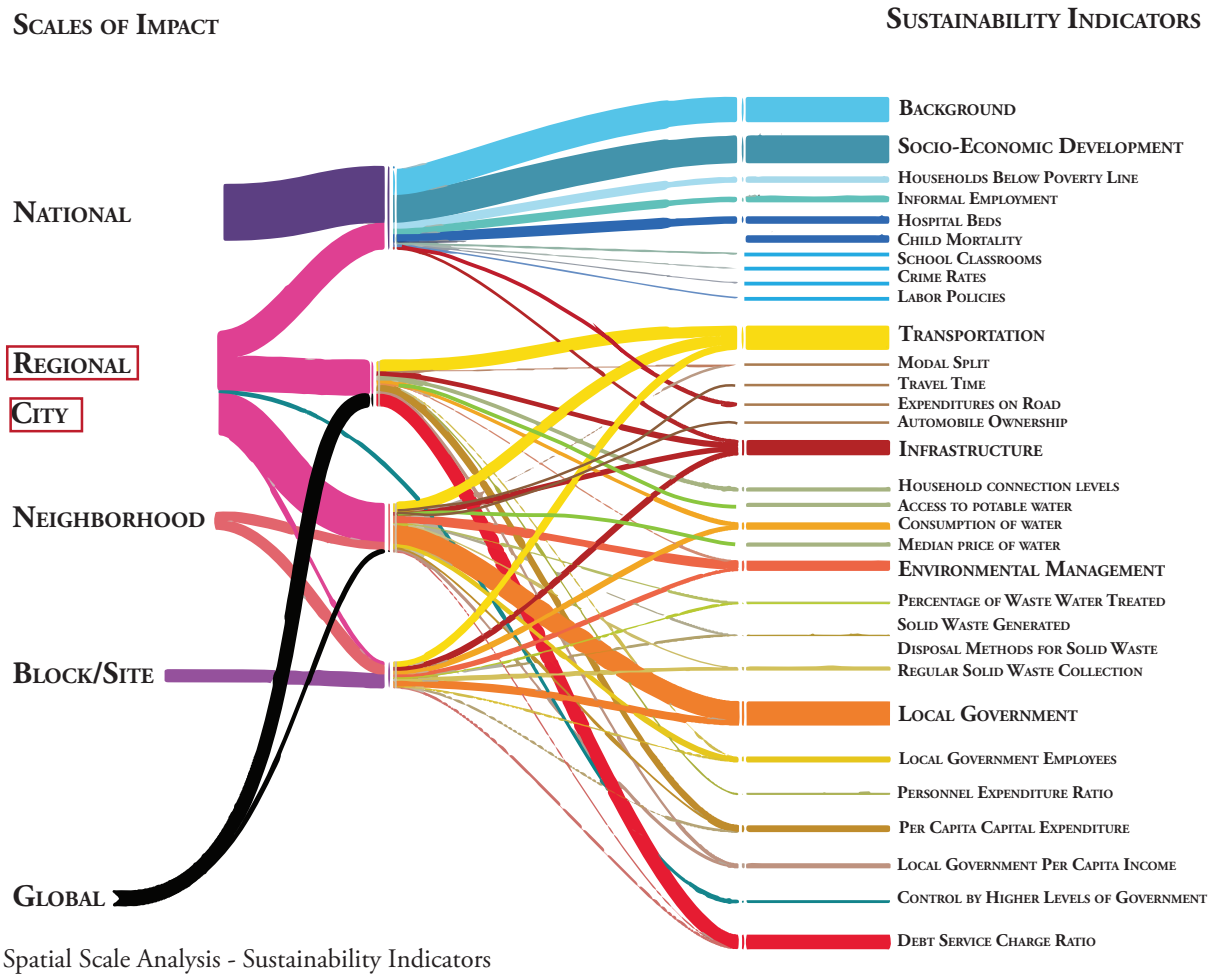


Figure (xv): Spatial Scale Analysis - Sustainability Indicators

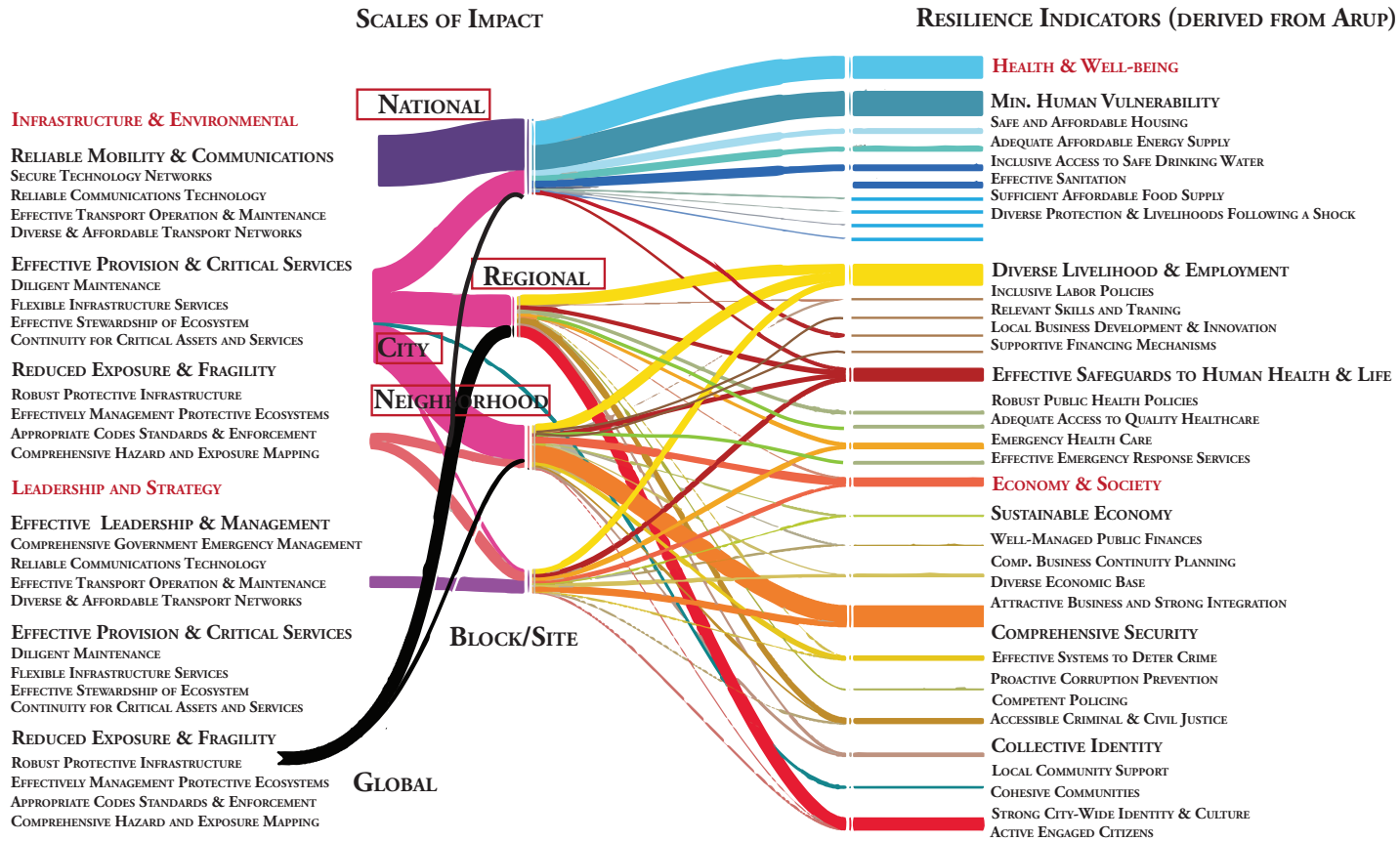


Figure (xvi): Spatial Scale Analysis - Resilience Indicators

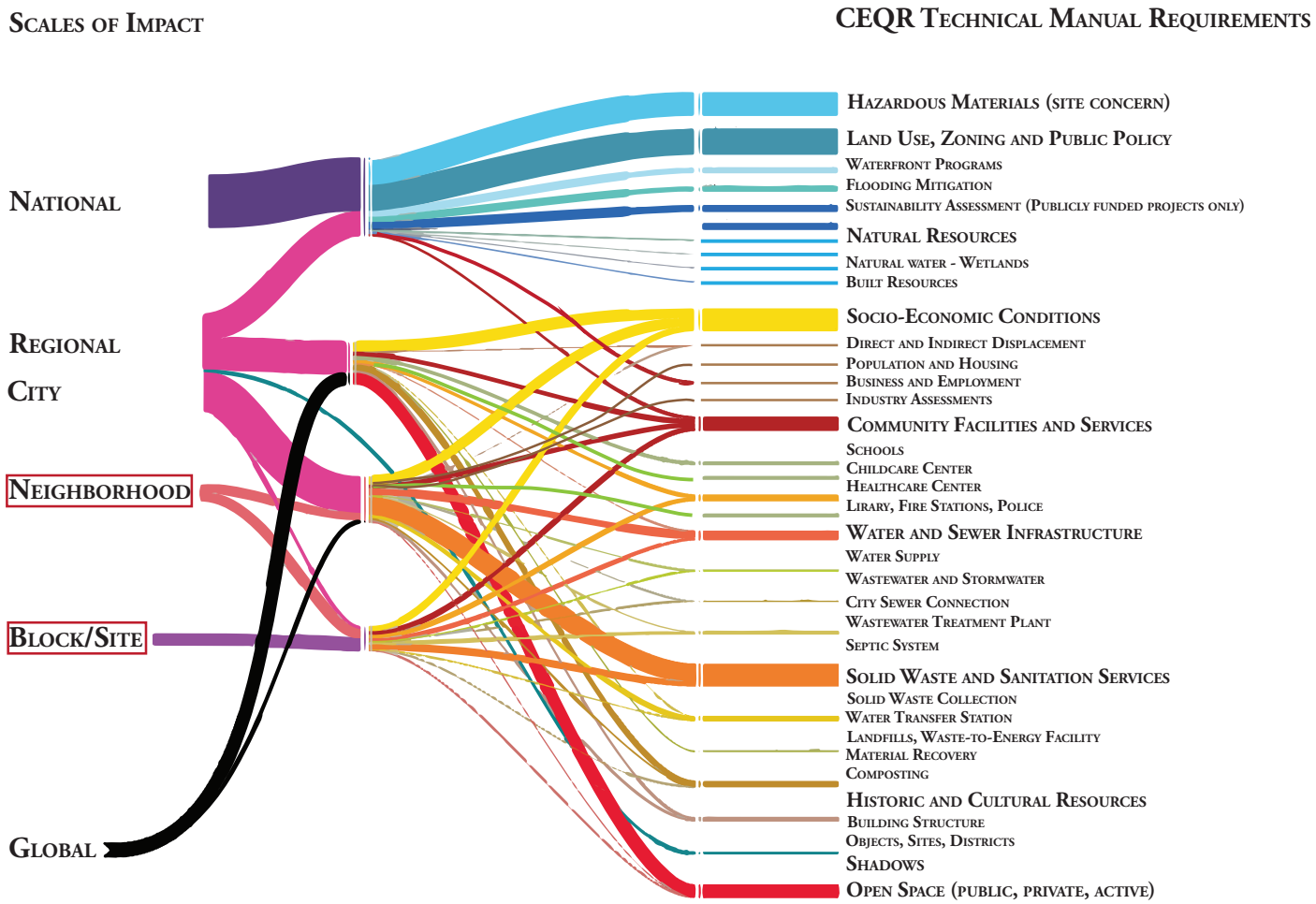


Figure (xvii): Spatial Scale Analysis - EIS Indicators

As observed in the gap analysis, the structure of the Environmental impact Statements does not define a core area of inquiry. The entire focus of the statement is to identify on the basis of the project and a specific site, the impacts that the manifestation would produce on the environment. And, even if significant impacts are observed, the project can technically still manifest (CEQR, manual). Also, as discussed before the subjectivity surrounding "significant impact" is often an area of manipulation. Moreover, as observed from the gap analysis and confirmed in the spatial scale analysis, the Environmental Impact Statement structure observes impacts through measurement of very site and neighborhood specific criteria. Whereas, we observe in the sustainability indicators that the scale of the region and the city are the most considered