Sustainable Urban Agriculture and Forestation: The Edible Connected City

by

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Declaration of Originality

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Abstract

Current global agricultural practices are recognized as unsustainable. The increase in overall human population as well as the global trend of rural to urban migration, partially as a result of historically and continual unsustainable agricultural practices, exacerbates the vicious cycle of poverty and hunger in developing countries. Furthermore, cities and regions in developed countries practice unsustainable food production, distribution and consumption patterns, and as a result, exceed their global ecological footprint (Rees 2009). Consequently, the world is facing a global food (FAO 2009) and water crisis (UN Sick Water 2010). Cities and Regions must learn to feed themselves to address local food insecurity as well as protect from the climate effects of increased urbanization, including the Urban Heat Island effect (UHIe) by optimizing and fully integrating the local ecosystem services of food, water and forest within a tightly woven compact urban form through the implementation of strategic urban and regional food system planning. Cities can mitigate climate change and reduce the UHIe, by implementing sustainable intensive urban agriculture approaches through policy and zoning interventions that include concepts such as intensively productive urban agriculture that includes green roofs, vertical farming and greenways as continuously productive and edible urban landscapes, referred to in this paper as continuously productive urban agriculture and forestation (CPUAF) in the private and public realm. A highly participative, adaptive systems approach is explored as the key to sustainability within an economic world order that included corporate social responsibility and social enterprise as the foundation for the integration of multiple synergies. An increasing body of evidence often links urban forestation with urban greenery initiatives, as a carbon sink to reduce UHI effects, to reduce GHG emissions and as a tool for urban beautification and place making (ISDR: 2009,109). Urban agriculture, through the production of local food is increasingly recognized as a means to reduce fossil fuel emissions by reducing transportation and production outputs, to provide a secure local food source, enhance biodiversity and educate the public regarding food source while fostering a sense of community, environmental awareness and stewardship. This thesis explores the links between intensive urban agriculture and forestation, and the relationship between climate change, and the UHI's as an adaptation and mitigation process in global cities, implemented as a interconnected, integrated, holistic urban management approach that has a further benefit of providing food security and a sustainable and local urban food source.

Key words: Sustainability, interrelatedness, climate change, urban heat island effects, global food crisis, global population growth, food security, food systems strategy, urban agriculture, urban forest management, urban heat island, ecological footprint, public participation, adaptive systems, intensive green roofs, vertical farming, green infrastructure, ecosystem services, ecological footprint, density, waste, water, continuously productive urban agriculture and forestation (CPUAF), agro ecology.

Table of Contents

List of Boxes

List of Figures

List of Abbreviations

AL	Agricultural Land
ALC	Agricultural Land Commission
ALR	Agricultural Land Reserve
BCIT	British Columbia Institute of Technology
BLHI	Boundary Layer Heat Island
CoCT	City of Cape Town, Republic of South Africa
CoJ	City of Johannesburg, Republic of South Africa
CoV	City of Vancouver, Canada
CPUAF	Continuously Productive Urban Agriculture and Forestation
CLUHI	Canopy Layer (Urban) Heat Island
CSR	Corporate Social Responsibility
CSA	Community Supported Agriculture
DTES	Downtown Eastside
EC	Environment Canada
EF	Ecological Footprint
FH	Fairmont Hotel
FAO	Food and Agriculture Organization
GCAP:2020	Greenest City Action Plan by 2020, The City of Vancouver
GEZ	Green Economic Zone

GHG	Green House Gas Emissions
HI_{soil}	Soil Layer Heat Island
IDP	Integrated Development Plan
IPCC	Intergovernmental Panel on Climate Change
LEED©	Leadership in Energy and Environmental Design
MVR	Metro Vancouver Region
MVRD	Metro Vancouver Regional District
SE	Social Enterprise
SEFC	South East False Creek
SOLE	Sole Food Saving Our Living Environment
SLHI	Surface Layer Heat Island
SPIN	**S**mall **P**roductive **IN**tensive Urban Farms
TOD's	Transit Oriented Development
UA	Urban Agriculture
UNEP	United Nations Environmental Program
UHIe	Urban Heat Island Effects
MVR	Metro Vancouver Region
MVRD	Metro Vancouver Regional District
RSA	Republic of South Africa
VCC	Vancouver Convention Center

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"Something wonderful always happens when you plant a seed".

-Wangari Maathai,

2004 Nobel Laureate, Sustainable Development, Democracy and Peace.

Introduction - Background and Rationale for the study

Restorative, regenerative and integrated urban agriculture and forestation is explored as an eco-infrastructure network of interconnectivity for human and ecological health. An edible and protective greenbelt is considered as an integrated component of urban management and as a solution to multiple and interrelated sustainability issues, in the age of global climate uncertainty. Closing the loops in consumption and production of food to reduce the ecological footprint at the city and regional level by producing food locally will improve the social viability, economic and ecological performance of cities while providing food security and optimization for improved urban and global resilience. The inter-relationship between the provisional ecosystem services of water and food supply is an intricate interconnected balance and the disruption of hydrology brought about by climate change and poor agricultural management practices has resulted in a global reduction in plant yield, impacting food security. Sustainable urban agriculture, through the application of the diversification and continuation of plant species and cycles, taking a living systems approach can protect water resources, close waste streams, and reduce GHG emissions. By considering the green infrastructure in the physical design and the function of the city, the climatological process and the relationship between climate change and local heat islands can be affected, reducing urban temperatures contributing to the feedback on the global climate. This is an integrated process that addresses multiple sustainability objectives, referred to in this thesis as continuously productive urban agriculture and forestation (CPUAF). Empirical evidence suggests that rural areas can no longer provide a sustainable food supply for growing global and urban populations (Amcoff & Westholm 2006). The reasons for the dwindling food supply include the de-population of rural hinterlands to urban areas, historically unsustainable mono-culture agriculture, and the use of pesticides and fertilizers, all outcomes of the Green Revolution of the 1960's (Amcoff & Westholm 2006, Benyus 2002). According to the FAO (2007), every human being has the right to food and they are responsible for realizing their own right (FAO 2007). Yet, there are 854 million people in the world who suffer from hunger as well as over 2 billion people who suffer from micronutrient deficiencies. Based on the WBDI (2009),[1] this equates to 42% of the global population

[1] Current Global Population: 6,775,235,741 2009 WBDI World Bank Development Indicators.
FAO statistical data on number of people, globally without adequate food supply: 2,854,000,000.

being denied their basic human right. While Rees (2011) states that "while cities can never totally be the sole source of their own food supply, as 7 hectares of ecological land is required to sustain each human being as defined by the ecological footprint" (Wackernagel and Rees 1998), they can, according to Bomke (2011) and Rees (2011), grow horticultural products that are suitable to their regional climate and support local supply during times of critical shortages. Cities must learn to feed themselves more sustainably as more than 70% of the world's population will live in urban areas by 2050 (UN Habitat: 2009, 8) and the overall global population is expected to reach 9 million in the same time frame (IFPRI: 2010, 12), exacerbating the global food supply. As a result, cities will require innovative and integrated strategies as local municipal planning interventions to feed themselves sustainably, as well as protect themselves from climate variables and the fall out from geo-political responses to food insecurity. Rarely has urban food production been connected to the process of urban forestation as a means to reduce climate and UHI effect's but it is time now to consider radical innovative and synergistic approaches to address the extraordinary challenges facing human existence.

The following literature review supports the main thesis question illustrated in the case study of the City of Vancouver, by providing the background as to why cities need to be more sustainable to address key global issues, believed to be reaching the tipping point. They include climate change, mass urbanization, global population growth, global food shortages due to poor agricultural practice, all of which contribute to local heat islands and urban food insecurity. Further, the review provides background as to how cities can become the source of their own food supply through green infrastructure planning as a means, defined as continuously productive urban agriculture and forestation (CPUAF), to address the key issues. Also, the review presents evidence of the tools and processes that are used to create climate resilient sustainable food systems in cities, demonstrated in the City of Vancouver case study, which includes local neighbourhood project examples. The review is divided in two sections. The first assesses the factors, implications and background on climate change and its impact on food security and urban infrastructure. The second section defines the tools and processes used by a city to develop a sustainable food and food and forestation system.

How can cities reduce risk from climate and ecosystem degradation?

If the mismanagement of land use has contributed to the effects of climate change, as the IPCC states (2007), an adaptive systems approach in planning is the first step that can alter the functional metabolism of cities that caused climate change in the first place. A more sustainable, integrated and intensively purposeful approach to the use of land is required. This includes the implementation of strategies to reduce car dependency and the transportation of food by establishing transit oriented development's (TOD's) in which higher density, mixed use areas, built around pedestrian oriented urban development (Ruth: 2009,30) include networks of connected greenways. Urban green corridors provide bike routes and walkways that inter-connect with community gardens and public orchards managed by Community Centers, while intensively productive urban farms overtake vacant lots, grassed playgrounds and yards, roofs and walls, while hard surfaces are traded for lush vegetative and edible landscapes (GRHS: PSC 2009). Furthermore, by implementing policy and by-law interventions that reduce transportation, link buildings and local food systems, and that promotes a continuous urban forest and integrated edible greenway's, it is possible to reverse the human effects on the ecosystem and the climate.

In the age of climate uncertainty, mass urbanization and increased population growth, and in the face of a looming global food crisis, it is essential for countries, municipalities and cities to take a planetary approach and implement sustainable and integrated, holistic and multi-sectoral, strategic goals and plans for action that protect humans, species and ecological systems for future generations (Brundtland 1989). The objective is to provide quantifiable environmental, economic and social planning interventions, (UNHSP: PSC: 2009 94) that assess risk and uncertainty, effect social change, and that intervene, to enhance climate resilience and environmental performance of cities, including the effects of the urban heat islands, "improving the four structural variables of urban patterns through form, density, grain and connectivity" (Alberti 1999). Restorative CPUAF, as a regional and municipal food strategy, can create a sustainable, resilient and healthy food system, which according to the Metro Vancouver Ecological Health Report, (MVEHAC: 2011,16), will protect and enhance ecosystem goods and services as well as reduce organic and wastewater (MVEHA: 2011,16). Integrated, low carbon

urban planning solutions in waste and wastewater management, the built environment, transportation, and urban agriculture are required to reduce urban poverty and sustain eco-system services (UNEP: 2010, 10;UNH: CCS: 2010,3). The best practices outlined in this report take a whole systems approach that propose closed loops, at all levels and answers the question: How do we, during this rapid pace of urbanization and resource over-utilization, achieve sustainable urban food systems, build local food security that contribute to a balanced urban metabolism? Is it possible to increase the sustainability of cities to reduce the impact on ecosystem services, reduce climate impacts and the UHI effects through the application of multiple synergies that integrate food systems and urban forestation? The answers may be found by answering the main thesis question that follows.

Methodology:

Research Question

How Can a City link Urban Agriculture (UA) and Urban Forestation as an integrated sustainable urban management solution to address global climate change, local UHI effects and provide local food security?

Why the City of Vancouver as a case study?

The City of Vancouver (CoV) was chosen as a Case Study as it has clear objectives, strategies and plans for action to reduce GHG emissions to meet Kyoto standards and become the "Greenest" city in the world by 2020. The CoV has a goal to be a global leader in Urban Food Systems by 2020 and demonstrates linkages between urban forestation and intensive urban agriculture within a nested system. The city has a mandatory tree replacement by-law and the CoV has successfully integrated TOD and well-designed density, with one of the largest urban forests in the world with evidence presented that demonstrates reduced GHG emissions and further suggests a lower UHI effect in urban areas where a mature tree canopy is present. Conversely, the CoV developed a baseline study, indicating where low levels of tree canopy and vegetation exist and produced a strategy for intervention that links the urban forest with agriculture which are clearly cross referenced in the Greenest City Action Plan: 2020 (GCAP: 2020). Furthermore, it is found, that areas with low levels of vegetation correlate with

independent scientific UHI studies where Canopy Layer Urban Heat Island temperatures are highest. Not only does this illustrate the value of vegetative cover, it demonstrates that the processes taken by the COV were successful in achieving these findings. Furthermore, the CoV case study suggests, through interviews and a diverse literature review that a strong history of democratized public participation and multi-sector engagement, as well as the application of the tools and processes described in **Section 2**, has led to an action plan (GCAP) and is described as a "How-to Roadmap" answering the research question. Furthermore, the case study demonstrates that an open system of communication is an integral aspect of the process. While the CoV, has not fully realized its goals, it is willing to look at global best practices and recognizes that many of the strategies proposed are transferable globally, a desired outcome of this research. The CoV is an example of a city, in early stages, that is set to be a global leader in food and forest integration, which answers the thesis question, "How to Link Urban Agriculture and Forestation" in the Case Study, Section 3. Intensive urban agriculture, integrated with a connected greenway and forest action plan, can begin to provide a safe and secure food source, reduce urban temperatures and climate impacts, addressing multiple synergies. The CoV best demonstrated this possibility, based on a review of major global cities.

Research Design

The field of planning is highly diverse, complex and interdisciplinary, concerned with meeting the needs of sustaining human population through the analysis of ecological, social and economic systems in order to influence policy and regulations that intervene in the structure, pattern and form of human settlement development. Therefore, the literature review and the case study of the City of Vancouver, follow the same pattern and systems approach that exist in the field of planning, combining qualitative and quantitative research approaches using mixed methods of design (Yin 2009). The approach is non-linear, organic in form, following the principles of community assembly (Benyus; 1997, 31) mimicking natural living plant systems, the principles of systems dynamics, where assemblies of ideas (plant species) eventually attain equilibrium, evolving over time. Analogies between organic systems such as plant communities and the planning and built environment are used as a form of reason to explain similarities in systems, large or small, living or humanly conceived. The research looks at the trends,

patterns and interactions of complex multiple systems that include climate change, the UHIe's, urban agriculture, forestation, human population growth and economics. In the cross hairs of these interactions lies the profession of planning and the solutions are found in the principles of planning sustainably. The theoretical abstractions and complexities analyzed in the literature review, **Sections 1 and 2,** become present or concrete in the approach utilized by the City of Vancouver, presented in the case study in **Section 3** and the local project examples of intensively productive urban farms located within the CoV, presented in **Section 4**. According to Casey, "using case studies remains one of the most challenging of social science endeavors" (Casey: 2009,3). However, triangulation of data, using multiple sources of evidence, can produce "a more convincing and accurate case study (Casey: 2009, 116)." The case study research follows the methods described by Yin (2009) in *Case Study Research: Design and Methods*. Although very time consuming, (a limitation described by Mouton (2009,150)) the benefit of using the case study method, is that it allows for in-depth insights, by establishing a rapport with the interviewees (Mouton, 2009:150). The Findings and conclusions are summarized in each section, with a complete summation in **Section 5.**

The methods in each section although using the same approach are weighted differently. For example, literature and scientific journals, theory and graphs are utilized heavily in **Section 1 and 2.** Whereas, photography, drawings and web-links are the tools, recommended by Yin (2009) to support converging evidence, which are utilized to a higher degree in the case study **Sections 3 and 4**. Meanwhile, the primary unstructured interview data are woven as a linking device to substantiate other means of evidence, as a primary source of evidence, throughout. The experts were selected as they are among the leading international and regional experts in their field[2]. The source of the primary evidence, gathered in the informal interview process relies on the experts methods of measurement, data collection and their studies, in which they support,

[2] See Section 7, Appendix 1 for information on the experts, their field of study and their contribution to their respective fields.

CPUAF has the potential to provide food security and mitigate climate effects if implemented on a large scale. The methods for **Section 3 and 4** are described within the section to elaborate on the approach utilized.

Unstructured Informal Interview

Prior to the interview process in Vancouver in July 2011, an unstructured informal interview with Stanley Visor, Head of Economic Development Facilitation, Agricultural Unit The City of Cape Town (CoCT), Republic of South Africa (RSA) took place in September 2010. There are three main purposes for the interview. Firstly, to obtain input from an expert in the field of Urban Agriculture into the design and methodology of the case study prior to conducting interviews in the City of Vancouver, Canada. This was in order to design a thesis, useful in a local as well as a broader global context. Secondly, to obtain insight into the challenges present in a somewhat comparative urban form, in a developing city region (CoCT), that may not be present in a developed city region. Finally, to experiment and practice with different data collection methods, to learn their strengths and weaknesses in a pilot situation, and develop a research case study that presents converging evidence from multiple sources (Yin: 2009, 118), that has practical application in a global context.

Visser was asked the following questions:
"How would you produce a document, that includes a case study of the CoV that is a useful and transferable tool for implementation of a food system in the CoCT, as well as in other developing regions? Furthermore, How could the CoCT benefit from a case study of the City of Vancouver's Food System Strategy? "

Visser (2011) responded that developing a food system strategy that works requires "creating an enabling environment" utilizing a systems approach. Holistic, multi stakeholder planning is integrally embedded and integrated "in the philosophical practice in developed countries", which Visser observed directly and through participative exchange in Toronto and Curitiba[3], and which is illustrated in the case study of the CoV

[3] http://www.rooftops.ca/CMSImages/file/Urban%20agriculture%20and%20food%20security/Urban%20Agriculture%20Africa%20Toronto%20Exchange%20-%20Visit%20report.pdf
Rooftops Canada, initiated a pilot learning exchange involving multiple stakeholders from Nairobi, Cape Town and Toronto, which will extend to other cities in Africa as it moves forward. Rooftops Canada sees urban agriculture as a

which utilizes a ground-up approach to planning, involving all stakeholders early in the process (EDC; 2010,9). However, this is one of the major stumbling blocks in the Cape Town and in the RSA context (Visser 2010). The various sectors do not plan holistically and the approach is "ad hoc", lacking in cohesion, resulting in difficulty with implementation (Visser 2010; RPCUA: 2011, 6). The responsibility for food security is "subsumed under the rubric of the IDPs", (UAPCoCT: 2007,7) (PPFS) [4]and must comply under the MSA (2000)(UAPCoCT: 2007, 7). Meanwhile, with no direct local or national policy on food security, the intentions are fragmented (PPFS).

How food policy should be integrated in planning at a city and regional level is a question that challenges the CoCT (RPCUA 11). "Improving the understanding and increasing awareness around the concepts of food security, food insecurity and what it takes to build a local food system which addresses all aspects of the food system, (2020 2) while aligning everyone involved, is a major challenge", according to Visser. It requires moving beyond the debate of food insecurity as "an invisible crisis" (Visser 2011) to begin actioning and implementing a strategic plan addressing local as well as global challenges while creating a target of reducing the CO2 footprint of food. As the City of Vancouver is addressing the issues defined by Visser, using a systems approach in an enabled environment, addressing multiple sustainability issues cohesively, while addressing CO2 emissions, it is a goal to design this thesis as a transferable document in developing regions. Testing methodologies, allowing for an open-ended response to informal questions, and requesting feedback on the design methodology of this thesis produced useful results for a stronger case study.