ones and for resilience indicators, the national, the regional, the city and the neighborhood scale are all catered to and considered for observation. This observation leads to an understanding of the approach and the focus of each of these indicator lists and structures and defines a scope to innovate and improvise within.

Chapter VIII: The Paradigmatic Shift – An Alternative Approach

Towards a Dynamic, Holistic Framework

The overall diagram and holistic framework derived from the existing EIAs and the urban sustainability and urban resilience indicators, has done so considering the goal as 'responsible' development and routing sustainability and resilience as 'drivers' towards that. This framework is aimed towards enhancements of the existing assessment procedures and sustainable development goals and spheres. There is intentional inclusion and reinforcing of special areas of concern, like system resilience and systemic sustainability and balance, more specifically the unaddressed issues of governance, health, climate, biodiversity and such. Since EIA is backed through legislation in practice, an attempt to expand the horizon of the 'environment' used in thus, is considered as a pragmatic route for resolving its current ineffectiveness.

The theoretical base for converging and combining the framework has been derived through the 'Sustainability Assessment Integrattion' approach which combines the following (Pg. 75. Hacking & Gutherie, 2008):

a. Comprehensiveness of themes

b. Integration of assessment techniques

c. And strategizing of a broad and forward-looking perspective (Pg. 75. Hacking & Gutherie, 2008)

The techniques to extend the arguments of integration within the assessment process, horizontally and through interconnections, is derived from the study (Pg. 75. Hacking & Gutherie, 2008).

This proposal for a novel framework has been achieved by integrating frameworks as a technique, to link existing established frameworks. Analyzing the gaps in the framework and bridging the gaps thus, is the main attempt of this framework. Though the framework needs to be derived through quantitative and simulation techniques, but as a first step this is an effort to complete the picture presenting a case for its further development and use to the decision-makers.

Responsible Environment Innovation - Part I

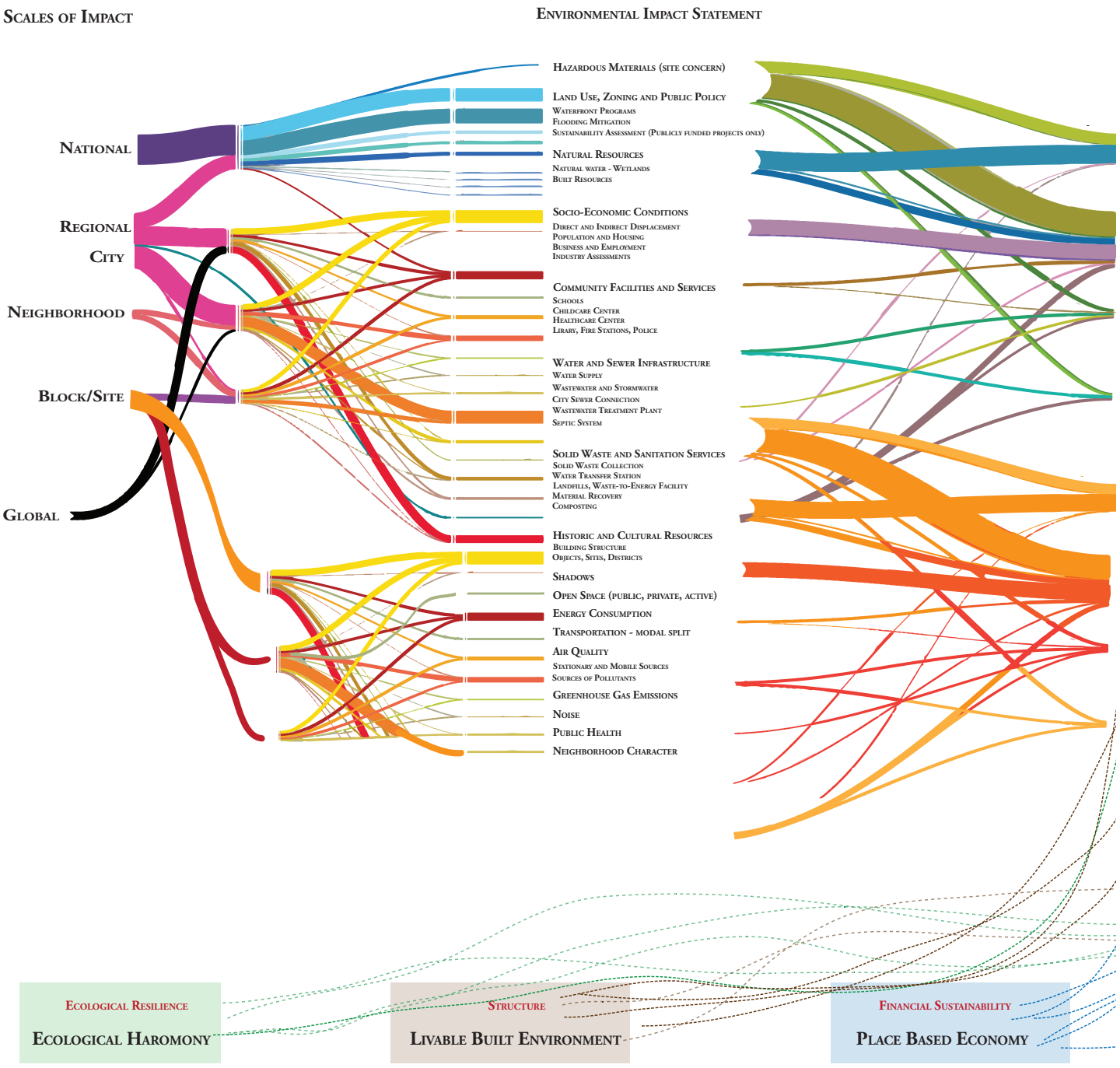


Figure (xviii): Innovation Framework - Part I

Responsible Environment Innovation - Part II

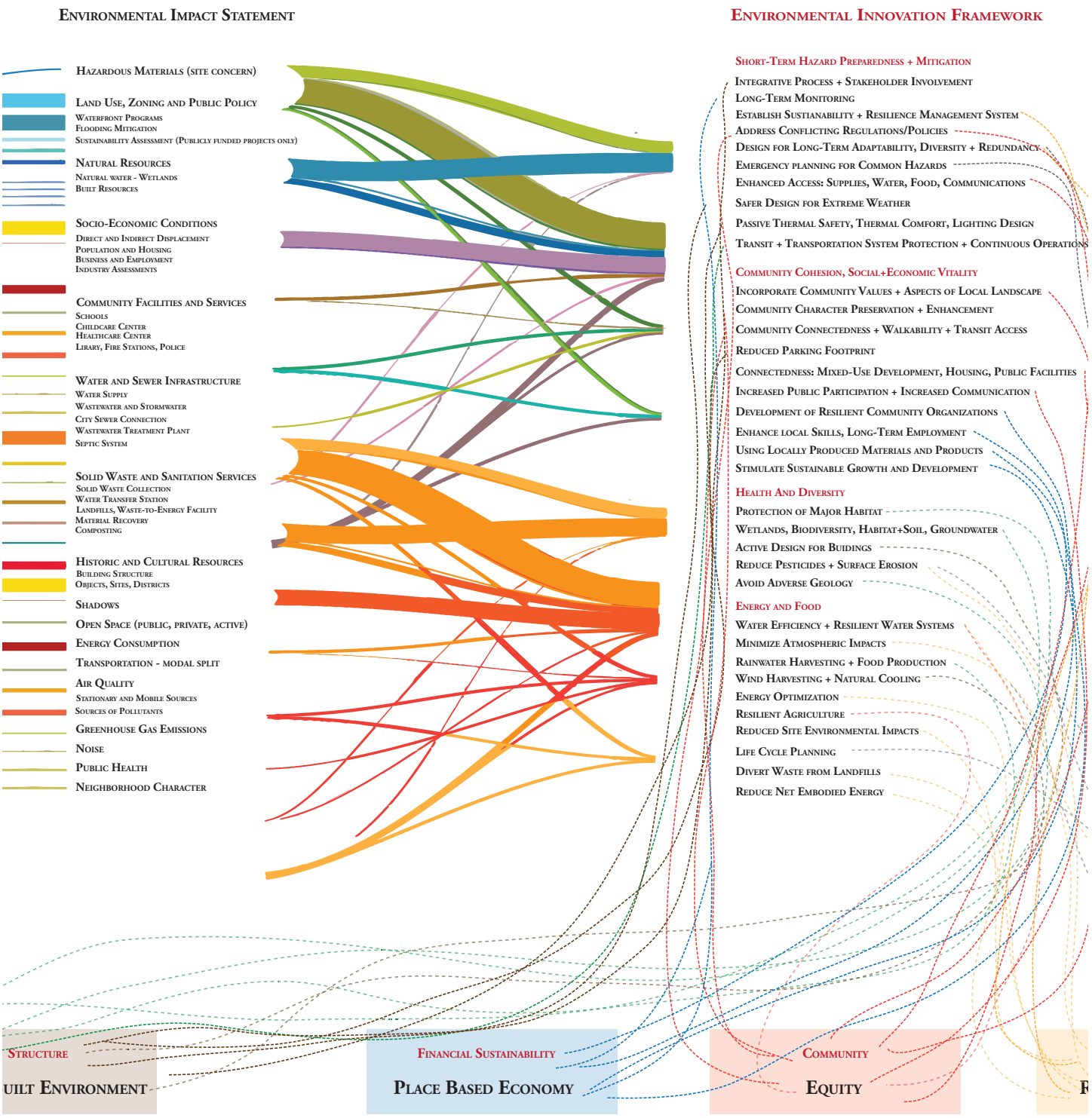


Figure (xix): Innovation Framework - Part II

Responsible Environment Innovation - Part III

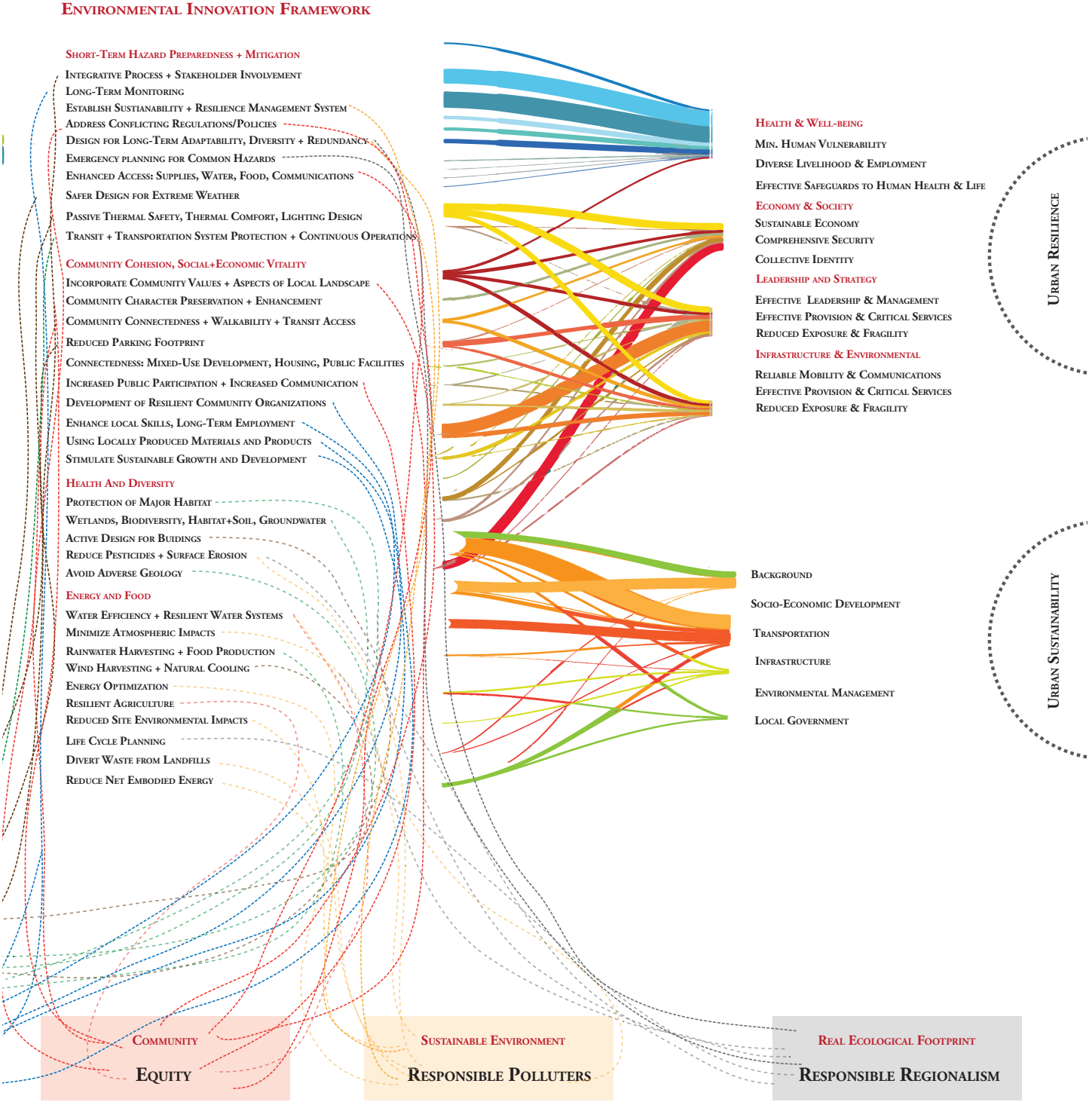


Figure (xx): Innovation Framework - Part III

This proposed framework seeks to combine and strengthen the scales of impact analysis that were found as lacking or missing in the gap analysis of the Environmental Impact Assessments. Moreover, this framework corresponds to the urban sustainability and urban resilience indicator frameworks closely, as in the spatial scale analysis of the indicators, it was realized that the indicator frameworks were in fact corresponding to scales of the socio-ecological systems that the EIA was in fact lacking in.

Chapter IX: Planning Implications and the Way Forward

Planning Implications