Research Methods

growing area of engagement in both Africa and Canada. The wider positive benefits associated with urban agriculture include: better management of urban waste through composting; reducing impact on climate change by "growing local"; recycling and reducing water use; and, generally contributing to sustainable environments and developing resilient cities. I met a member of Rooftop at the Aids Conference in August 2010 in Vienna; it was through Rooftops that I engaged in a reciprocal exchange of information and ideas with Visser in Cape Town.

[4] According to the UNHSP Global Report on Human Settlement 2009, Page 63, based on a case study on South Africa, there are many problems with the SA IDP process. Firstly, it is based on a five-year cycle and not on a long-term vision. There are problems with line functions operating in isolation, resulting in a disjuncture between SDF'S and Land Use Management, as well as the lack of implementation of zoning ordinances, which could promote social inclusion. Further, participation is seen at a profession government level and not at a citizen or stakeholder level. Participation remains rhetorical in South Africa. Further the IDP process lacks understanding or motivation at the municipal and political levels to engage citizenry.

The case studies cross reference as a feedback loop, to the literature review, (**Sections 1 and 2)** and triangulate data from informal interviews with experts and professionals in the diverse and interrelated fields of planning. The method of measuring was provided by the experts in the informal interviewing process and the data was what the experts said regarding their respective field of expertise. The experts interviewed also provided documentation and references to other experts, and professions relating to the thesis. The experts included Dr. William Rees, inventor of the Ecological Footprint, Dr. Tim Oke, Global Urban Heat Island expert, Dr. Moura Quayle, Food Systems Educator, and Dr. Art Bomke, agro-ecology educator. Several experts recommended each other as a source of information and each provided further contacts and investigative leads that enriched the outcome of the research approach. A detailed list of the interviewees noted above, include planners and professionals in the field of climate change, social, economic and regional planning as well as innovators and practitioners from the field of urban agriculture and is provided as Appendix 1. The interviews substantiate the other five sources of evidence, and provide background information to enrich the literature utilizing a narrative approach. The expert evidence, woven throughout the text was gathered in the informal interview process during the month of July 2011, in the CoV. Initially, documentation provided by the experts and professionals, as well as from books and academic literature, is combined with direct and participant observation during field research, photographic documentation, and observation of the physical environments. These means of research are the six sources of evidence recommended by Yin (2009) and are the most commonly used in case study research. In addition, mapping is incorporated as a means to explain the geographic location and climatic environment and the interrelationship between planning systems such as the UHI effects and the urban forest (Diagram 1.6. & 1.7). The case study research supports the rationale for "why we need to be more sustainable" defined in the literature review, **Section 1**, while demonstrating the tools and processes in action, used by the CoV to implement the GCAP from **Section 2** and applied in **Section 3 and Section 4**. Hyperlinks to websites are incorporated in **Sections 3 and 4,** for ease of accessibility as a database, suggested by Yin (2009) to support converging evidence, Using flexible design to weave multiple cases, using mixed methods has provided what Yin (2009, 63) describes as "a richer and stronger array of evidence than can be accomplished by any single method alone."

In summary, the case study research uses 1) multiple sources of evidence, 2) creates a case study database and 3) maintains a chain of evidence, which according to Yin, are the three principles of data collection, which contribute to a strong case study (Yin 2009, 100). The case study database is integrated within the case study for use by the reader to access processes and tools for action in any region, a desired outcome of this research.

This document is structured in five sections, following the introduction.

Section 1 Literature Review: Why Cities must become more Sustainable and the Source of Their Own Food Supply

This section is a synthesis and review of the interrelationship of global agriculture and deforestation practices resulting in global climate change, local UHIe's and the interactions with global and urban population growth, resulting in the effect on human health and the degradation of ecosystem services. The section attempts to bring together the most critical of global issues facing humanity today through the review of literature including journal publications, printed books, and the most recent of policy documents produced by international organizations such as FAO, UNEP, the IPCC, as well as Cities and Regions around the globe. This section discusses the ambiguity in the definition of "Urban Food and Forestation" as well as the lack of multi-disciplinary policy and legislation, which hampers the integration of the two systems, by reviewing a broad array of publications. The section reviews literature on urban, rural and global agricultural and forestation practices and histories, which suggests both empirically and quantifiably that non-sustainable mono-culture agricultural practices have affected the quality of human food, forest and water supply The ecological footprint concept and methodology developed by Rees and Wackenagel (1997), as discussed during an informal interview with Rees (2011), support the evidence that the production and consumption methods of producing food are unsustainable and that we are living well beyond the carrying capacity of the planet to sustain itself. Increased urban growth and increased global populations and the emptying out of rural areas and hinterlands to cities and megacities indicate that cities must become an increased source of their own food supply to address multiple synergies. The Urban Heat Island, **Section 1.3,** includes a methods section, (**1.3.2**) as the gathering of the literature required rigorous personal

and email discussions with the global expert, Dr. Tim Oke (2011). The literature review, **Section 1**, provides the background and rationale for cities to become more sustainable and the source of their own food supply.

Section 2 Literature Review: The Tools and Processes

Section 2 investigated and presents the tools and processes required to integrate climate resilient continuously productive sustainable food and forestation planning in cities and regions. Included is the review of the link between economic, ecological and human systems, the ecological footprint and the one planet approach, climate modeling, public participation, adaptive systems planning and regional and municipal interactions. As well, an examination of social and behavioral tools is defined as "making the abstract visible" through education, stewardship and community interaction in "third place"[5] spaces, and is incorporated in the definition of a continuously productive urban agriculture and forest (CPUAF) system. The literature reviews green roofs and vertical landscaping as tools that integrate sustainable food systems and provides a global case study of an urban rooftop farm in New York, obtained through an e-mail interview. The review looks at an adaptive management model in Vienna, Austria. Finally, Continuously Productive Urban Agriculture and Forestation (CPUAF) is defined and proposed as a model of sustainability, that includes components of agro-ecology permaculture, agro-forestry and forest gardening. Suggested as a mainstream sustainable agriculture and forestation approach in the 21st century urban planning context, CPUAF is proposed as a model of urban agriculture and forestation in combination with the tools and processes utilized in this section and applied in the CoV. The matrix of a CPUAF is described in **Section 5.**

Section 3: Case Study – The City of Vancouver's Greenest City Action Plan by 2020 (GCAP)

[5] "Third places" is a term devised by Urban Theorist Ray Oldenburg. It defines the diverse, mixed use of public space located between home and office at the heart of community activity, social engagement and interaction. At the time of his writing, urban farms, community gardens, continuous greenways and pocket parks did not exist in most cities.

Sections One and Two of the literature review take a global perspective and provides the background as to why cities must feed themselves, reviewing the tools they can use to do so. **Section 3** looks locally, by way of case study of the City of Vancouver (CoV), and addresses the main thesis question **"How would a city, as a component of integrated planning, go about the process of integrating a sustainable food system, protecting ecosystem services, addressing climate issues, including the effects of the UHI's while providing local food security"?** The CoV case study presents the history of public participation and its influence on the support of integrated mixed-use density development, and the preservation of ecological systems within the region. The study examines the role and involvement of multiple stakeholders such as the CoV, the Park Board, the ALC, The Urban Task Force and the MVRD, which have historically, and are in the process of further integrating interconnected natural area as landscape and as food source, to improve city and regional ecosystems health in a sustainable manner. A review of theory and practical academic literature, triangulated with local case studies and informal interviews with global experts in a variety of fields, brings the abstractions presented in **Sections 1 and 2** into practical application in **Section 3** and in **Section 4,** which presents examples of local scale sustainable agriculture and forestation projects.

Section 4: Examples of Continuously Productive Urban Agriculture and Forestation (CPUAF) projects and applications.

A study of Sole Food, **a social enterprise (SE),** illustrates intensive urban agricultural production, supported by a flexible and supportive planning system, while the study of the Fairmont Hotel (FH), illustrates a **corporate social responsibility (CSR)** program that supports ecosystem services within a sustainable economic framework. Within the FH project review, is a discussion of a LEED® Platinum awarded green roof installation without agriculture, the Vancouver Convention Centre (VCC), and a critique of the LEED® rating tool. Also, presented is a new economic partnership model referred to as **Community Supported Agriculture (CSA)**. The three projects illustrate intensive and sustainable food and forestation systems in practice. They are presented to enable people on the ground to implement local urban farms. The conclusion recommends areas where further policy innovation and synthesizing of best

global practices can further improve the sustainability outcome of the CoV and act as a guide to assist other cities and regions attempting to improve local food security and ecological and human health and wellbeing.

Section 5: Summary, Recommendations, Future Research and Conclusions

Section 5 summarizes the literature review, and answers the thesis question by demonstrating how the city of Vancouver has implemented policy to integrate a connected greenway and food system as well as provide an opportunity for local urban farmers and agro-business development. This section provides a matrix and summary of interventions and recommendations for implementation at a city and regional level and provides recommendations for practical interventions for local projects and interventions.

Sustainable Agriculture & Forestation: The Edible Connected City.

Literature Review

Section 1

Why must cities become more sustainable and the source of their own food supply?

1.1. Climate Change: Linking Urban Agriculture & Forestation

1.1.1. Climate Change: The Inconvenient Truth – Global effects

Never before in the history of humanity have we faced a more paramount challenge that threatens human and species existence. Overwhelming research concludes that we are living beyond our means, exceeding the ecological carrying capacity of the planet. The outcomes: resource depletion, climate change, resulting in droughts, floods and famines, increased summer mortality as a result of increased heat in large cites (Ruth 76), as well as food and water insecurity, are issues affecting ecological and social equilibrium, global economic stability, particularly in developing countries (UNEP 2010; UN Habitat: 2009, 3; IPCC 2000). Human consumption of agricultural products including wood, fiber as well as fossil fuel, measured by our ecological footprint, has overshot the capacity of the planet to sustain itself by 30% (Rees & Wackenagel: 1997,49; Arrow: 2008,109), and threatens the ability to sustain human and species populations at the current rate of expansion (Rees 1997). While industrial pollution, deforestation, agriculture and land use change has lead to a build up of GHGs in the atmosphere, the earth's natural ability to restore balance to the carbon cycle is further exacerbated through feedback loops by the global reduction in vegetation resulting in increased temperatures (UNHSP 2011). As a result, reduced vegetation through deforestation, mass urbanization and monoculture agriculture is an assault on the eco-system on two fronts. Furthermore, there is evidence to suggest that we are reaching the tipping point, or the point where runaway global warming (Gladwell 2000) could take place regardless of the current level of intervention to limit exponential growth to prevent further ecological overshoot (Rees 2009). Jared Diamond takes a strong approach to the tipping point and refers to it as "ecocide" (Diamond: 2005, 6)[6], the point of complete global environmental collapse. This is supported by the UN Global Report on Human Settlement (2011) that states "human actions are pushing the earth's climate beyond a tipping point where changes in human behavior and systems will no longer be able to mitigate the effects of climate change." How have cities contributed to the effects that include urban deforestation and what role can they play to mitigate through the restoration of a green infrastructure that also provides a reliable food source?

[6] Jared Diamond (2005:6) suggests that human population growth is one of the eight contributing factors to historical societal collapses. Food and water insecurity are threats to human survival and increased heat islands within rapidly growing urban areas and slums intensify risks.

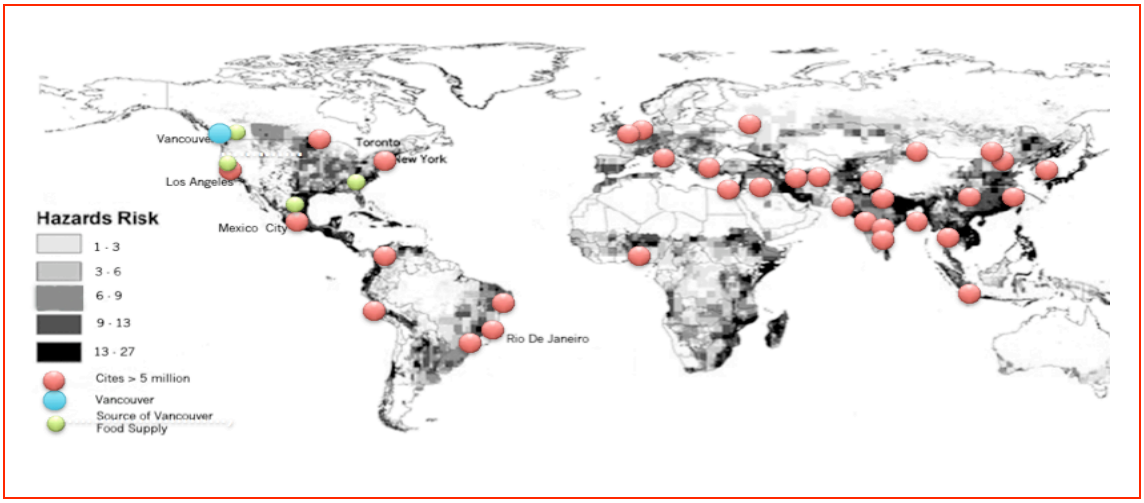

Figure 1.1. A Global Decrease in Crop Yield - Hazards and Risks.
Source : http://www.unhabitat.org/downloads/docs/GRHS2011-1.pdf Expanded on de Sherbinin: http://infoserver.ciesin.org/documents/vulofglob_contactshtml.pdf

1.1.2. Weather Change - Relevance to Urban Areas and Food Systems

Extreme weather events, including increased temperatures and precipitation as well as increased drought frequency (Trenberth et al. 2007) expanding drought regions, and rising sea levels are likely to cause extensive damage to the ecosystem (Solomon et al. 2007) affecting global and local food and water security, as well as urban infrastructure and human health. All of the above mentioned impacts have been given a high probably of occurring; some over 95 percent, (Ruth: 2006, 76) according to numerous IPCC meta analysis modeling experiments, based on individual ICPP statistical reporting (IPCC 2001) and is further substantiated in the ICPP 2007 simulation models. We have started to see a global decrease in crop yield (Houghton: 2007, 39) as a result of severe drought (FAO 2011) occurring in Asia and India with this trend expected to occur in many regions, including the Southern US, Mexico, and Sub Saharan Africa as illustrated in Figure 1.1. Agriculture is the most vulnerable of sectors to climate variability (ICHSR 2011), as cultivated land particularly in coastal areas is likely to be lost due to rising sea levels resulting in increased flooding and erosion. Climate failure and worldwide soil loss of 24 billion tons (Orr: 3, 1995) is resulting in a global increase in rural migration to urban areas. The trend is impacting the capacity of urban services and infrastructure to provide shelter, food and water for increasing urban populations (ICHSR: 2011, 78). Heat related mortality in urban areas is attributed to both global climate temperature increases (Kristie et al. 2006; Campbell & Lendrum 2007; McMichael 2003; Adger et al. 2003; Lieshout et al. 2004) and local UHI effects, which have increased ambient air temperatures in some

cities between 5 to 9 degrees F. (Stone: 2009, 318). According to Duncan (2011), the mitigation strategies for reducing the effect of climate change and the effects of local UHI's are congruent and we should be prepared for future scenarios, (Quayle 2011) even if they do not exist in all cities today. Although UHIs are smaller scale phenomena, they are linked to climate change (Ruth 2009; Voogt: 2004,3) in that as global temperatures increase, urban temperature increases occur correspondingly. Furthermore, as global populations are projected to increase from the current 6.8 to 9.1 billion by 2050 (FAO 2011; UN Habitat, 2011), the percentage of urban population will compound energy outputs and resources, compounding the negative effects of climate change and HI effects in urban cities.

1.1.3. Historical Ecological Collapses and Human Fallibility

The combination of human population growth coupled and overuse of finite resources that included forests and food and water supply, have caused societal collapse in the past, and is documented by Diamond in *Collapse* (2005) and by Rees in *Globalization and Sustainability (*2002). For example, both experts suggest that the documented failure in the 1700's of the inhabitants of Easter Island to manage their use of resources and ecosystem services, despite the complexity of their social structure, points to "bio-cultural determinism" as the root of human social behavioral. In other words, it is possible, as the literature suggests, that we have a genetic predisposition to un-sustainability. Further, according to Rees (2011), who cites Tainter (1988), collapse is not a new phenomenon in human evolution and "what is perhaps most intriguing in the evolution of human societies is the regularity with which the pattern of increasing complexity is interrupted by collapse" (Rees citing from Tainter: 1995, 399). Orr, an environmental educator who, like Rees proposes ecological sustainability over technological advances, contributes that the fallibility of humans lies in our limited "ability to coordinate or comprehend things beyond a certain scale" (Quayle: 1995, 463; Orr: 1992,25). Grappling with the scale and complexity of climate change as well as what Quayle describes as the "messiness of systems, linkages, processes, patterns and context" (Quayle1995) requires a new paradigm. While previous societal collapses were limited to islands or regions, the current scenario before us is collectively, a global challenge facing all of humanity and brought about by complex interactions, including urbanization, tied to the global economy and overuse of resources including soil, water

and forest, limiting the capacity of the earth to continue to produce food. If we are in a state of increasing complexity as a society, can we simplify the process toward sustainability by interrelating multiple objectives in order to prevent collapse?

1.1.4. Climate Scenario Storytelling: A means of solving the problem

The IPCC developed and approved six emissions storylines and scenarios to assist cities that include variances in projected population, consumption economic, and social growth. While all six scenarios are considered sound in their own right, the B2 model is the scenario which aligns with this thesis and which describes a world in which the emphasis is placed on local, less complex solutions to attain social and environmental and economic sustainability (IPCC 2007). The scenario is oriented toward environmental protection and social equity, focusing on local and regional level solutions (IPCC 2007) to solve global issues. Based on the research found, the (CoV) is applying the B2 model by taking a "one planet approach" to reduce the ecological footprint, GHG emissions, while working closely with the public and the Metro Vancouver Regional District (MVRD) to address the effects of climate change through adaptive systems planning and a comprehensive action plan detailed in the case study. Planners in the CoV prepare for local resilience in the face of global crop failure, resource depletion, increased sea level rise and global geopolitical instability though a multifunctional approach that integrates food systems planning within urban forestation planning.

1.1.5. The Impacts of Climate on Eco System Services

In 2005, based on the input of 1,360 experts from around the globe, the United Nations Millennium Ecosystem Assessment (MEA: 2005,5; Rees 2010; EHAP: 2011, 5) published the first broad based scientific assessment of the state of the world's ecosystems and their services. In their conclusion, the Millennium Ecosystem Assessment Board wrote:

> "*Human activity is putting such strain on the natural functions of the Earth that the ability of the planet's ecosystems to sustain future generations can no longer be taken for granted".*

Strategic local and regional actions are necessary to address ecological degradation on a global scale.

1.1.6. Climate Change: Urban Implication

"Global atmospheric concentrations of carbon dioxide, methane and nitrous oxide have increased markedly as a result of human activity since 1750 and now far exceed pre-industrial values determined from ice core spanning many thousands of years. The global increases in carbon dioxide concentration are due primarily to **fossil fuel use** and land **use change, including deforestation**, while those of methane and nitrous oxide are primarily due to **agriculture**."

Figure 1.2. The IPCC Statement of Climate Impact on Agriculture. Source: IPCC 2007.

According to The Intergovernmental Panel on Climate Change (IPCC) quantifiable research predict that global temperatures will rise between 1.4 and 8 degrees C over the next one hundred years as a result of emissions of carbon dioxide, methane and sulphur, (Ruth 76) caused by human activity (IPCC 2001; Environment Canada: 2009,5). (Figure 1.2). New information presented in 2007 by the ICPP stated, " the warming of the climate system is unequivocal". In this larger global challenge facing humanity, cities play a very large role as the cause as well as solution through adaption and mitigation processes (UNHSP: 2011,9). Cities, which are concentrated industrial and transportation hubs, take up only 2% of the global land mass, yet contribute as much as 75% of the GHG released into the atmosphere (UNHSP: 2011,9), with two main categories of impacts identified, pertaining to carbon cycles in cities. The first includes the emission of GHGs and the production of solid waste, which effect the growth and the health of vegetation and ecosystems, while the second impact refers to land use changes, including urban deforestation, and the subsuming of agricultural land surrounding cities as a result of suburbanization. While solid waste contributes to Methane emissions, the later contributes to the reduction of the positive affects of CO2 uptake normally produced by vegetation (McPherson 1999, Gill 2007, McPherson, et al. 1994, UNHSSP: 2011,44) in cities. While the total amount of global CO2 uptake loss as a result of urban deforestation is not verified scientifically, it is estimated that globally, the amount of vegetative cover (trees and shrubs) in cities account for only 5 to 25% of the surfaces, while the cover in rural areas amounts to 75% or more (Gill 2007), suggesting a loss of vegetation in urban areas of between 7 and 33% due to urbanization. The restructuring of the urban metabolism (Ruth: 2006, 158) through the application of multi-dimensional sustainable strategies, include reshaping economic and social systems (Gering 2011),

such as the inclusion of a Green Economic Zone (GEZ), and Social Enterprise, as per the Vancouver model, is what is needed to address current climate issues.

1.1.7. Summary

Restoring and regenerating the biophysical form of the city by implementing an integrated, multi-functional urban forest and food production system as CPUAF requires further investigation as to the benefits that the two can play within the local urban management systems, and the effect on the global climate system. For example, in the case study, The COV is implementing "The Greenest City Action Plan by 2020" (GCAP 2011). The Urban Forest Management Plan (Duncan 2011) calls for the inclusion of local food and which, according to Duncan (2011), " will require 25% of the municipal landscape to be edible by 2020", as a component of the overall objective to reduce GHG emissions. Further, it recognized that increasing shade produces a lighter footprint by reducing building cooling and the inclusion of interconnected greenways for walking and biking, will reduce vehicle transportation, thus reducing CO2 emissions (GCAP 2011). Reversing feedback loops that contribute to global climate issues requires an applied intervention that crosscuts through forestation and agriculture practices, in the urban environment as well as applications to the built environment and social and economic structures. In order to address these mounting crises, what is needed is a clear definition of what a local food and forest action plan looks like and how it could be implemented. **Continuously Productive Urban Agricultural Forestation (CPUAF)**", is defined as an integrated system and a tool for implementation in **Section 2, Chapter** 11, and is proposed as the overarching tool for action, grounded in the principles of sustainability defined in **Section 1, Chapter 6** of this thesis.

1.2. Linking The Urban Forest and Urban Agriculture

1.2.1. A Global Void in Definition and Policy

The Habitat Trust (www.hat.bc.ca) defines the urban forest as all of the treed landscape that may be found in a community or urban center. The City of Victoria, Canada (http://www.victoria.ca) expands the term to include all trees, shrubs, and groundcover as well as the soil in which they are grown. The definition is ambiguous and may or may not include agriculture. The UN Food and Agriculture Organization (FAO), the UN governing body responsible for Food Systems and Forestation, provides no clear definition in their forest management summary; however, the FAO (2011a) calls on countries "to pay more attention" to the managing and protecting of urban and peri-urban forests and trees as global populations increasingly live in urban areas. The FAO's DG of Forestry defines the contribution of urban forests (FAO 2011a) as providing resilience by mitigating and adapting to climate effects, playing an important role in protecting city environments. The FAO (2011a) mentions in one paragraph, "urban agriculture and agro forestry, and home gardening supplement household food supplies, while they are however, not common practices globally". This appears accurate, based on a comprehensive review by Neuner et al. (2011), citing local and regional examples from over 25 US and Canadian cities and regions of innovative regulatory tools and institutional mechanisms to strengthen food systems. The report found only one city that integrates agriculture and forestation, the City of Portland (Neuner et al. 2011, 6) that included the promotion of tree planting as a component of their food system policy. Had the Neuner report expanded outside of North America, it would have found that the City of Havana, has a long history of agro ecology, agro forestry and urban agriculture. Viljoen (2008,35) estimates 20,000 people in the city grow fruit and vegetables on local neighbourhood lots. Also, the City of Vancouver, Canada was not included in the report, although this city clearly articulated goals, integrating food and forestation, to become a global leader in urban food system planning (GCAP, 2011). The CoV Food System strategy is integrated in the planning processes, as illustrated by in GC2020: Action Plan (2011,102), clearly cross-referencing local food to include fruit trees within its planning strategy. Furthermore, although the city is planning to plant 150,000 trees by 2020, (Duncan 2011) the park board is cognitive of the biomass layer and will include it in the implementation, ensuring that 25% of all public forestation will include edible agriculture.

There is evidence from the case study and review that urban agriculture and forestation are robustly proceeding, supported by the CoV while waiting for policy and zoning interventions to catch up with public activity. This is clearly a cutting edge process and the sharing of interventions and best practices, particularly with developing regions, is necessary.

The FAO points to a lack of policy and legislation that hamper (2011a) "successful integrated approaches to urban forestry." However in order to mediate the global gap in definition, as well as develop a current estimation of global urban food production, the FAO is in the process of developing guidelines, which will highlight significant innovations taking place around the world to assist in local forestation practices. However "Food and Nutritional Security" is only one of fifteen themes, included in the projected provisional content (FAO 2011a) of the draft guideline.

The FAO Food Systems For Cities (2011b) document provides a more thorough, multidisciplinary definition of the integration of urban agriculture and forestation.

> *"Multifunctional landscape management, integrating agriculture, trees and forests help to make cities more resilient. It does so not only by diversifying urban food sources and income opportunities, but also by maintaining open green spaces, enhancing vegetation cover and water infiltration, and contributing to sustainable water and natural resource management. Urban forestry, including agro-forestry, especially helps to improve air quality, reduces urban warming, curbs erosion and enhances urban biodiversity"*

Further refinement in terminology comes from the Government of Canada, Department of Agriculture's definition of Agro forestry as, "an integrated and intensive agricultural production system that includes trees and shrubs as an essential component to achieve environmental, economic and social goals. This means that trees are not incidental but are recognized as contributing to improved productivity, yield, profitability and sustainability (AAFC 2011). The Agro Forestry definition is the closest to recognizing the benefit of the entire vegetative system that includes trees within an agricultural setting, however, as the FAO recognizes, there is a gap in the global definition and recognition of the linkages between urban forestry and agriculture. **Section 2.14**, of this thesis closes the gap with the terminology Continuously Productive Urban Agriculture and

Forestation (CPUAF) defined as linking all surfaces, vertical and horizontal including rooftops and vacant lots to provide for human species and ecological continuum and to provide urban food security and climate resilience reduce the UHI effect. The culmination of all the process and tools necessary to achieve a successful CPUAF model is in the process of implementation in the CoV, presented in the case study, **Sections 3 and 4.**

1.2.2. Urban Forestation: A Baseline for Intervention and modeled quantifiable data on green cover

A large body of evidence suggests that urban forestation can reduce global CO2 emissions, protect local ecological systems through transpiration and storm water retention while providing cooling, shading and wind reduction effects associated with UHIs, such as the paper by Nowak (2002). As well, evidence presented by CMHC (2006, 10) from four sources, quantify the benefits of green roof vegetation[7]. The UN Habitat 2009 Global Report on Human Settlement, states that "Cities with lower levels of disaster preparedness are more at risk", and further, the report recommends "Tree planting as one of the three main steps to achieve "carbon neutral cities (UN Habitat: 2009,117; ISDR: WB: 2009,109). McPherson, (1994, p. 154 from Akbari, et al. 1988) found that the large scale planting of trees and the use of white surfaces can conserve about 2% of US carbon emissions per year. A late study of the Chicago area, by McPherson et al. (1997,1), found that a 10% increase in tree coverage, approximately three trees per building lot, can save $50 to $90 per dwelling unit by increasing shade, lowering summer temperatures and reducing wind speeds. However, according to Gill et.al. (2007, 116), "little is known about the quantity and quality of green space required" to adapt to growing global climate change issues and interrelated UHI effects. As a result, Gill et. al. (2007) produced scenarios, for future planning based on increased and reduced cover that involved the mapping of urban morphology types in a case study of the City of Manchester, England. The model quantified environmental functions, using a

[7] Bass et.al. (2002). Modeling the Impact of Green Roof Infrastructure on the Urban Heat Island in Toronto. The Green Roof Infrastructure Monitor: 4 (1). Bass B., et.al. (2003). The Thermal Impact of Green Roofs on Toronto's Urban Heat Island. Presented at the Greening Roofs for Sustainable Communities Conference, Chicago, Ill. Liu, K. & Baskaran, B. (2003). Thermal Performance of Green Roofs through Field Evaluation. Presented at the Greening Rooftops for Sustainable Communities Conference, Chicago, Ill. Liu, K. & Minor, J. (2003). A Performance Evaluation of an Extensive Green Roof. Presented at the Greening Rooftops for Sustainable Communities Conference, Washington, D.C.

number of modeling tools that support the necessity for green urban infrastructure and can be extrapolated to other cities, as the findings are similar to the McPherson Chicago study of 1997. For example, adding 10% green cover to a CBD, a high-density residential area, or industrial/warehouse area with little green, maximum surface temperatures will remain at or below 1961 to 1990 baseline temperatures (Giles 2007). However, if 10% green cover is removed, the scenario indicated a temperature increase of 8% in CBD's and 7% in High Density Residential area by the 2080's. This study is useful as it models future scenarios' based on global increased temperature predictions. This is supported by Alan Duncan with the CoV (2011) who confirmed that it is important to remember that trees grow over time and therefore, a model is necessary to determine what was planted, when it will reach it's optimum benefits. Also, it is necessary to identify "hot spots" or areas of intervention where the municipality can intervene to increase tree, park and vegetative surfaces. The CoV is an example of a city that has established a baseline, identifying (figures 1.6 & 1.7) areas that are park and greenspace deficient, a necessary step to move forward in the integration of food and forest systems.

1.2.3. Urban Agriculture: Linking quantifiable data to green cover

While the Gill et al. (2007), McPherson (1997) and Nowak (2002) studies provide insight into the benefits of the green infrastructure and a baseline for intervention in terms of canopy and the benefits of vegetative and ground cover, there is little quantifiable data available concerning the beneficial interrelationship between urban agriculture and forestation as a means to mitigate the global and local effects noted above. However, one study from Malaysia (Amir 2009, from Wong 2009), found that wall temperatures could be reduced by 4 to 12 degrees C by installing an edible biofacade, with variables dependent upon leaf foliage and type of planting system. The study of edible legumes on vertical surfaces, found that darker green leaf foliage, produced a higher CO2 uptake, (Amir from Blanc, 2008, 105) suggesting that energy consumption can be lowered by the use of vertical gardens. Further research to measure the most sustainable edible processes and applications, as well as interrelationships between cover and canopy and the built and urban environment is necessary in order to produce a baseline and implementation strategy that optimizes a reliable food source and reduces local and global climate effects. As further vacant lots become recognized as a source of food production, it is an opportunity to undertake before and after field studies of the benefits

of specific urban agriculture and forestation processes. Furthermore, studies of city lot conversions are an ideal source for small test studies of urban temperature improvements in microclimate situations.

1.2.4. Urban Grass, Monocrops or Diversity and Polyculture: Defining the baseline and typography of Sustainable urban agriculture

The Gill et al. study (2007, p. 121) found that ornamental lawn grass is not a solution to improving heat sinks as part of an energy exchange, particularly in projected future drought situations. As lawns do not offer a cooling effect due to a shallow root system and are drought intolerant, they should therefore, be avoided in the urban environment. While another solution was not suggested by Gill et al. (2007) this thesis argues that an intensive form of urban agriculture, where (Benyus 1997, from Jackson, 26) "successive crops, of community assembly, with as few as eight species" and as further demonstrated at The UBC Urban Farm, Dept. of Food & Land Systems, operated by students of Agro Ecology (Bomke 2011) under the guidance of Dr. Art Bomke, is a sustainable solution as a replacement for urban grass, providing soil protection and other benefits. Other variations on crop diversity, integrated with forestation, are demonstrated at Sole Food (Dory 2011) and the Fairmont Rooftop garden (Evans 2011) and by Fresh Roots Urban Farm (Lablow 2011) in the CoV, in which intensive agriculture and inter-planting results in soil protection. On the other hand, the wholesale planting of wheat on front yards in the CoV, in the Lawns to Loafs project, aimed to produce 100 pounds of wheat in an unspecified time frame, is a mono crop, which is in itself, unsustainable (Benyus, 1997). According to Benyus (1997, 26) quoting Wes Jackson "we cannot stay with mono crops, as only poly crops are able to pay their own bills." While planting wheat is catchy and could, according to Rees, (2011) get people talking about growing their own food, this thesis argues that it is essential for cities to get serious about sustainable local food production and its role, value and placement within the urban spatial typography. Similarly, small community gardens, which Quayle (2011) describes as "spiritual and social," which may create awareness about local food production, "have little productive value". Further and agreeing with Quayle (2011) "planting small community gardens on the City Hall lawn, is sending the wrong message about getting serious about sustainable urban food production". According to Quayle

(2011), “it is important to think of a business model around a productive landscape” and “determine what a sustainable city would look like,” (Rees 2011), and determine, quantifiably, the form of a sustainable urban farm. Alan Duncan (2011) adds insight into the functionality by stating, “communal gardening, where groups plan and share crops and resources is more effective than individual community gardening.” Duncan goes on to say (2011), “Sole Food is an example of what the future of urban food production will be, where we are serious about producing food, treating it as a serious function in an urban environment and you integrate it in the social fabric of the community you are doing it in”. Furthermore, Quayle supports the initial query where linking quantifiable data to the benefits of urban agricultural and forestation by stating (2011) “it is necessary, to know as a baseline, what size a sustainable urban plot should be.” Further analysis is required, to fully assess what a truly sustainable approach to urban agriculture looks like, in which inputs and outputs of the system remain in ecological, social and economic balance.

1.2.5. Findings

The project example of the SOLE food Social Enterprise (SE), **Section 4.3,** provides insight into the potential baseline for a sustainable plot size or operation, and is discussed in Chapter 5, in the Findings Section.

1.2.6. Summary – Local Food Security, The Risk of Distant food supply - Linking back to Climate Change

Extremes in climate translate as a cost to human and species health and well being as well as creating detrimental disturbances in economic activity and food security as a result of reduced agricultural production (Ruth: 2009, 76). If we consider that much of our food, globally speaking, comes from “elsewhere” is necessary to consider the implications if the source of our distant food supply is produced in a higher risk area, or whether our city is located in a high hazard area. As an example, the Metro Vancouver Region (MVR), is situated in what is considered a lower risk area, (UNHSP: 2011, 4) (Figure 1.1), compared to other regions, the food supply comes from around the globe, with the bulk of fresh produce imported from California, Mexico and Florida, (FSBV. 79:2009), all of which are expected to experience high risk climate effects (See Figure

1.1). In order to protect against distant climate effects and crop failure, it is essential to establish a resilient and sustainable local food system to provide local food security, while assessing the risks associated with global supply. We can no longer expect to get food from somewhere else, such as the rural hinterlands with no understanding of how it is grown, how it arrives and how much energy it took to get it there (Yeung 2009).

Increased vegetation in cities as CPUAF has the ability to mitigate global and local climate variables contributes to the solution and not the problem, according to the experts. This requires an intensification of local food production to meet increasing urban demands as well as to protect from global effects of climate change and the local climate effects. According to Rees (2011), "self-sufficiency requires massive restructuring of our diet, which would include abandoning meat consumption, as well as the adoption of massive lifestyle changes as well as the re-assessment of available land". The sustainable lifestyle changes supported by Rees (2011), require massive societal transformation which is questionable, considering our predisposition to un-sustainability discussed in Section 1.6. However, cities can contribute by intervening with land use policy and regulations that assess "What is Land" to include vertical surfaces as well as public and private conversions, to encourage integrated and continuously productive urban agriculture and forestation as a normative approach to sustainable urban land use management and climate mitigation.

1.3. Urban Heat Island

An Urban Heat Island (UHI) describes the warmth of both the atmosphere or air temperature and the surfaces in cities or towns, compared to their surroundings (Oke 2011;Voogt 2004). The difference between the warmest urban and the surrounding rural temperatures define the UHI (Oke: 2001, 5) and is the principal diagnostic feature of heat islands (McPherson: 2007, 152). The heat island is an unintentional climate modification or "extra warmth" (Oke 2011) to the regional characteristic of the earth's physical surface and atmosphere (Voogt 2004) brought about by human alteration of the natural landscape (Ruth 2009). Generally, urban areas retain heat and have higher air temperatures than the surrounding areas (Oke 2011; UNHSP 2011). Evidence suggests that urban growth has produced what is know globally as the urban heat island (UHI) effect (Dixon & Thomas 2003) and is responsible for a rise in ambient temperatures in some cities of between 5 to 9 degrees F (Stone: 2009,319; McPherson 1994). According to Oke and Wynn (2001,15) "large scale climate change masks local effects." and while the effects of these changes over time remain uncertain, they do provide, according to Stone, (2009, 318) "an important present day window for investigating the future impacts of climate change on cities." The extremes of Heat Island temperatures are context specific varying from city to city and region to region, and depend upon urban form such as sprawl, green infrastructure as well as regional geographical context that may include forestation, mountains and waterways. While the City of Vancouver, (CoV) subject of the case study, (GCAP: 2011,14), "is home to the world's most spectacular urban forests" it does present areas with higher temperatures, such as warehouse and industrial areas that are consistent with research findings on Heat Islands, were low density sprawl produces more heat energy (Stone 2009; Oke 2011; UNHSP: 2011,54) and which create higher human discomfort. The structure of heat islands is well documented in climatological studies, developing from around the world (Chandler 1965; Landsberg 1981; Oke 1986; Oke 2011; Voogt 2004). However, there is confusion and looseness, even in academic circles about the nature and reporting of the phenomenon (Oke 2011), and according to Oke (2011), "as many as 45% of the studies are sufficiently poorly documented and therefore they fail". This thesis is an applied study and incorporates the scientific concept of UHIs and their relationship to larger climate effects. It provides a brief description of the properties and function of Heat Islands and further endeavors to coalesce from an applied research approach, the potential benefits of the integration of

urban agriculture and forestation, particularly in industrial area, on underutilized land including urban lawns, as well as on vertical facades and roofs. It looks at the relationship to building systems, as well as urban form and patterning, applying the principles of sustainability in the realm of planning.