Fundamentally, the development of land and hence policies governing thus are directly related to environmental change, as land is considered one of the biggest resources in nature. In recent years, the approach of governments at all levels using land-use planning as a driver for sustainable development has been fairly evident. Planning system has now embraced responsibility of promoting sustainable use of resources like water, energy, minerals and land, preserving biodiversity and protecting the cultural environment of regions and are increasingly being seen as having potential to reduce greenhouse gas emissions and promote sustainable transportation options. The positive implications in introducing sustainability measures and concepts into tangible planning frameworks is a paradigmatic shift in thinking that encourages from thinking about a 'parcel' of land to a region that encompasses the wider ecosystem. It broadens the scope of planning and introduces the urgency to consider implications of planning policies across disciplines and across spatial scales. It would be unreasonable however to expect major changes in scales of comprehensive plans and other planning tools to change overnight to complement this shift in approach, but the broader conception of the environmental while planning land-use due to sustainable development concepts, can be considered a significant change.

Also as the world is in an era of fast-change due to changing patterns of climate and increasing unpredictability of system resilience, governments at all scales are investing considerably in resilience planning and recovery plans for regions. Indicators measuring resilience of systems, at tangible scales and intervals in time are much required now to improve policy decisions and implementation strategies. The linkage between resilience and sustainability indicators and their integration in Environmental impact Assessment Structures that this study seeks to inquire can have magnanimous implications on how policies are ideated currently in the planning forum. The use of resilience as a tool to not only strengthen communities in the case of unpredictable disruptions but to plan towards creation of sustainable communities in the longer future, can be a concept with immense planning implications at various scales of governance.