1.3.2. Methods

The data collected for this chapter comes from a literature review of climate studies represented in journal articles and publications. An interview with Dr. Tim Oke in 2011, in Vancouver B.C. Canada, provided much of the primary data. His generosity in providing numerous journal articles, unpublished PowerPoint presentations and continuing email correspondence enriches and provides additional depth to this applied research analysis. Field research conducted at SOLE food Social Enterprise, which includes an interview with Seann Dory, Manager, attempts to demonstrate the potential for Canopy Layer Urban Heat Island (CLUHI) and climate interventions, which interface with all systems of sustainability as a cohesive and integrated study.

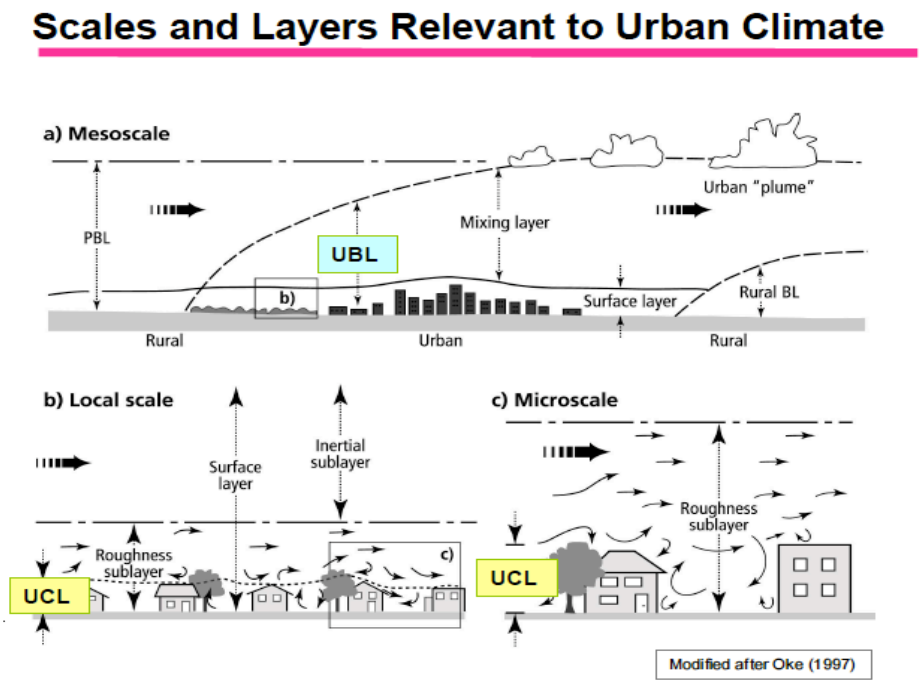

Figure 1.3 Scales and Types of Heat Islands. Larger scales are often measured by satellite imagery. Source Dr. T. Oke, 2011.

1.3.3. Types of Urban Heat Islands - Scale

There are three basic scales associated with the Heat Island and according to Oke (2011) “it is important to understand this basic principle before discussing and applying models and theory to the phenomena”, in order to accurately represent potential mitigation strategies. The scales are referred to as the mesoscale, the local scale and the microscale (Figure 1.3), which indicates that there is not one, but several Heat Islands (Oke 2011; EPA 2009; Voogt 2004). The following defines the four heat islands, of which the last three contribute to the overall increased heat formation of the Boundary Layer. Mitigating and adaptive strategies such as urban greening, that include tree planting and urban agriculture, at ground, against and on vertical surfaces, as well as on rooftops, particularly in warehouse and higher density areas and their contribution to the mitigation of the effects are explored.

1.3.4. The Heat Island Layers and Urban Agriculture and Forestation

1.3.4.a. The Boundary Layer Heat Island (BLHI) operates in the Mesoscale and is associated with the warming of the urban atmosphere (Voogt 2004). The BLHI extends up as a dome, over the urbanized region by as much as one km during the day (Oke 2011, Voogt 2004, McPherson 1994) causing warming downwind in associated rural areas. The other heat islands are located within the BLHI (Figure 1.3). Rooftops fall within the boundary layer, and can create a higher surface temperature or SLHI, if they are not kept moist, shaded or covered with appropriate vegetation. Intensive rooftop garden interventions are beneficial in the area of food production and provide thermal qualities, reducing GHG emissions by reducing thermal loads from air conditioning and heating (EPA 2009). In hotter cites (Oke 2011) the benefits are as much as 80% in relation to conventional asphalt roofs (Ruth from Stone, 2009, 336; UNEP 2010). A vicious cycle of heat and air-conditioning use contributes to higher air temperatures and increased GHG emissions and requires additional energy use to mitigate the effects of the initial use. It is this vicious cycle of thermal load, which can be mitigated through the implementation of green roof agriculture.

As well, intensive green roofs, can provide ecosystem services that include storm water retention to prevent pollution and provide pollination if a diversity of vegetation is included (MVR 2011; Evans 2011) in the application. However, according to Oke (2011), "unless there is a massive conversion, they are unlikely to benefit the BLHI or the Canopy Layer Heat Island (CLHI)". The benefits of rooftop gardens could increase if they are tended as gardens and not left to dry out as is the case in the SEFC Rooftop Garden LEED © (See Figure 1.2) which suggests to Oke (2011) "it is thermally relatively inefficient although it's hydrological role may be better". In other words, on principle, without evidence, as rooftop agriculture require stewardship and attention, the thermal benefit would be more advantageous than non-agriculture vegetation, which may go unattended after implementation. It is suggested to go beyond LEED © and embrace a CPUAF approach, that requires bylaw intervention to encourage implementation.

Figure 1.4. South East False Creek Community Centre Green Roof received LEED© Gold Certification. Photo Credit: V. Durant.

1.3.4.b. The Canopy Layer Heat Island (CLHI), also an atmospheric heat island, operates on the **local scale** as well as the **microscale (**Oke 2011; EPA 2009; Voogt 2004). The CLHI is associated with the air temperatures within human scale from the ground to the tops of trees and beneath roof level and is the scale and layer in which planners and architects are working. It is within this layer that a multitude of microclimates can exist which contribute to both the local as well as the larger boundary area temperatures (Oke 2011). It is within this layer where by-law interventions can

effect change through the requirement for vertical agriculture, the provision of tree canopy on private and public property as well as interventions to pavement, parking or vacant lots, particularly in low density and industrial areas. It is the area in which detailed temperature studies of over 400 points, near surface, undertaken by Oke and published in *Vancouver and Its Regions* (2001), support the hypothesis that " the lower density sprawled industrial areas are more susceptible to surface heat build up". Not only did the study provide canopy layer information, it also more clearly reports near surface layer temperatures than does large-scale satellite imagery, (Oke 2011) "due to the viewing geometry which cannot see under trees, awnings or on vertical surfaces". Duncan agrees that the Landsat system is flawed and that cities should invest in planting trees instead of measuring them. On the other hand, the Oke study, Figure 1.5, is a useful baseline assessment, as it is highly detailed and resulted in the findings that industrial areas have higher temperatures due to lack of vegetation, while the densely populated West End has lower temperatures, most likely due to the tree canopy and physical configuration of the buildings in the area. Furthermore, the CoV urban forest baseline studies (Figure 1.6 and 1.7) correlate to the Oke temperature study (Figure 1.5) and the findings suggest that industrial areas do not meet the target of being within 5 minutes from parks, greenways, or other green spaces (GCAP: 2011, 98). While UHIs are not a focus area for the CoV, higher temperatures in the industrial areas that include the DTES, can contribute to human discomfort. While Oke, Duncan and Rees (2011), concur that Vancouver does not experience an overall UHI effect that causes as much concern as it does in other regions, the CoV, according to Duncan (2011) and Quayle (2011) should prepare for future uncertainties such as heat waves and anomalies. The CoV adopted an extreme hot weather preparedness plan in 2010, after the death of a homeless man on the hottest day in recorded history in 2009 http://vancouver.ca/ctyclerk/cclerk/20100706/documents/rr1.pdf. The intent of the plan is to protect vulnerable populations. However, the preparedness plan is the only document in any of the COV documents reviewed that discusses the UHI. While there is very little evidence of cross-referencing or integration of UHI strategies with global climate strategies, for the most part, the UHI requires the same mitigation processes as required for climate protection, therefore sustainable urban forestation practices, with the integration of intensive local food production can be applied as mitigation strategies to address both problems.

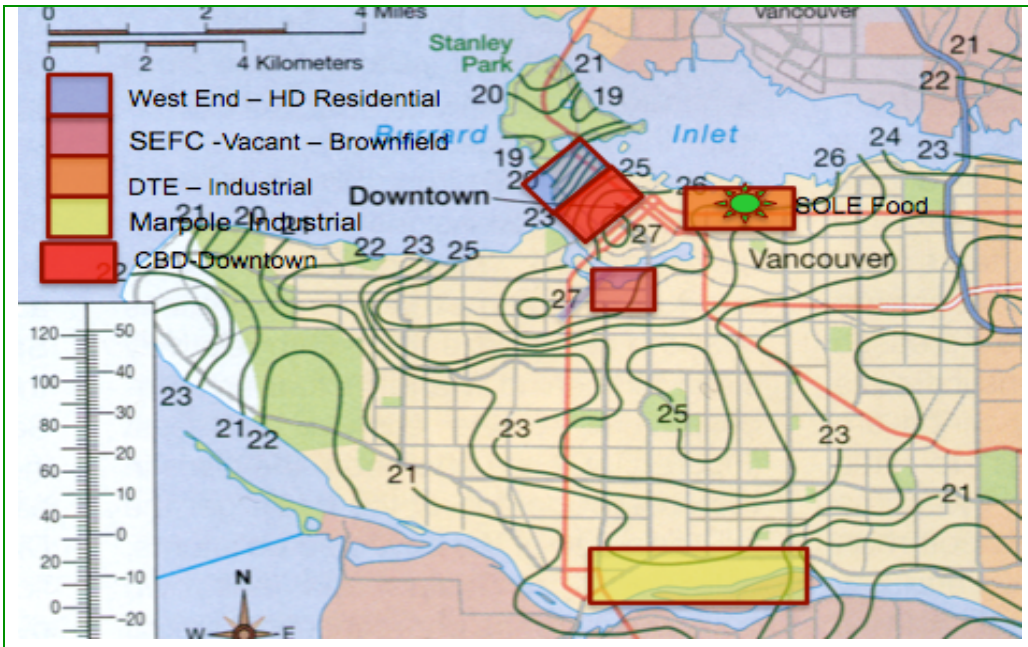

Figure 1.5 Vancouver and Its Regions 2000 Temperature Study. Source: Oke 2011.
(Colour Coding added by this author to illustrate hot and cool areas referred to in the thesis document)
Temperature studies of 400 points near surface located in the Canopy Layer that the industrial areas, where the DTES is located as well as the vacant, former industrial land of SEFC have higher temperatures than forested areas indicated in green. Note that recent development of the east side of SEFC is not indicated on this map. The Downtown Eastside (DTE) where SOLE food and the Port of Vancouver are located have relatively high CLHI consistent with temperature studies of other industrial area. The West End, which is indicated in blue, is a densely populated high-rise location with a large tree canopy integrated in the area as well as being situated near Stanley Park, the largest urban forest in North America has lower temperatures .The downtown or CBD has high SCHI, consistent with global studies.

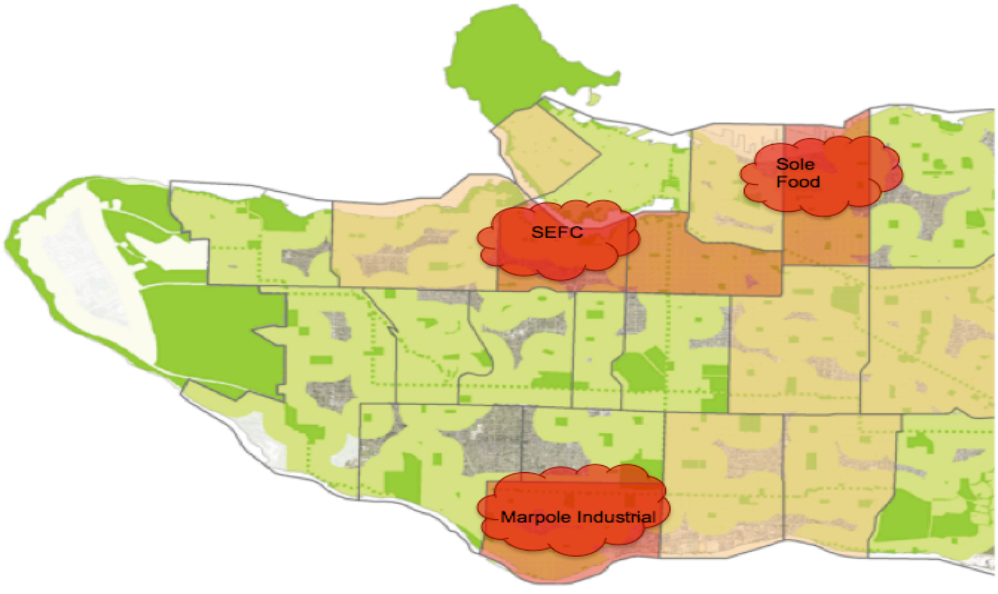

Figure 1.6. Park Deficiency Baseline Study from GCAP 2020 Talk Green to Us Website CoV
Key areas with higher temperatures correlate to the areas with higher temperatures and are highlighted . V.Durant.

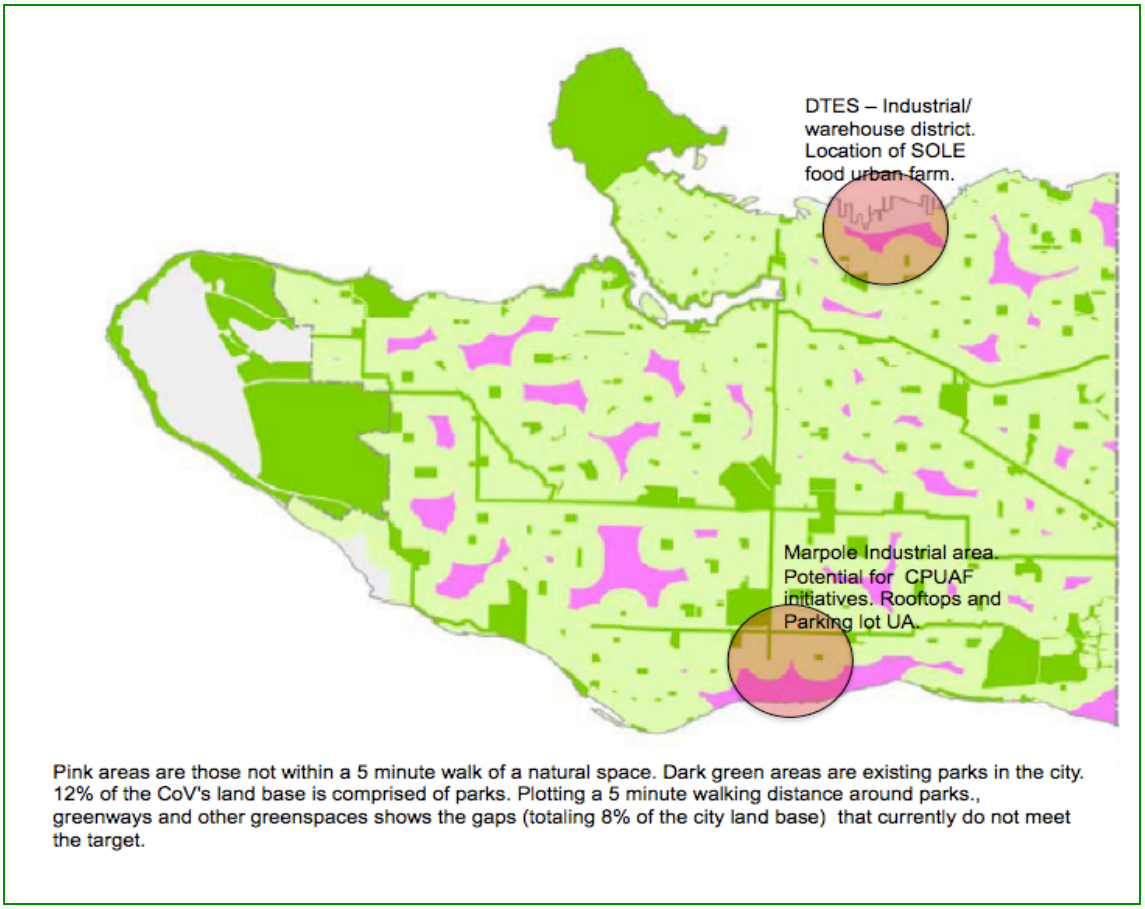

Figure 1.7 Diagram – GCAP: 2020 – Areas distanced from green space (Key areas highlighted by author) Hot Spots indicate where Industrial Areas with higher CLHI temperatures correlate to the Oke study of 1972.

1.3.4.c. The Surface Layer Heat Island (SLHI) refers to the warmth of urban surfaces (Voogt 2004) and is depicted through thermal imaging (EPA 2009). They can lead to temperature differences due to the permeability or refractedness of a surface and can lead to greater temperatures variances between dry, wet, shaded or vegetated surfaces (Voogt: 2004,3). What is significant here is that climate change scenarios do not consider urban surfaces, while there is according to Gill et al. (2007), "likely to be significant urban warming over and above expected for rural areas" (Wilby & Perry 2006; Wilby 2007). In other words it is likely that surface temperatures will increase, if adaption and mitigation strategies to increase wetness and shade through the implementation of urban agriculture and forestation initiatives within the canopy layer are not implemented.

1.3.4.d. The Soil Layer Heat Island (HI_{soil}) There has been little research about the near surface soil temperatures in urban areas. Urban soil temperatures affect ecological metabolism and micro-biodiversity as they affect root growth, decomposition of organic matter, the activity of soil organisms, and urban vegetation as they sequester carbon as well as respirates carbon from urban soil (Oke 2011). According to Oke (2011), urban agriculture could on principal, assist in cooling urban soil temperatures as well as slow Co2 emissions, although further research is needed in order to study before and after installations to measure soil temperatures in specific applications.