Recommendations

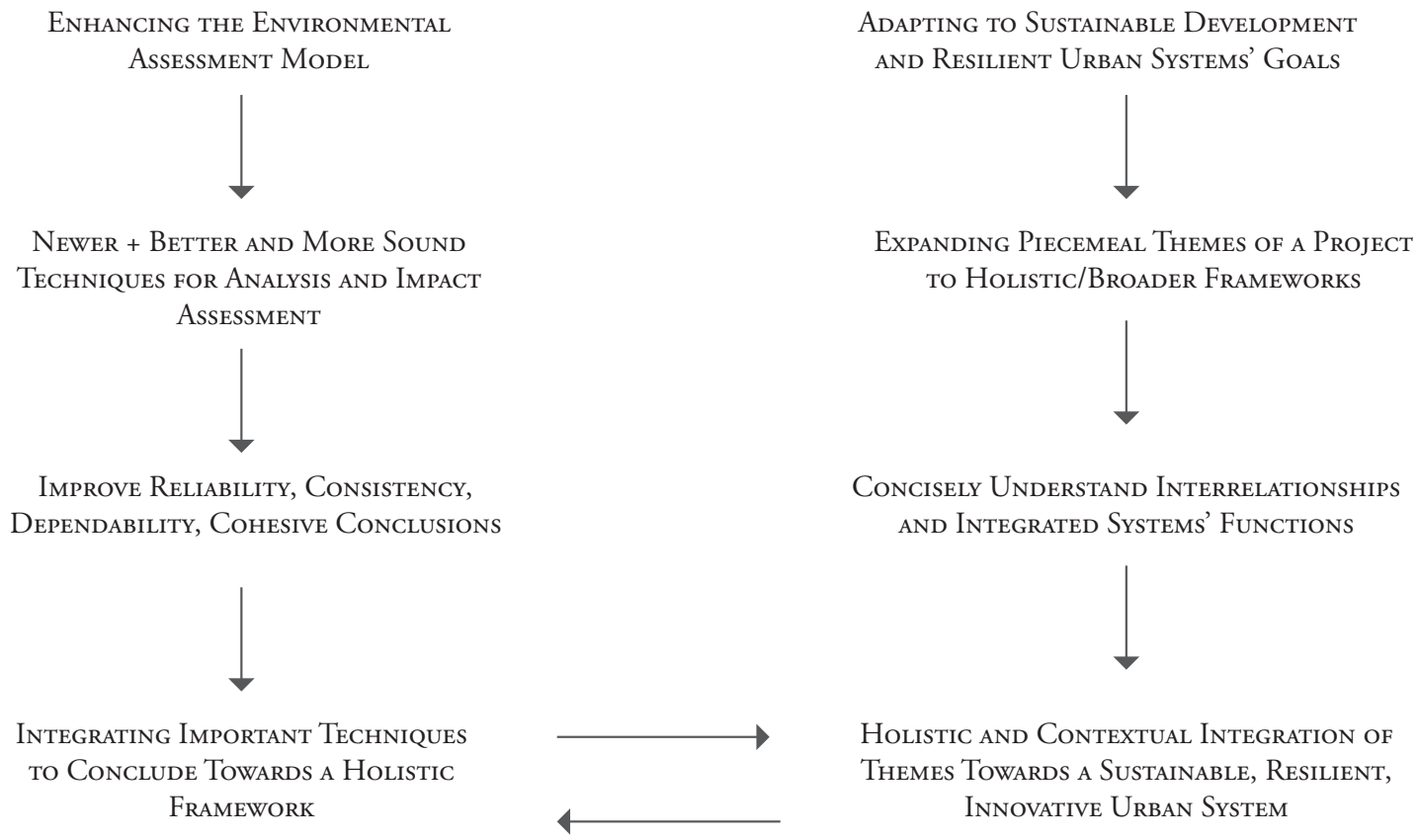


Figure (xxi): Recommendations (Derived from Pg. 78. Hacking & Gutherie, 2008)

This study, analysis and subsequent innovation strategy aims at enhancing the environmental assessment model in an attempt to better the techniques used for the analysis and impact assessment. This model aims to increase the reliability, consistency and dependability, while integrating the major principles relevant today in designing an urban system. This integration also aims towards the corollary effect of enhancing the techniques used for analysis used in impact assessment.

The parallel study of defining resilience and sustainability indicators and their manifestations supplement this study, expanding the themes of a project manifestation to make the framework more holistic and broad. This aims at defining a framework that is more sustainable, resilient and innovative as a whole, to better design urban systems. Also important is the integration within an already existing, fairly successful legislative system so as to make sustainability and resiliency of urban systems not an optional inclusion but more a mandatory application.

The Way Forward and Threats to the Study

The basic lack of clarity in definition of terms governing an urban systems and their design leads to a major loss in constructive discussions in their design and understanding. This study, hence, by means of "unpacking" important terms and definitions into a discernible framework, facilitates common understanding of concepts and aims towards application of thus. The threat however to such as approach is the contextual focus that tends to get attached to these otherwise massive terms, which if not applied and understood properly, may lead to mis-construction of views and solutions.