1.3.5. Materials and Urban Form

Urban development has resulted in the reduction of vegetative cover that provided shading, evaporative cooling, rain and stormwater inception as well as storage and infiltration functions (EPA 2009; Gill et al. 2007). These natural cooling mechanisms, often overlooked and undervalued ecosystem services (Daly 1997), are increasingly displaced in urban areas with asphalt roofs, non-permeable building surfaces and concrete pavement. However, what is significant here, according to Oke (2011), is that while cities are better heat stores than rural areas, "construction materials do not necessarily have greater thermal conductivity and heat capacity to those of moist soil." "What is significant is the convoluted configuration of the materials that exposes much larger areas for heat exchange than a flat site, and that they (the building materials) are often dry, due to their ability to shed and not store water (Oke: 2011,126)". This refers in part to urban form, know as urban geometry, (McPherson 1994, from Oke 1988b) which is the "type" of density, or the ratio of an object, its vertical surfaces (a building, a bush or a tree) and its relationship to canyons, or open spaces as well as how they interact with air flow and deflect solar radiation. Both the structure and material composition can enhance or reduce the ability of a surface to absorb and retain or deflect solar radiation (Ruth 2009).

The relationship between $UHI_{UCL,}$ climate change, and how we densify is not the main subject of this thesis; however, it is significant to the planning and configuration of urban green space in relation to the multi -dimensional built environment. The relationship is significant to the planning of an urban environment and it's potential for reducing the UHI_{UCL} as it also provides the groundwork for this thesis by introducing the potential for

the application of scale, volume and verticality, of the green infrastructure in planning. Furthermore, Gill et al. (2007, from Urbed 2004) suggests, “the green infrastructure should operate at all spatial scales from urban areas to the surrounding countryside”, an interconnected network of green space that conserves natural ecosystem values and functions and provides associated benefits to human populations (Gill et al. 2007, 116). As an extension of interconnected networks of greenspace, the concept builds upon Viljoen's proposal (2008) that incorporates continuous productive urban landscapes, integrating urban agriculture to further contribute to the concept of interconnected networks of edible vegetation. This is further supported in the case study review where the CoV Park Board is implementing projects and polices that connect urban agriculture within the forest management plan as part of the GCAP: 2020.

1.3.6. The Relationship between Density and the UHI

Density can play a role in build up of localized temperature, by increasing local temperatures; however, the three dimensional configuration of an urban environment, the amount of vegetation, the building reflectiveness and the canyons which permit airflow, are all instrumental in the amount of temperature increase. The type of density and the amount of dissipation of heat is variable and dependent upon a number of factors. For example, studies indicate that doubling of urban density decreases vehicle use between 20 to 30% per household, while a recent study in Toronto dealt with the issue of density and GHG emissions explicitly (UNHSP: 2011, 54). The study supported the earlier findings that low-density suburban neighbourhoods utilize 2 to 2.5% times more energy than high-density urban core areas (UNHSP: 2011, 54). According to Rees (2011)”, the Vancouver West End is a global example of well designed, densely compact urban form”. Duncan (2011) attributes the lower temperatures in the area to the size and spacing of the urban street trees, which provide a high degree of shading, within the canopy layer. The temperature readings produced by Oke in 1972 (provided in 2011) (Figure 1.5), provide evidence of the lower temperatures, despite the dense form. This thesis suggests that the carefully developed view corridors, theoretically function as urban wind canyons, and the well proportioned mix of medium and high rise buildings in combination with the close proximity to the largest urban park in North America (Boddy: 2004, 2), and the shading provided by the mature urban street trees are in combination, responsible for the lower temperatures and reduced GHG emission.

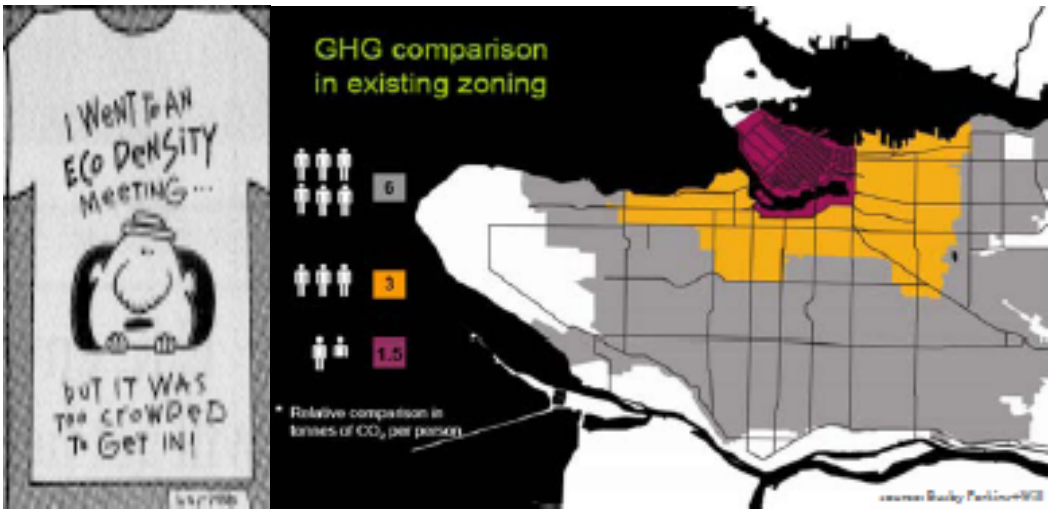

Figure 1.8. 1. The citizenry of Vancouver appreciate the ecological rewards presented by densely compacted urban form demonstrated in a local cartoon. 2. Lower GHG emission demonstrated in High Density Residential Areas. Source: (CoV) Density comparisons to lowered GHG emissions from the GCAP: 2020.

1.3.7. Risk to Human Health

1.3.7.a. Health Global Statistics. Most climate change research has been conducted on the direct effects of climate on health, with several conceptual models developed to frame research on the direct effect of climate change impacts on human health (McMichael et. al. 2003). Climate change is conceptualized, in most of these models, as impacting human health directly or indirectly (Haines et al. 2006). Direct effects might be death and illness due to thermal extremes arising from severe heat waves (Campbell-Lendrum 2007). Since 1970, the World Health Organization (WHO) conservatively attributes 150,000 deaths per annum to such effects, including heat waves and flooding due to climate change (Adger et al. 2003; Campbell-Lendrum 2007; Ebi et al. 2006; Lieshout et al. 2004).

1.3.7.b. Health - Local Application - According to a recent report (CoJCC: 2011, 64) “Heat-related mortality rates, while related to high average temperature levels, are predominantly related to sudden and extreme deviation” and variations from normative yearly temperatures (for that time of year). This suggests that sudden spikes in temperature are more dangerous to health and more deaths occur as a result. Furthermore, heat deaths are more frequent during hot nights and are linked to the UHIe (CoJCC: 2011, 65). A heat wave occurs when the temperature remains 5 degrees Celsius higher for three consecutive days than the average maximum temperature

(Health Canada 2010). Higher average temperatures, as predicted as a result of climate change, indicate that when a heat wave occurs, the consequences are likely to be more severe in the future, than in the present time (Diaz et al. 2006). In addition, higher humidity exacerbates risk as human physiology makes it more difficult to lose excess heat through evaporation (COJCC: 2011, 65). In geographical locations, such as the CoV, where future rainfall is predicated to increase, resulting in higher humidity, along with temperature increases as a result of climate change (Environment Canada 2002), heat related deaths could follow. According to a study by Smoyer-Tomic, et al. (2003) a temperature of 30 degrees C in Vancouver would be considered highly anomalous and could have an effect on human health. According to Quayle (2011), and Duncan (2011) preparing for extremes, even in cites which do not normally experience regular heat waves by incorporating interconnected greenspace which could also provides the added benefit of intensive agricultural production could protect from heat related mortality.

1.3.8. Vancouver Context

It is the elderly and the most vulnerable members of the population that experience the highest rate of heat related illness as well as mortality, as the European heat wave in 2003 which killed 30,0000 (Habitat Debate: 2007,7; Oke 2011) bears witness. The effects of UHIs are expected to be less extreme in the CoV and MVR by comparison to the occurrences in Europe and in other regions; however, the data found concerning climate uncertainty and temperature anomalies suggest they will occur. Integrating food and forestation planning, an ecological approach taken by the CoV, is shown to reduce climate effects as well as heat island effects and is a useful model, applicable in any global city or region.

1.3.9. Summary – The Urban Heat Island

It is necessary to reduce the negative climate impacts of carbon sequestion, reduce heat related mortality and the impacts of climate change as well as provide a reliable food source by improving urban green space by increasing vegetated surfaces which will go beyond providing rooftop greenery and ornamental tree planting (ISDR: 2009,109) to provide sustainable local food security for increasing urban populations. There is substantial evidence; studies and modeling that indicate that urban forestation will

reduce urban temperatures. There is a gap in recent literature which links the UHI and urban agriculture as a means to mitigate the effects of climate change, reduce urban temperatures, and provide the additional benefit of a sustainable urban food source. This chapter has attempted to define the role of CPUAF to formally suggest the amalgamation of these two green infrastructure systems in the global and regional climate debate. Furthermore, very little quantifiable research on the effect of urban agriculture as a forestation practice to mitigate the heat island effect in the canopy and boundary layers and further research is required.

1.4. Global Population growth and the rural to urban shift

1.4.1. The Challenge of both Global and Urban Population Growth

The global trend of increased migration of job seekers from rural communities to urban areas, as well as increased world population growth, particularly in developing countries, are the contributing factors which have produced phenomenal growth of urban centers to 50% of the global population in 2008. It is expected that by 2050, 70% of the world's population will live in urban areas, and in addition, new megacities with populations of over 10 million people and hyper cities of over 20 billion inhabitants are predicted (UN Habitat: 2009,8). By 2025, 83% of the world's population is expected to live in developing countries (UNCED 1992; Viljoen: 2008,20) and the overall world's population is expected to reach 9 billion by 2050 (IFPRI: 2010, 12) and 16 billion people by the end of the century (UN 2011). The expansion of global urban population growth is the equivalent of one new city the size of Lagos (7.9 million) appearing on the planet every two months (FAO: DRC: 2010, 2). Currently, one in three urban dwellers lives in slums or informal settlements in inequitable conditions. Inadequate and fragmented urban development and infrastructure planning create health risks associated with lack of water and sanitation (UN Habitat-WHO: 2011,24). According to Habitat and WHO (2011), climate change will multiply the intensity of these risks through heat waves, storms and changing weather patterns and threaten food security and human health. The UN Habitat 2009 Global Report on Human Settlement (2009,117), states, "Cities with lower levels of economic viability and disaster preparedness, including infrastructure planning are more at risk to climate uncertainties". However, the report recommends (2009, 109), "Tree planting as one of the three main steps to achieve carbon neutral cities."

Meanwhile, Agenda 21 (UNCED 1992) said, "major adjustments in policy at all levels in developed and developing countries are needed in agriculture, the environment and macro-economics to create conditions for sustainable agriculture." The production of food is fundamental to human life, underpinning all other activities (Viljoen: 2008,20). The question is, can urban forestation and urban agriculture as an integrated process address all major areas of policy adjustment recommended by the UNCED? The City of Vancouver believes so, and they are in the process of introducing policies and programs to integrate the two elements in their infrastructure planning to address the challenges noted above in the face of global population and urban growth.

The challenge for urban and social planners is to develop strategies and policies that minimize carbon, waste and water outputs (Yeung 2010), by developing more sustainable resilient cities, by reconnecting people to the earth beneath their feet and through interventions that create an understanding of the cyclical inter- relationships in nature, through food production, and in the built community environment through the implementation of visible restorative activities of food production and forestation. By taking what the World Bank (2009) refers to as "Forest mitigation activities," a role which they recommend for city planners, a step further through innovative agricultural forestation, cities can also provide food security, along with the benefit of carbon sinks to also reduce the UHI effect.

The effects of climate change will affect future generations and affect mostly those who can do little about it. The poor, the homeless, and the elderly who often create the smallest ecological footprint, will feel the greatest effects of climate change, health effects, and food insecurity particularly in developing countries (Climate Resilient Cities: WB: 2009,109; Guenther & Vittori 2009). City and urban planners must address these issues and "get serious about urban sustainability" and vulnerability (Rees 2011), recognizing that all cities and regions are participants in the larger global challenge that threaten what Rees defines as (2011b, p1) " the functional integrity and even the survival of cities." The implementation of policy and behavioral change that educates and prepares global urban citizens by providing an enabling environment to establish a means to feed themselves, is one of the greatest challenges facing cities today and requires immediate and unprecedented solutions.

1.4.2. The Rural and the Urban Shift

The world's populations have shifted from rural to urban living. As well, global trends indicate (Amcoff & Westholm 2006), the agricultural work force is aging in rural areas, decreasing productivity in the hinterlands, as the young relocate to cities in search of improved living conditions. The problems that have arisen as a result of increased urbanization include degraded global ecosystems, poverty, resulting in food insecurity and malnutrition (Viljoen 2009; Visser 2011) particularly in developing countries. The trends are occurring globally, and according to Alan Duncan, Environmental Planner with the Park Board at the CoV (2011), "concerns about food security, as a result of climate change as well as an urban preference for local and organic production has led to a significant attitudinal shift to growing food on public land". With growing urban populations, the implementation of productive and sustainable urban agriculture and urban forestation practices are at the forefront of community and urban infrastructure planning to reduce outputs in food production, as rural populations are no longer available to support urban masses.

1.4.3. Trends in urban food production and demographic shift

According to UNDP as far back as 1996, there were 800 million people engaged in urban agriculture globally with the majority in Asian cites and region (Viljoen: 2008, 35) and in Havana, 20,000 people grow fruit and vegetables on local neighborhood lots. Meanwhile Yeung (2006) states, "Urban agriculture is 15 times more productive than rural agriculture ".

In the City of Vancouver for example, there is an increased presence of urban agriculture. Once reserved for backyards, it is literally spilling out into the streets, onto vacant lots, front yards, city boulevards, school grounds, parks, and traffic circles and the process is highly supported by planners while policy has yet to catch up with the active, youthful and educated urban agro-ecologists. The process is highly influenced by Dr. Art Bomke, who led the agro-ecology program at UBC and who believes in the participatory process between farmers and the community. Bomke was instrumental in providing contacts and resources pertaining to public participation, as well as connections to local food initiatives, which enriched this thesis. Observations regarding

age and education demographics were verified in interviews with Chris Thoreau (2011), and Brent Mansfield (2011), co-chair of the Vancouver Food Policy Council, that the majority of individuals engaged in the process are under 35, university educated, mostly in the field of agro-ecology and many have no generational background in the process of farming. While, the rural farming population is aging, the urban farming population appears to be gaining momentum with the youth. Further research is necessary to fully analyze the trend, to compare global statistics and demographic trends.

1.4.4. Summary - Baseline of Sustainability - Vancouver Context

There is vague information on the current numbers of the percentage of urban population engaged in urban agriculture. According to the Food Secure Baseline Report (Ashmead and Zbeetnoff 2009), 22% of the provincial food supply is produced in the Metro area. Details are provided for selected outlying cities within the Metro area; however, there is very little information available on the urban food productivity within the CoV. There is a need for more accurate production information in order to establish a baseline for action. Marc Schutzbank, UBC MA, Food and Land Sciences, is preparing an urban farming census to measure economic, social and environmental outcomes of urban farming within the CoV and it is hoped he can shed light on the demographics as well as establish a baseline of existing production based on a quantifiable census. As well the outcome of his thesis is focused on determining the economic, social and environmental sustainability of current productions and practices. *marc.schutzbank@gmail.com.*

It is essential in all regions to gather a consensus on the amount of local urban agricultural production that is taking place within their area, as well as assess the sustainability of the processes, in order to assess risks and determine strategies for local action.

1.5. – Agriculture

The following literature review assesses monoculture agriculture, which includes, the massive use of petroleum and chemical based fertilizers and pesticides, introduced during the Green Revolution. High input, unsustainable agriculture, contributed to the loss of non-renewable global soil, resulting in rural to urban migration, subsuming further farmland surrounding sprawling urban areas and increasingly threatens global food security. Meeting the increased food demands of growing populations, while considering the effects of climate change and the impact of extreme weather events on global crop yield is discussed. The growing trend toward local organic and intensive urban agriculture is a positive feedback to the challenges of increased urban and global population increases, with different drivers between developed and developing countries. As well, the interrelationship of rural to urban agricultural history, the disconnection and reconnection is investigated. This is supported with methods that include a literature review of articles and publications, Interviews with municipal and global experts and field research from the City of Vancouver, Canada (CoV) and the City of Cape Town, South Africa (CoCT).

1.5.1. Biotechnology - Un-Sustainable Agricultural practices as a contributing factor to urban growth and poverty

A contributing factor to growing urban populations, particularly in developing countries can be attributed to the Green Revolution in Agriculture (Capra 2003; Benyus: 2002, 53; Abrams: 1993, 68-70). According to Capra (2003, 162), “all over the world, large numbers of people have left rural areas and joined the masses of urban unemployed as victims of the Green Revolution.” It is well documented that between, the 1940’s and the 70’s, the biotech industry, convinced developing nations, to synthetically control natural systems, to give up sustainable indigenous agricultural practices, which had supported cultures for centuries, in exchange for highly profitable, single yield foreign crops, utilizing hybridized seeds, in a process widely known as mono-culture, or mono crop farming (IFPRI, 2010; Wheeler: 2004, 29; Benyus: 2002, pp.50-58; Abrams: 1993, 68). The brainchild of the petroleum and chemical industry the homogenized crops promote and require a high input, of chemicals and pesticide, to maintain high yields, as the process lacks natural resistance to pest infection and disease (Benyus: 2002, 50;

Abrams: 1993, pp.68 & 74; Capra: 2003, 162). Entire nations converted from native derived healthy diets, which promised to be the answer to global poverty. The extensive use of fertilizers and pesticides, in concert with mechanization, energy intensive large corporate farms emerged, forcing single family farming out of business, and resulted in mass migration into urban areas, contributing to a shift in urbanization and poverty on a global scale (Capra: 2003, 162; Benyus: 2002, 53). Mass urbanization, places extreme pressure on already over taxed urban infrastructure, waste, water and food systems and requires a "Sustainable Revolution" in order to feed growing urban populations.

1.5.2. Causes of Soil Loss on a global scale – a case for continuously productive urban agriculture and forestation

Prior to 1950 the earth lost 50% of all of its productive, nonrenewable topsoil and since, we have lost an additional 30%, with the trends consistent in developed and developing countries (Mollison1990). In Canada, we have lost half of our nutrient rich prairie soil to agricultural exports and mechanized farming (Rees & Wackernagel 1996). Furthermore, Abrams quotes William Brune, in his testimony before the US Senate Committee (1998 84), " the US had lost more an 75% of its origin topsoil to erosion caused by unsound farming practices." Soil is produced by the interaction of rainfall and the de-composition and actions of plants (Mollison 1990) and in order to sustain soil and maintain nutrients, land must be rested and planted with cover crops (Bomke 2011; Abram: 1998 84;Dory 2011). Deforestation and the over productivity of land, the action of the tilling of soil to produce mono-crop grains, results in a global loss of 12 tons of soil per person per year as leaving fields fallow results in wind erosion and further soil loss. In addition, urban sprawl as a result of uncontrolled development further threatens this finite resource.

1.5.3. ALR Loss – Protecting a Finite Resource: Urban Growth Beyond the Urban Edge

While soil loss is threatening global crop yields, the sprawl of cities further threatens food security by subsuming agricultural land (Yeung: 2006,171). Mollison (2009) and Yeung (2006, 282), both write that cities are located on 11% of the earth's most productive

agricultural lands. Protecting rural, agricultural and resource land by firmly restricting development outside of the urban edge or growth boundaries is a desired outcome of sustainable urban food system planning (Beatly & Manning: 1997, 47). Yet, it is a challenge even in countries where municipal, regional and provincial legislation limits development and where legislation is defined and enforceable. For example, in South Africa, according to Visser (2011), "priority for development is often given to mining operations", while in the US, the Department of Agriculture estimates that two million acres of open space continues to be subsumed every year by urban growth (NRCS 1997), despite legislature zoning and land use regulations.

1.5.4. Vancouver and Regional Context

In the BC context, prior to the creation of the Provincial Agricultural Land Reserve (ALR) in 1973, it is estimated that 6000 hectares (15,000 acres) of prime and irreplaceable agricultural land was lost to urban development yearly (Quayle 1998). However, much of the ALR land continues to be lost to Industrial expansion. Despite protection, 178,5 hectares of prime agricultural land was released by the Agricultural Land Commission, (ALC), in the municipality of Abbotsford in order to meet the municipalities "20 year projected need for additional industrial land" (Forever Farmland: 2006, 25). The implications are far reaching, considering the looming global issue of food security, the interrelationship of climate change and the CUHI and the hypothesis that industrial sprawl areas are more susceptible to heat build-up (Oke 2011).

This is an example of loss, occurring within a system of governance, which supports agricultural land protection. Loss of agricultural land globally in areas without effective protection will only multiply the threat of global food security. Couple the cost to the ecosystem by importing food from distant shores, with the finite limit of available agricultural land, it is then necessary to reassess the spatial typography of cities by developing multilinked strategies and policies that link urban food security with urban forestation. According to the IFPRA (2010, 78), "Climate change acts as a threat multiplier, making the challenges of sustainable food security much more difficult". While there are regional variables in the rational for needing to address food security, a whole systems approach addressing the major components, such as climate change, population growth and global crop failure are the main drivers.

1.5.5. Food Security – What is it and why is it so urgent to integrate in urban planning strategies?

One of the more widely accepted definitions of food security was developed at the United Nations World Food Summit in 1996 and states:

"Food security exists when all people, at all times, have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy lifestyle. "

Cities in developing countries according to Lehman (2011) "cannot have the same strategies or debates as those in developed countries". The pattern and form of urban slums and informal unregulated and overcrowded settlements are generally devoid of urban green space and agriculture, and are a result of rapid urbanization and population grown, characteristic of developing countries, where 95% of global urban growth is occurring (DBSA: 2009,7). Cultural, political and social variables have resulted in diverse outcomes in developing countries, and therefore, the implementation of connected green space and continual urban agricultural forestation and local food production requires context specific strategies and approaches (CoCT 2007; DBSA 2009; Viljoen: 2005,35). According to Visser (2011), "food security drivers in developing countries focus on household food insecurity, nutrition, poverty alleviation, income creation, as well economic sustainability and skills development" (CoCT 2007, Viljoen: 2008, 35). Meanwhile, in 2003 the COV Council took steps (O'Neil 2011) to develop a sustainable food system that fostered equitable food access, nutrition, community development and environmental health, resulting in the formation of the Food Policy Council, and advisory board of multiple stakeholders. The process outlined in the GCAP: 2020 (2011) evolved to address emissions and systematically places food systems in a larger nested system (Figure 1.14). While the process of developing food system security may be context specific, in any environment it requires (Visser 2011) "creating an enabling environment, utilizing a systems approach, with multi stakeholder planning integrally embedded and integrated in the philosophical practice (UAP: CoCT: 2007, 3)". Visser defines the basic processes for how a food system should function in any urban management environment, while the variables of why we must be more sustainably food secure vary from region to region. The larger rationale for requiring a sustainable food and forestation system is defined throughout this literature review. For example, the B.C.

Baseline Report (FSBV: 2009, 5) states, "food security is achieved when the structure and capacity of the food system, in its entirety can meet the food related human, cultural economic, social and environmental needs of individuals and the community." In the CoV and MVR context, food security is defined as achievable through the satisfaction of five key areas including adequacy. Adequacy is meant to include nutritional quality, safety and suitability of food sources and methods of food supply (FSBV: 2009, 5), which arguably, must go beyond the realm of the local community and consider the impact on the larger social, economic and ecological systems within the global community.

1.5.6. Safe and Healthy Local Foods

Healthy food is by no means just nutritious food. The handling of food, including the inputs such as pesticides, should be safe for not only the end users, but for all humans, for species, and for the ecosystem, which includes the soil, the water and the air that come in contact with food, through the inputs and outputs of agricultural production. Unfortunately, this is not always the case.

Figure 1.9 the most affected globally – Ugandan boy carrying beans in the foothills of the Bwindi Forest. Photo © V. Durant.

According to the UNEP, at least 40,000 people are killed each year and up to one million people become ill or permanently damaged through the misuse of pesticides, mainly in developing countries (Viljoen: 2008, 45). Further, 11 million cases of pesticide poisoning occur annually in Africa alone, which may increase the risk of chronic health as the less-costly, obsolete and older pesticides, find their way to the developing world (Goldman & Tran 2002). In the US, agriculture is identified "as the number one polluting industry in the country", due to leaching pesticides Benyus (1997, 19). To make matters worse, pesticides and fertilizers, the high energy inputs required in large scale mono-crop farming, are petroleum based, contributing, 20% to US CO2 emissions while globally

agricultural land use contributes 12% annually to global GHG emissions (LaSalle, et al. 2008; ICPP 2007). It is estimated that society spends 10-kilo carbons of hydrocarbon to produce 1 kilocalorie of food (Benyus 1997, 19); In other words "each of us is eating thirteen barrels of oil a year." It is no wonder there is a growing global interest in organic, safe and locally grown food.

1.5.7. Organic Production and Trends

Global trends indicate an increase in consumer demand for organic foods according to the International Federation of Organic Agriculture Movements (IFOAM 2000), estimating a global production growth rate of between 20 and 30 percent annually. The report indicates that the global demand, mainly in Europe and North America has increased by 43% between 2002 and 2005, resulting in a global undersupply of organic food produce. While there is a gap in the demand for local organics, the process is widely practiced in the CoV where local urban farms use organic methods to produce horticulture products (Dory 2011; Evans 2011;Thoreau 2011), which can reduce Co2 emissions and provide a healthier, safe food source.

1.5.7. A Return to City Farming

While edible landscaping was an integrated component of city design and culture dating back to the Hanging Gardens of Babylon, it was in the Renaissance that food production became associated with peasantry and gardening, as a recreational and individual pastime, associated with the upper classes (Strutynski: 2005, 4). Food production was removed out of sight and mind from urban dwellers.

1.5.8. Summary

There is a global resurgence and interest in local food production, for the reasons outlined in this chapter. It is increasingly evident, and supported in the CoV, detailed in the case study. Alan Slater, Environmental Planner with the Park Board COV, (2011) confirms there is "a significant attitudinal shift, toward growing food locally, on public land, between 2009 and 2011, due to an increased preference for local and organic production", which he attributes to "growing concerns about climate change and food

security and health". Knowing where food comes from and how it is grown, by producing local, organically grown foods and by relying less on pesticide laden, mono cropped foods from distant shores is a way of providing a safe, reliable source of food. According to the experts interviewed, protecting global and local populations from a contaminated food supply will reduce GHG emissions and contribute to the reduction of the UHI effect. How the CoV Park Board and Social Planning, responds to urban food security and production and the integration in the urban forestry planning is detailed in the CoV Case Study, **Section 3** and in project examples in **Section 4.**

1.6 Defining Sustainability – The Overarching Principal

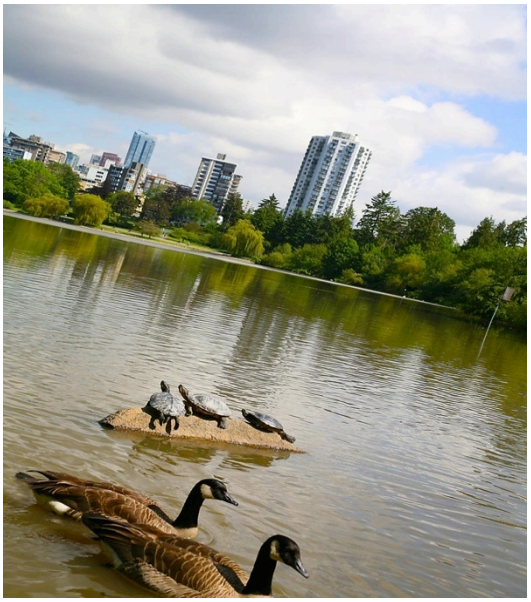

Figure 1.10 Integrated greenway and the density of the West End in the CoV.
Photo © Durant 2009

"An object seen in isolation from the whole is not the real thing".

- Masanobu Fukuoka, Japanese farmer who developed a revolutionary method of sustainable agriculture, from The One Straw Revolution: An Introduction to Natural Farming, 1986. New York. New York Review Books.

"A good solution solves more than one problem and it doesn't make new problems. I am talking about health as opposed to almost any cure, coherence of pattern as opposed to almost any solution produced piecemeal or in isolation ".

- Wendell Berry, from "Solving the Pattern," in The Gift of Good Land, p 141, North Point Press 1981 (From Reed, 2009)

What is sustainability?

This section attempts to define the term "sustainability", and provide a historical context. As well, it attempts to contribute to the answer as to why it is necessary for cities to contribute to their own food source by integrating food systems with other ecological services, such as continuous urban forestation, in the age of "accelerated global degradation" (Rees 2010) and climate uncertainly.

Jonathan Porritt, former director of Friends of the Earth and Chairperson of the UK Sustainable Development Commission offered this widely accepted and straightforward definition, "If something is sustainable, it means we can go on doing it indefinitely. If it isn't we can't," from Reed (2009).

Sustainability is the synchronistic, collective movement of numerous activities as though they were one entity. It is a practice of sustaining life that emulates natural critical systems such as the schooling of fish or the flocking of birds. It is about the common linking thread that weaves human activity into the fabric of the ecological system. Human activity includes agriculture, movement or transportation, building and manufacturing as well as engaging in cultural activates. Doing so principally, with simplicity and grace, is the greatest change facing society today. V. Durant

1.6.1. The Historical Context

In the 1970's, the concept of "Sustainability" began to emerge as awareness that modern developmental practices were leading to global environmental and social crisis (Wheeler: 2004,20). The term "sustainable development" appeared in 1972 when Donella Meadows, along with a team of research scientists, co-authored, *Limits to Growth,* using MIT models based on trends in global population growth as well as resource consumption (Wheeler. 2004). They concluded, using numerous models, that human systems were heading for collapse by the mid-twenty first century and that there were limits to growth due to human population and resources limitations (Wheeler 2004; Meadows 1974).

1.6.2. Contradictions in Definition

Sustainability entered the global mainstream in 1987 as a result of Gro Brundtland's Report, *Our Common Future*, presented to the UNEP in Nairobi (Wheeler 2004; WCED 1998). In her report on human ecological sustainability she stated, in summary, "Sustainable development is as a path to progress, essential for poverty alleviation, necessary to balance international economic inequalities" (WCED). She continued that "Growth was absolutely necessary to overcome mass poverty", and that "Development does not imply absolute limits to growth itself"; however, recognizing that, "We are approaching critical thresholds in many areas" and therefore, "The present pattern of development cannot continue and must be changed (WCED; 1998 10)". *Our Common Future* led to the Rio Conference, the second Earth Summit in 1992 and, through the sustainability treaty outcome in the Agenda 21, Rio led to the Kyoto authorization process (Ruth: 2006, 75).

Brundtland' s report led to the formation of a number of diplomatic treaties including Principle Three of the Rio Declaration (Robinson 1993) and her definition of sustainable development as "paths of progress that meet the needs and aspirations of the present generation without compromising the ability of future generations to meet their own needs," offered a moral (Capra 2000) and ethical (Ruth: 2009, 74) starting point to grasp "why we need to be sustainable" and why we need a sustainable food system; to take only what we need and leave the rest for our children, our grandchildren and the socially

disadvantaged and to balance economic and social inequalities between developed and developing nations. However, the definition is vague as to what we "need" (Wheeler; 2004,23), and it does not define the process of how we are to implement sustainability in practice. According to Capra (2000), "This has led to confusion about the meaning of sustainability even within the environmental movement." Furthermore, the statement that "development does not imply absolute limits to growth (WCED 1998)", is contradictory, resulting in the blurring of concepts (Reed 2009). However, the statements were accepted at the time as "authority" beyond what was considered by many as "the alarmist report", *Limits to Growth* (Wheeler 2004). Finally, Brundtland's approach has been viewed as too accommodating to developing nations and does not address the issue of continuous un-controlled economic growth (Wheeler: 2004, 23) in a finite ecosystem. To not imply that there are absolute limits to growth is the polar opposite to the accuracy of "the limits to growth", revisited by Meadows twenty years after 1974, and found it's predictions accurate. Meadows team found that human populations to be in a position of overshoot (Wheeler 2004, 22). Supported further by Rees (2011) who stated, "Sustainability through growth is a modern myth, constructed to delude humanity in the face of contrary evidence." Finally contributing evidence by the MEA in 2005 confirms, and is repeated from the last section, that ecosystems can no longer be taken for granted if we are to sustain future generations.

The Brundtland report (WCED 1987) identified close inter-linkages between poverty, rapid urbanization, environmental degradation caused by large-scale agricultural production, resource depletion and a common concern for humanity and planetary survival. Although at times vague, she expressed concerns that developmental impacts on the environment required improved management of the global ecosystems. Finally, it is recognized that Brundtland provided a "moral compass" (Ruth 2009), that led to the positive implementation of sustainable global policies that at the time, moved sustainability toward the forefront of human consciousness, leaving room for further analysis, definition and critique and debate.

1.6.3. Systems Planning: Economics moves toward Recognition of the Ecological System

It was Herman Daly who provided the more precise definition in terms of matter, or goods and services and energy flows, and in and out of the construct of the "steady state" (Wheeler: 2004, 22) economic system in relation to the ecological system:

Output Rules:

Waste emissions should be within the assimilative capacity of the environment to absorb without degradation of future waste absorptive capacity of other important services.

Input Rules:

1. Renewable harvest rates of renewable resources should be within the regenerative capacity of the ecosystem

2. Non – Renewable: depletion rates should be equal to the rate at which renewable substitutes can be developed and deployed. (Ruth: 2006, 76) from (Daly in Photiades: 1998 and in course lectures, 1997).

Daly provided a quantifiable description and measures for the input output and through puts of material flows which, was accepted by the IPCC (Ruth: 2006,76) and reflected in the Kyoto Protocol as a quantifiable process.

The figure below, (1.11) shows a visual representation of the transition from an Economic to an Ecological World View of sustainability as defined by Daly in 1992 and supported academically by Rees (2002) and Wheeler (2004, 31). It is an ecological model with society and its constructed human-made economic system, which includes, the City, and all its functions, the built environment and the urban food system, nested within the larger global ecosystem.

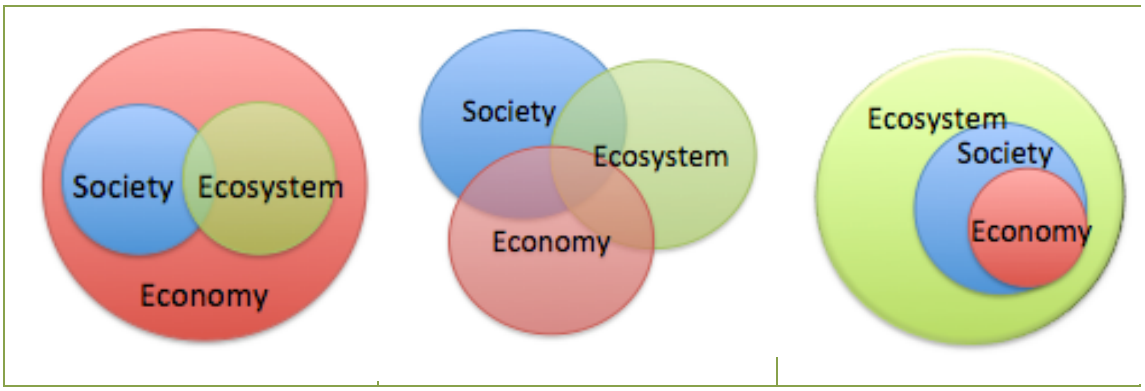

Figure 1.11. The transition from an economic to an ecological worldview of sustainability. The economy and society are nested within the larger global ecosystem. Illustration by V.Durant as defined by (Daly 1992) (Wheeler: 31 2004)(Rees 2002).

1.6.4 The Link between Economics and the Ecological Systems –

Comprehensive, urban agriculture and forestation planning and policy will utilize systems modeling analysis, first developed by a team of analysts at MIT, to include a comprehensive technological quantifiable tool that first linked the world economy with the environment and identify that collapse could be avoided through early interventions in the area of behavior, policy and technology (Turner; 2008, 2). The Ltg Model, while others have evolved since, is the first to identify that there are limits to sustainable growth, and that oscillations in feedback loops, such as resource overuse, can cause instability in systems and that not all signals of instability in a system, or lifecycle can be easily identified in the present. Scenario analysis (Turner; 2008, 25) examines the complex interactions of nested systems, identifying eight subsystems of the global economic system. The sub systems include:

1. Population: 2.Birth: 3. Death rates: 4. Services per capita (Health and Education effect birth & death rate): 5.Food production & consumption per capita: 6. Industrial production – water, food scarcity and security, waste flows: 7. Consumption of natural resources – peak oil, resource depletion: 8. Pollution – consequences of ecosystem conditions on human health and wellbeing.