This study is a first attempt to strengthen at a very basic level, an existing framework, through gap analysis and spatial scale of application analysis, that intends to enhance application and reliability on the system. Through drawing of interrelationships between concepts governing similar outcomes and intentions, this study provides a basis to enhance applicability and avoiding redundancy in further devising policy frameworks to better design urban systems.

Futher detailed work into developing tangible assessment strategies and techniques for all the sub-areas within the framework, needs to be done to provide a powerful and innovative single framework for practical results.

Conclusion

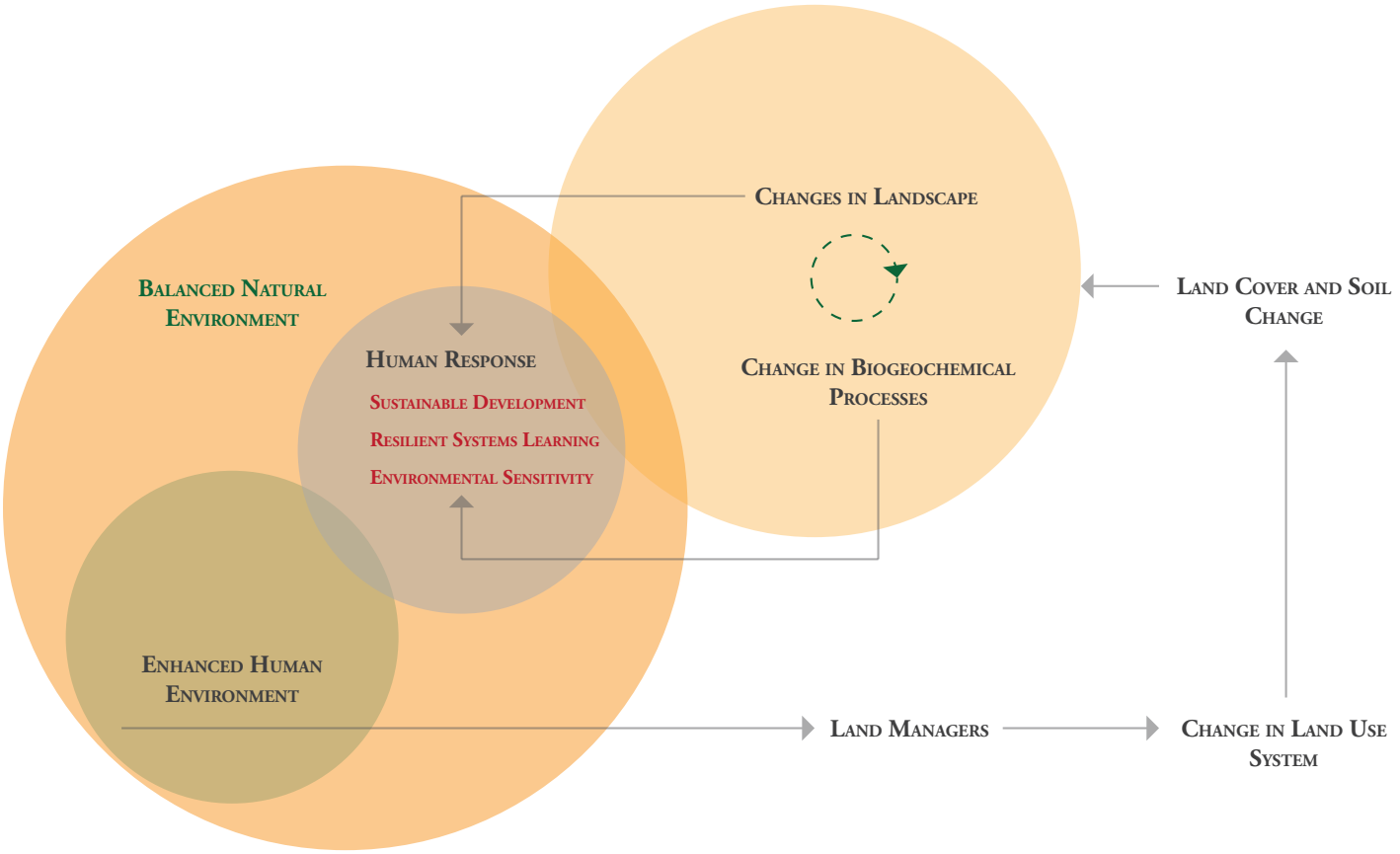


Figure (xxii): Towards a Balanced Eco-system

As a conclusion to this study, this diagram represents the understanding of the urban system in context with the natural environment, and where 'sustainable development' and 'resilient systems learning' fit in the designing of urban systems - and if the 'Innovation Framework' be further studied, devised and be implemented, how the urban system we inhabit can be in balance with the larger natural system that it is a part of.

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