Applying the principles of limits to growth and encompassing the understanding of the interconnectivity of multiple nested systems is the foundation of a good food system, strategic planning strategy. A strategic baseline for continuity, linking past present and future, understanding how a trend extends forward and interacts with other trends, the

constraints, feedbacks and oscillations involved, are the necessary elements of a resilient integrated food system and forestation strategy. In Section 1.6.10 of this literature review, ten interconnected systems are identified and include Access to Nature (Forestation), Local Food Systems, Buildings, Climate Leadership and the Ecological Footprint (See figure 1.13) as a component of the rational for, why we need to be sustainable. The ten subsystems are nested in a larger system, which identifies climate, waste and the ecosystem as the overarching systems (Figure1.14), which is further realized in the Case Study of the CoV, **Section 3.**

Urbanization is the convergence of all human activity including social, political and economic dynamism. The transformation of consumption and production patterns into compact visible functions is a projected outcome of CPUAF. Making the abstract visible (Pliny, from Guenther & Vittori 2008), by showing the threads of connectivity in the urban planning food, forestation, and waste streams and the local and global economic systems associated with food production and consumption context, is the cornerstone to this theory. While local conditions and means of application are unique and the approach must be site specific. However, the larger global feedback loops of climate, waste and ecosystems, are inexplicitly linked to the eight economic systems identified by Turner as well as the ten local systems identified in the CoV approach. Therefore, a systems approach using this model can be applied to any city region.

1.6.5. Leveraging System: Making the Abstract Visible:

All eight subsystems identified by Turner (2008) are inexplicitly interwoven and interconnected in the global food system. As well as the regional, city interrelationships, the fine grain of community interaction is nested or linked to larger global systems. Global economic patterns of consumption and production of food must be transformed in order to maintain what Rees (2011) describes as a "steady state economy, "[8] where by food sources are localized to protect from geo-political and global climate insecurity and the impact on food security.

[8] http://www.scarp.ubc.ca/newsbytes/2011/feb/07/reflection-prof-william-rees from www.oneearthweb.org/ (accessed March 11.2011)

We can no longer expect that we will get food from somewhere else (Yeung: 2006,280) such as a rural place off in the hinterlands with no understanding of how or where it is grown, how it arrives and how much energy it takes to transport it.

On the most intricate of community and city scales, making visible the energy flows in the physical and phenomenological sensorial field of human experience is according to Pliny, from Guenther & Vittori (2008 14), "recognized to trigger brain functions that may better connect us to these significant environmental sequences (2008,14)". Making visible and present, the life cycles and energy flows of plants and vegetation, water capture and waste removal, and even economic flows, through, "nodes of material intersection" are effective ways in which to intervene in a system (Meadows: 1998,2). Local farmers markets and small scale urban food manufacturing community and communal gardens, boulevard planting, and productive urban farms made visible in the everyday life of humans, in their movement through the continuously productive urban landscape of food and forest, removes the abstraction, and unearth the hidden connections, "leverages behavior change" (Meadows:1998,3) to create positive feedback loops in the greater nested systems.

1.6.6. Current Model of Economic Growth equals growing Social Inequity and Shrinking Ecosystems

Despite the expansion of the global economy "three fold" (Rees 2002) since "Our Common Future" we have seen, during the same period, carbon dioxide increase by 30% (Rees 2002), while so called "sustainable development" has consumed half of the world's wetlands. In the meantime, chronic poverty is increasing and the income gap between the OECD countries and the South is growing. Statistics indicate that from 1800 to the present day, the poverty gap has widened from 3:1 to 25:1 globally (Orr: 1995), while ecosystem services are diminished. In an interview with Rees (2011), he provided an article (Rees 2002) in which he is quoted:

"The (growing economic)[9] expansionist myth is not only wrecking the environment, but is also deepening the misery of millions of impoverished people. Moreover, these trends are increasingly connected. It is the worlds poor-those most directly dependent on local ecosystems for their livelihoods-who suffer the most when ecosystems are degraded or collapse (WRI/UNDP 2000 as cited by Rees 2002: 9)."

The poor are disproportionately affected by climate change in both developed and developing regions, for a number of reasons, that include a lack of infrastructure (UNHSP: 2011,78). Climate change, human and ecosystem health, food security and the economy are inexplicitly linked and an ecological approach to economic and social systems is necessary to prevent further effects.

The polarity or Cartesian split, of humanity from nature is the rift or gaping hole in our psychic development that must be "replanted" literally, as an adaptive, complex systems process of planning ecologically and socially more sustainable cities. The process of the pursuit of sustainable development, with the economy embedded in an environmental system, must be further embedded in a highly democratized participatory planning process. Further, supported by Orr (1992,2, also quoted in Quayle: 1995, 46), a proponent of ecological literacy, he said, "Sustainability, citizenry and real democracy are linked." The concept of participatory planning is defined in **Section 2** of the Literature Review and demonstrated in the Vancouver Case Study **(Section 3)**, while the concept of ecological literacy as a component of the ecological model follows.

1.6.7. The Transition to the Ecological Model of Sustainability as the Core Value in Planning

The concept of sustainability, can be seen as the "core values and goals" that supports ethical action in an interdependent world (Wheeler: 2004, 31), and has emerged as "the starting point for action that underpins urban planning," Orr (1992,25-27, from Quayle: 1995,463) emphasizes that nature is the model for designing places and economies and for societal systems, which influences our decisions about scale and centralization. Wheeler has refined a simple process oriented definition of sustainability, emphasizing long term welfare that supports social equity with the economy embedded in the system,

[9] The words "growing economic" are inserted within the quote as Rees states earlier in the article, "The Expansionist myth is closely associated with neoliberal economics", under the heading, Dissecting Expansionism. This concept of the economic process views the economy as self-sustaining and not constrained by the environment (Rees 2002)

"Sustainable development is development that improves the long-term health of human and ecological systems" (Wheeler: 2004, 31). His definition avoids debate over "needs" while emphasizing the transformative process of continually moving towards healthy human and natural communities. Wheeler describes a transition from an economic to an environmental perspective that sees economic values as only a subset of broader social and ecological values (Wheeler: 2004, 31). The purpose is not to be "less bad" according to Reed (2009) by simply being more efficient, but to actually restore a systems capacity for it to continuously self organize and evolve and to regenerate, giving new life to it. It is recognized that sustainability is the core value of planning (Wheeler 2004) and planning in which a secure and stable urban food system, and a local food economy is embedded in that system (GCAP: 2011, 5).

UNEP Defines Green -
To define the term 'green', this study borrows from the United Nations Environment Program (UNEP) definition which has a focus on those activities that restore or preserve environmental quality, reduce energy, materials and water consumption, de-carbonize the economy, and minimize or altogether avoid the generation of all forms of waste and pollution. As growing the local food economy is central to Greenest City 2020 vision to create a sustainable economy, the UNEP definition is supplemented by the inclusion of local food. The definition is further expanded to allow for non-union and part-time workers. Voluntary work is currently excluded from the definition of 'job' for the purposes of this Action Plan.

Figure: 1.12. Illustration by: Langemach, MCT from: http://www.vancouversun.com/opinion/oped/rosperity+without+growth+possible/5422347/story.html
Prosperity without growth

1.6.8. How do cities in all their complexity, approach the interrelatedness of sustainability issues?

With the rapid transitioning and transformations of social cultural, economic and institutional structures of cities, new global issues have emerged. While the expanse of cities extend well beyond their physical spatial form, not only "as massive consumptive entities of ecological land and water" (Rees 2011), as defined in the Ecological Footprint (EF) (Wackernagel & Rees 1997) and as technology and manufacturing hubs. More recently, they have been perceived, according to Ruth (2009, 156), as "problem solving nuclei" as engines, for regional development, innovation and as knowledge. Orr (1992,2) defines the core principle of ecological sustainability as, "the paradigm, based on the concept of interrelatedness as a system of knowledge, with education of its citizenry as the salvation, as the underpinning of the ecological systems". Engaged, educated and informed citizenry with an understanding of interrelatedness of sustainability issues is the understory for the success of the conceptualization of the CoV's Greenest City Action Plan: 2020. How the CoV has developed a strategic, administrative, ecological Action Plan, addressing multiple sustainability issues, is presented in the case study, **Section 3.**

1.6.9. Transform economic and institutional structures that shape society

Social enterprise has a vital role in this new ecologically sustainable economy, as the days of "unrestrained profiteering" (Sun 2011)[10]and economic growth at the expense of a finite ecological system will come to an end, one way or another. Most hopefully, change will occur in a positive manner and not following the same pattern of collapse defined by Rees (2001), Diamond (2005) and Tainter (1998), discussed in **Section 1.1.3**. The service of community is a new vision for economic growth which involves Social Enterprise, Corporate Social Responsibility, as well as a model proposed by Kira Gering, planner at the CoV (2011) which goes beyond the Charitable Model, whereby, organizations share profit and risk with social enterprises and individuals as partners in economic development. An example of this model is developing rapidly in the CoV and is defined in the urban farming community as Community Supported Agriculture (CSA). New social enterprises are using the power of business to solve social and ecological problems while thriving financially as an outcome as demonstrated in the Fairmont Hotel and SOLE food examples, in **Section 4**.

[10] To Read More:
http://www.vancouversun.com/business/Prosperity+without+growth+possible/5422347/story.html#ixzz1Yf9Uziti

1. 7. Conclusion - Urban Agriculture and Forestation

Cities and regions must move from food consumption to food production to reduce their ecological footprint and reduce global GHG emissions. Countries, regions and cities need to consider the restructuring of food policy and agricultural production and shift toward creative optimization of urban and peri-urban land to conserve finite natural resources and protect ecosystem services which include water, soil and forests. Not only has urban population growth placed large demands on cities, urban sprawl has subsumed large amounts of productive global agricultural lands (Wheeler: 2004,4). Urban agriculture is the catalyst to integrate water management, provide food security and urban resilience in the age of climate uncertainty. Continuously productive urban agricultural forestation (CPUAF) is a restorative regenerative living systems approach to mitigate climate change, by reducing CO2 emissions, by reduced transportation and production costs and by reducing the UHI effect which is linked to climate change. Locally based food production is an increasingly necessary integral and integrated component of urban food and forest management in reducing the ecological footprint of cities and regions, and are of particular benefit in industrial areas. The optimization of vertical and horizontal space in the built and urban environment as potential agricultural land, including rooftops, boulevards, connected greenway and buildings is essential in the 21^{st,} century, as cities must learn to feed themselves and engage in cyclical reciprocal interconnectivity with their own food source as global trends in urbanization and unsustainable rural agriculture practices and increasing global population stresses the carrying capacity of the planet to sustain human and species populations. Further, the approach to urban agricultural forestation must be continuously productive, diverse, self-renewing and multifunctional; circulating matter and energy through localized geographical region or biospheres.

Social equity, economic viability and the balance of ecological systems do not need to be in contradiction with each other. A shift from an economic lead value system to a one planet, living systems approach in a steady state, can intervene in the current trend toward ecological degradation caused by unsustainable practices. Shifting to a value system that nurtures life's ecological sources, including water, soil, forest and food, and where economic values become "an embedded subset" nested within the social and the

larger ecological systems is the starting point for sustainable urban planning (Wheeler 2004). **Section 4** of this report provides an analysis of the implementation of the process at a City and Regional level in the City of Vancouver, recognizing that all of humanity are participants in the larger global challenge and that actions that are taken locally are felt globally; therefore, conversely, restorative and regenerative reversals can be taken locally to effect larger systems. Cities must develop adaptive systems and mitigating strategies that integrate urban food systems in larger nested subsystems, utilizing an ecological model of sustainability. The objective is to transition and transform City/regions at a municipal and regional level to create resilience to address the global challenge of urban population growth, climate change and degraded agricultural land, forest and water.

The tools needed to address these challenges draw from a toolbox of various processes, theories, and strategies outlined in **Section 2**. A case study, **Section 3** of the City of Vancouver, demonstrates the tools and processes and is further demonstrated with local project examples in **Section 4.** Conclusions and Recommendations are described in **Section 5.**

Sustainable Agriculture & Forestation: The Edible Connected City

Section 2

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The Tools and Processes used to create climate resilient sustainable local food and forest systems in Cities and Regions.

Literature Review Section 2

Introduction

The tools and processes used by planners to integrate a climate resilient sustainable food and forest system in city and regional planning are reviewed in this section. Methods include a survey of current literature and documentation, and data collection from a series of unstructured interviews.

The Tools and processes include: 1. Ecological footprint analysis: 2. Climate modeling: 3. Complex adaptive systems planning: 4. Public participation: 5. Social change: 6. Place making (shifting spatial typographies in harmony with nature): 7. Density: 8. Stewardship: 9. Municipal and provincial interaction and collaboration: 10. Economic model includes Social Enterprise (SE) Corporate Social Responsibility (CSR) and Community Supported Agriculture (CSA), green roofs and vertical farming, and continuously productive urban agriculture and forestation (CPUAF), which integrates all of the above mentioned tools with agro-ecology and forest gardening.

2.1. The Ecological Footprint

The Ecological Footprint (EF) is an indicator of "biophysical limits " central to ecological economics (Costanza 2000). EF analysis is defined by the developers Rees and Wackernagel (1998), as an accounting tool that enables us to estimate the resource consumption and waste assimilation requirement of a defined human population or economy in terms of a corresponding productive land and water ecosystem, wherever on earth that land and water may be located (Rees 2000, from Costanza 2000; Rees & Wackernagel 1998, 9; GCAP: 2011, 105). Waste assimilation included the absorption of Co2 emissions (carbon sink) generated using prevailing technologies and resource management practices (global footprint network 2011).

The biological carrying capacity of productive land and water available on the planet for use by each person, in 2005 was 13.4 billion hectares. At that time, there were 6.5 billion people on the planet, providing 2.1 global hectares per person, not including land required by other species. Currently, increased population and degradation of ecological systems has reduced the amount of biophysical space per person to 1.8 hectares per person (GCAP 2011). Increased global population coupled with further degeneration of ecosystems will result in a reduced regenerative capacity further exceeding the biophysical supply, and increasing the EF per person on the planet (global footprint network 2011).

In an interview with Rees (2011) he states "Cities are economic entities; the centers for governance and places for social, cultural and environmental diversity. What is forgotten in the structural component of the cities that they are living breathing biophysical entities, consisting of literally 10's of millions of human bodies, all of which need to be fed, sheltered and clothed. That accounts for the biological metabolism, the aggregate of all of the human metabolic requirements." In other words, cities are living metabolic systems, with throughputs, inputs and outputs that far exceed their physical geographical boundaries.

"The urban core, is a dead entity, unable to sustain itself without the productive component that reaches far beyond it's physical boundaries. From all of this, we must consider and weigh the true costs", which Rees (2011) continues are "Invisible to monetary analyses of material goods consumed by the inhabitants of cities on the ecosystem". Cities are consuming entities; far exceeding their material outputs, of which, Rees refers to as "The Ecological Footprint of a city". Goods supplied to the world's consumptive urban entities must travel long distances, damaging human health, agricultural land and the climate, while consuming forests, air, and water in order to feed and cloth urban dwellers. Meanwhile, the effects go unnoticed by the human inhabitants within the physical boundaries of the city. While cities can never be sustainable, (Rees & Wackernagel, 1998), Rees (2011) said, "They can become more nearly self sufficient in food." By producing closer to home using sustainable production methods, including CPUAF, the experts interviewed, indicate less throughputs and less human demand on the ecosystem will contribute to the restorative and regenerative capacity of nature.

While, there is debate as to whether the EF is a useful guideline for broad use by policymakers to achieve sustainability, Costanza analyses the pros and cons and then argues that the EF tool is a useful provisional indicator of sustainability on a global scale (Costanza 2000, from Costanza 1999). It not only measures the sustainability gap but it also provides what Rees & Wackernagel (1998) describe as "insight into strategies for sustainable urban development." While the EF is not a dynamic modeling tool, which has predictive capacity, it does provide a snapshot of current ecological demands, based on prevalent technologies and social norms (Rees & Wackernagel 1998). The EF, should not be confused with The Carbon Footprint calculator, a tool used in the climate debate to measure tonnes of carbon produced as an economic measure and is not a bio-productive measure of land or water area (global footprint network, 2011).

According to the Global Footprint Network, over 100 cities and regions around the world have utilized the EF to inform policy, develop goals, strategies, to measure performance and to address sustainability issues < www.**footprint**network.org/ > (Accessed 2011.11.23). As well, entire countries including Japan, Germany, France and the UK have conducted national reviews of their EF. The City of

Vancouver incorporates the EF as a target area and details about how the process is utilized in relation to food and forestation defined in **Section 3.**

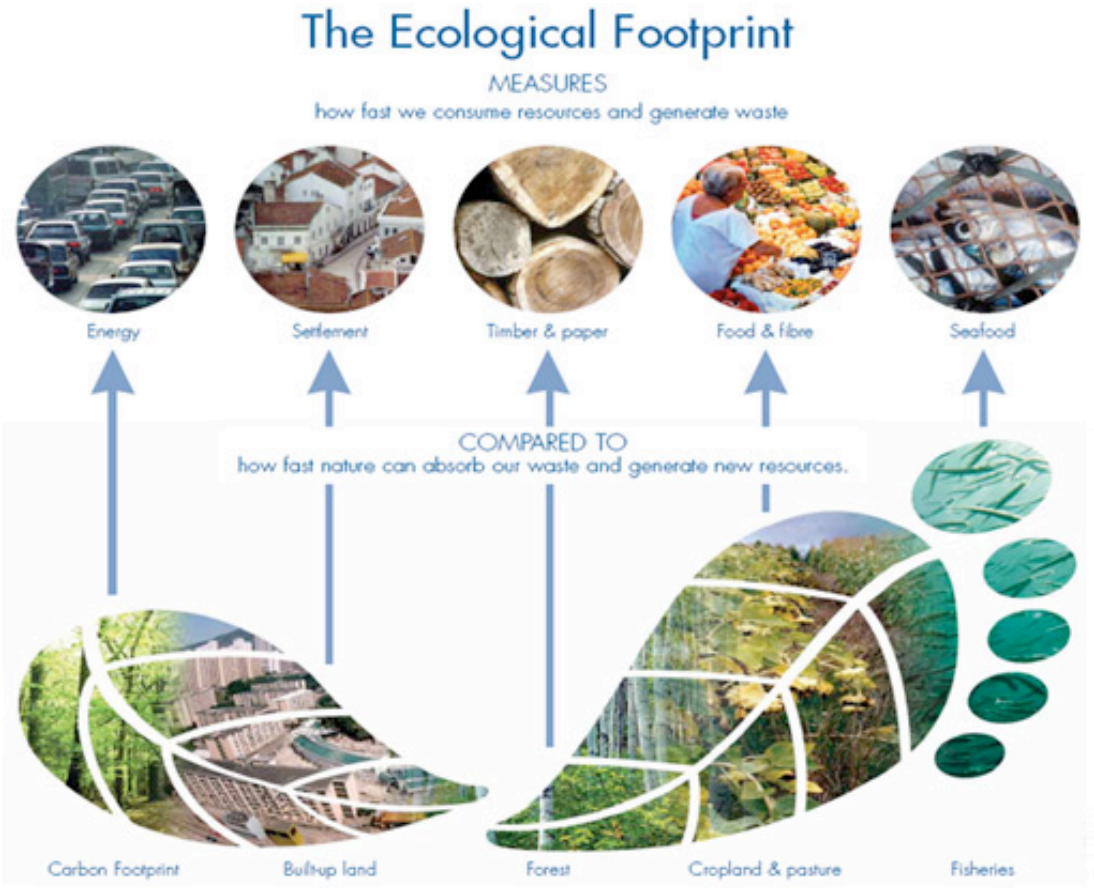

Figure 2.1 Source Global Footprint Network 2011. < www.footprintnetwork.org/ > Components of the Ecological Footprint

2.2. Climate Modeling: How are food systems and climate models integrated regionally and municipally?

Initially, it is essential for cities and regions to produce local and long term climate change forecasting plans using climate modeling, which provide the way forward to produce local strategic action plans. In Canada, Environment Canada, a Federal Department, produced the original analysis for the Greater Vancouver Regional District, now the Metro Vancouver Region, (MVR) in which the CoV is located

(Environment Canada 2000). Canada was one of the first countries to explore climate change impacts at a regional scale, in the McKenzie Basin Study of 1997, which, along with country wide regional studies, broke new ground in engaging local stakeholders in impact and risk planning related responses and discussions (Ruth: 2006,117, from Cohen1997; Environment Canada 1997). Community involvement and collection of information and perspectives are continuous aspects of the process. Many global city regions conduct climate assessments to ascertain risks and prepare mitigation and adaptation strategies, based on national and regional studies that address local effects.

2.3. Complex, Adaptive Systems Planning & Transitional Management

A complex systems approach to sustainable city planning is identified by Ruth (2006, p.p. 156 -159), as cross-disciplinary and process oriented that integrate highly linked domains in nested and complex systems. The approach includes the measuring of the limited capacity of the ecosystem, utilizing the EF, and involves food, waste, water and transportation. The approach is reviewed in detail in **Section 1., Sustainability Chapter, 6.2 to 6.10,** and demonstrated in the project studies, **Section 4**. The approach has moved beyond the older model of physical planning to consider less tangible inputs and outputs in a system (Wheeler 2004).

Transition Management, steers the process which (Ruth: 2006,167). "Allows for diversity and informed dissent" in the short term. It occurs in a protective stable democratic system, were newcomers can break down the system, causing disequilibrium, a necessary requirement to innovate (Ruth: 2006,165), leading to a stable sustainable system. The pattern emulates the ecosystem in the "Science of community assembly", extensively researched in the field and through computer modeling by Wes Jackson and the Land institute (Benyus: 1997, pp.30-31). Equilibrium and complex, persistent order is arrived at by allowing a system to create it's own order over time, in which Benyus (1997,31) describes, "having a

history makes a community last". Functioning examples of this include Sole Food in the CoV (2011), in which a policy in which to operate an urban farm does not exist in the system as yet. However, the flexibility in the system allowed the planners to break the system allowing the pathway to innovation. There are many global examples, which include the Grange (2011), in New York and the Hundertwasser House in Vienna (2010), which both required an adaptive municipal approach to transition to a more sustainable city as the outcome.

An adaptive approach is a continually evolving, self organizing, organic living system operating on a multitude of scales were patterns emerge, and were the solution for one problem solves many others (Reed: 2009,59; Capra: 2002,93; Fisk: 2008, 14). The patterns and similarities of complex adaptive systems emulate the biological patterns of regenerative and sustainable agriculture, (Benyus: 1997 p.24 & 44), whereby low energy inputs are leveraged into high productivity and were the sweet spot between complexity and chaos converge allowing for the creative force of self-organization to emerge. Kira Gerwing, planner with the CoV put it simply (2011), "Complexity does not have to be complicated." Finally, agro ecologist Jack Ewel, from Benyus (1997,24) said, " When you imitate the vegetative structure of an ecosystem, you will be granted function." In other words, when you take a living systems approach to the planning of cities recognizing that they are biophysical entities, whole answers to the multiple problems of sustainability will arise.

A key element of the process of complex systems planning is the participatory model (Ruth 2006; Quayle 2011; Visser 2011; Quayle 1998), which engages a broad range of stakeholders, who identify qualitatively and quantifiably, the issues and provide a baseline for intervention and a catalyst for action. They include local citizens, businesses, community partnerships and multiple levels of government and departments in a process of co-evolution. Information from regional climate modeling, ecological footprint analysis and task force outcomes, inform the participatory process. As well, the public, through adaptive systems management reciprocally lead aspects of regional and municipal planning, through action and feedback. Examples of this are Sole Food and the Fairmont Hotel, CPUAF models, presented in **Section 4**, as applied theory of the Social Change Model, of social activism described eloquently by Rees (2011) in **Section 3.5.**

2.4. Public Participation - the unobstructed flow of information and knowledge

A good integrated plan requires public disclosure, a free flow of information (Meadows 1999) about local and global trends and impacts, engages all levels of government, sectors and civil society. This requires good governance, strong and transparent leadership and a strategic action plan that guides the future of a municipality and region by applying the principle of reciprocity to enhance feedback between community and government. According to UN Habitat, "active citizenship control in the planning process is considered the most transformative of all forms of participation" (UN Habitat: 2009,93)." An educated populace is one that knows the facts as well as the commonality and effects of global trends and can participate collaboratively in the integrated planning process. A visionary approach, knowing when to intervene in a system (Meadows 1999), is an applied systems approach, which when applied to the structure of information flows, becomes a powerful tool to create new possibilities, change organizations and individual behaviors, and produce significant crosscutting changes that effect the balance and dynamism of multiple systems. According to Meadows (1999), information is a powerful tool to regulate behavior and effect change through small shifts in a system. Technology has yet to create a sustainable world, but self-organizing behavioral systems are the paradigms that can lead to change and have the ability to transcend, and to define the scope and degree of a food and forestation system framework. The CoV and the MVR are examples of strong advocacy for engaging public participation through innovative outreach approaches such as workshops, forums such as Pecka Kucha, interactive webpage (EDC: 2010,9), youth initiatives, advisory boards such as the Urban Task Forces and Councils, such as the Food Policy Council discussed in **Section 3.4.**

A response, holistic whole systems planning approach to build climate resilience (IFPRI: 2009,43) that emulates the syncopated and reciprocal rhythms of all systems found in nature is the foundation for resilient planning and continued human existence (IFPRI: 2009,43). Upon completion of a climate analysis Cities and Regions must work toward a planetary solution that engages citizens, businesses and governments through wide public consultation and through

strategic partnerships with businesses, other levels of government, universities and NGO'S (GCAP 2011; Quayle 2011) as exemplified in the structuring of the Urban Task Force (UTF) and the success of its outcome. A strategic action plan as a road map for achieving specific and integrated sustainability goals, supported by measurables and achievables, is shaped by the engagement and participation of an active and educated population. A strategic food and forestation system integrated in a complete urban management action plan acknowledges that a healthy community is a wealthy community (GCAP: 2011,6). An integrated whole system future plan utilizes a systems approach to facilitate the development of sector specific plans, recognizing that patterns of land use including density, connected green systems, urban food systems, waste management and transportation are all components of, and consistent with larger regional as well as larger global systems (GCAPAP:2011, 25). This supports Brundtland's statement that (WCED: 1998, 4). "Fair access through broad participation in decision making is required" and that the process of change is cross cutting "Comprising every field of human activity", to achieve the goal of sustainable development.

2.5. Social Change Model

The model for social change encourages highly participatory, non-hierarchical leadership, or adaptive and transitional management, and is a process of transforming the way in which society is organized (UNICEF 2005; Chavis & Wanderman 1990), focusing on community as the catalyst for change. Behaviour change strategies, on the other hand, focus on the individual as a locus for change and is program and less process oriented. A community-based approach allows, through the participatory process, groups to identify their own problems and voice their concerns and make their own decisions in solving problems. This is a highly democratized process, which is at the heart of the planning process in the CoV. Social mobilization can bring together a wide range of community, corporate and institutional partners as illustrated by the Out of The Rain Project (http://www.outoftherain.org), which brought focus and action around issues of homelessness within the CoV. However, the process which stopped the implementation of a freeway, in the 1960's in the CoV was a catalyst for citizenry

power, and is a defining moment in its history of civil activism within the city (Rees 2011; Oke & Wynn 2001). The details of the history of democratized public participation and social activism follow in **Section 3.5**.

2.6. Place Making and Ecosystem Interconnectivity

Jane Jacobs, asked the question (1998, 95), "why are there so often no people where the parks are and no parks were there people are?" She was referring to the lack of multiple activities taking place in vast unsafe, underutilized and uni-functional traditional park environments. The morphology of a sustainable neighbourhood is one that is vibrant, with a mix of "organized complexity (Jacobs: 1989,14)." They include residential and commercial uses, which support a continuum of community facilities, retail activities and public spaces (CNU 2009), evolved to include active green spaces. Urban theorist, Ray Oldenburg would classify the overlay of diverse uses as "third places" located between home and office as the heart of community activity, public interaction, and the foundation of a functioning and healthy democratic society (CNU 2009; Oldenburg1999). Third places were initially described to include coffee shops, pubs and post offices where diverse users of the community would engage in social activities and human interactions. Neither Jacob nor Oldenburg conceptualized the inclusion of urban farms, farmers markets, community or communal gardens, vertical agriculture, vegetative roofs or continuously productive greenways and pocket parks in their description of areas of civic engagement, as these activated did not exist to any great extent at the time of their writing. However, these new gathering places, which encompass the natural world, have multiple, and expanded purposes, synthesizing systems and patterns of human social interactions (Quayle 2011) to include ecological interactions with other species, plants and life cycle activities such as composting, water harvesting, honey gathering and rigorous agricultural production. They are socially, and economically active *linking places,* where interconnectivity with bio-systems, plants and species not formerly thought of in the urban environment takes place and where climate protection, as well as human health and wellbeing emerges as *the making places* of sustainability.

Encouraging new social norms that effectively increase reciprocal relationships between humans, other species and ecological systems are essential to pursue sustainability in the larger system (Reed: 2009, 51). It is through direct corporeal, or physical and experiential interaction and what Abrams (1996,27) refers to as

"sensory reciprocity" with the ecosystem that in turn, provides feedback loops that further encourage ecological connectivity, promote environmental awareness and stewardship.

The works of Merle-Ponte and Husserl, phenomenological philosophers, influenced psychology and cognitive science, in their own writing as well as the writings of others such as Abrams (1997). Their research linked the importance of direct sensorial, experiential interconnectivity (mediated by the body) and reciprocity between humans and natural ecological systems (Abrams from Merle-Ponte: 1997 p.p.36-37). Their research has led to the hypothesis in the theory of evolutionary biology which is referred to as "connected behavior' (Fisk: 2008, p.p. 14-15), a structural component of the human neo-cortex. Connected behaviour seeks to perceive the presence of patterned behavior, or life events in the environment with the ability to perceive the hidden connections between phenomena and the non-linear dynamics (Fisk, from Guenther, R. & Vittori, G. 2008). These theories, describe the link between the unconscious interconnection to what Capra (2003) refers to as the "web of life" in life cycles of living systems including plants and other species. Quayle (2011), discusses the complexity of attachment to the environment with the idea of place identity relating to environmental psychology, while conversely, the understanding of the characteristics of community is simple (Quayle: 1997, 101). These areas of research provide the background to understanding why it is important to make the abstract visible in the planning of sustainable cities by bringing complex theoretical theories literally closer to the ground. In other words, by creating visible waterways that connect greenways of trees and plants, and the life cycle of fruits and vegetables are visible on the vine, and the viable economics and activity of urban agriculture is present in the everyday life of humans within the urban environment, in neighbourhoods and in community, will better facilitate the importance and reciprocal interconnectivity of multiple living systems and the role they play in sustaining human and species existence.

According to Rees, prominent urban analysts have recognized that cities could be conceived as ecosystems (Rees 2011, from Douglas 1981), yet the majority of papers in scientific journals focus on the impacts of urbanization on non-human plants and animals (Rees: 2011,3). If then, as most scientists confirm that cities are

"un-natural habitats for other species" as Rees explains, then why is it so difficult to perceive that we are also species, of nature, and are not well adapted to un-natural urban environments that we have created? If we are not well adapted to the built – environment and spatial framework that we have constructed then how can we proceed to alter urban form to be synchronistic to the biophysical entities we have created for ourselves? Place making, in visual and experiential ecological harmony with natural systems, that encompasses a wide range of food production activities, or CPUAF, that solves a number of patterns, is a tool that can intervene to provide a reliable local food source, and mitigate the effects of climate change and the UHI effect.

2.6.2. Urban Form to Reduce GHG emissions and Heat Islands

Smart Growth, which links transportation oriented development **(TOD'S)** through the reduction in automobile dependency as high density, compact, mixed use urban form, and which utilizes land and green infrastructure efficiently, is demonstrated as a model of social, economic and environmental sustainability (Ruth: 2006,13). Further, the integration of these planning tools are supported by UN Habitat (2010) as the major tool to reduce GHG emissions per capita and mitigate climate change, (Ruth: 2006, p. 30&16). The goal for large cities according to UNHS (2009,124) is "To reduce GHG emissions by 50% by 2050 in line with the IPCC global agenda" by providing more sustainable transportation. Transit oriented development (TOD) reduces car use per capita. According to a 2007 US study, "by shifting 60% of new growth to compact patterns, a reduction in CO2 emissions by 85 million metric tones annually by 2030" (UNHPSC: 2010,125; Ewing et.al. 2007) would be realized. A combination of TOD and High Density Development, with a clearly defined urban edge or growth boundary, reduced car trips in the City of Vancouver by 31, 000 per day and increased cycling and walking trips by 107,000 per day (UNHPSC: 2010,125), reducing GHG emissions. Connected greenways which, contribute to reduced vehicle transportation, by providing a multi-modal means of transportation, integrated within a dense, TOD, have the potential to further mitigate climate issues by incorporating a continuously productive food system as a model of CPUAF.

2.6.3. Urban Form - The Synergies between Climate Change and the UHI effects

Conversely, evidence suggests that sprawl, according to Ruth (2006, 13), " which accelerates the loss of natural areas and farmland" leads to high resource consumption, (Ruth 2006 from Cobb, 1998) as well as contributes to increased infrastructure and service delivery costs (Ruth 2006; Anderson & Santore 2002). Of significance, NASA (2010) researchers identified, using satellite technology that traditional farm land, where mono cropping practices are applied", is an exasperating force that contributes to the UHI effect surrounding urban build up more so than dense forested areas surrounding cities." Furthermore, Marc Imhoff, the leader of the NASA research group commented (2010), "as a result, the condition of the rural land around the city matters a great deal." While an Urban Heat island is described as the difference between the air and surface temperatures of surrounding area (Voogt 2004; EPA 2009; Oke 2011), than surrounding metropolitan and rural area utilizing mono-cropping agriculture as well as a more sprawled approach to planning can have a significant effect on a well designed densely populated and highly treed urban area. Therefore an integrated regional and municipal approach that recognizes the synergistic and symbiotic relationship between larger and smaller systems is necessary in addressing climate change and UHI effects. The challenge is for city, regional and infrastructure planners and policy makers to consider edible vegetative patterns that include, layered tree planting, continuously evolving and diverse layers of vegetation, that do not permit ground to return to a fallow state and which provides a buffer or urban edge of innovative and intensive, CPUAF to protect from climate adversity to reduce the impact of the UHI effects. As well, regional development that applies principles of smart growth, as well as polyculture agriculture is required to reduce regional impacts on city/regions. Research in the Case study of the City of Vancouver, indicates that well designed densely populated areas of the city have lower near surface temperatures (UCHI) , however, low lying industrial areas are effected more by increased urban temperatures and that the threat of loss of regional agricultural land to industrial development can have an impact on the region as a whole.

2.6. 4. Summary

According to a UNHS study (2010,129), creating an ecologically connected sense of place, by increasing photosynthetic materials will enhance biodiversity, recreational pursuits and increase food production and is achievable through developmental controls that focus on vegetative rooftops and vertical walls. In addition, as demonstrated in the project examples within the CoV, **Section 4**, and presented in the UNHS report (2010: p.p.125 &130) by transforming streets to provide calming activities, and which have connected greenways, encourage walking and cycling, demonstrate increased economic development and improved urban revitalization and reduced climate impacts. Furthermore, the addition of food production improves local food security and fosters stewardship for the local ecosystem.

2.7. Stewardship

Stewardship refers to "the careful management of something entrusted to one's care such as natural resources" (Merraim-Webster 2011), while the principle of stewardship according to Guenther et al, (2008, 5) "is intrinsic to the idea of sustainable development." In 1992, the Union of Concerned Scientists, issued a strong warning to humanity concerning stewardship of the environment:

> "We hereby warn humanity of what lies ahead. A great change in our stewardship of the earth and the life of it is required, if vast misery is to be avoided and our global home on this planet is not be irretrievably mutilated (Union of Concerned Scientists, 1992 from Guenther et al. 2008, 5)."

Stewardship is required on all scales as a component of global, regional. municipal and community environmental management and can be integrated into agriculture and forestation management. Stewardship goes hand in hand with place making, and fosters a sense of pride in community, increasing local economic development,

while reducing food miles travelled, the ecological footprint and increases social capital while protecting the ecological systems and the climate.

The garden city model (Viljoen: 2005, 99) of vacant underutilized urban green space, segregated populations of people and services, creating a dichotomy of divided spaces, where absence of human activity, coalesce into social and psychological uneasiness in vast voids of underutilized urban edge parkland without purpose. Instead, CPUAF is a form of place making, that is active, dense and compact and which has the potential to swath the urban landscape with outstretched fingers of continuous greenways and diverse agricultural actives to protect cities and their inhabitants from heat build up and providing cool shaded pedestrian corridors and a supply of local food.

Continuously productive agricultural space that is permeable, active, integrated and diverse in structure, pattern and form will provide a living system, which encourages increased stewardship in the urban landscape. Smart Growth, TOD with compaction and densification of the built and living environment are useful tools in the patterning of cities to reduce climate change and the UHI through reduced transportation and through the integration of urban agriculture and forestation, CPUAF in the living environment.

Stewardship of community orchards and communal gardens in recreational facilities, according to Duncan and Quayle (2011), can increase urban greenspace and urban agricultural production. Neighbourhood participation in public space, while integrating agriculture in the living environment, makes present and visible the life cycles in nature as well as presents increased opportunity for stewardship in the day-to-day lives of urban citizens.

2.8 Regional and Municipal Collaborative Process

The relationship between society and space, to include the economics of globalization and the network society is greatly debated and not intended as a major topic of this thesis (Soja 2000; Castells 2000). It is however recognized that

cities are large consumptive entities of materials and resources, and waste producers, with economic and ecological footprints that far exceed their local boundaries, well beyond their local metropolitan region (Rees 2011) having global implications. It is the purpose of this thesis to look at the collaborative process that occurs between a city and it's region as a tool to address sustainability issues that includes climate change, the UHI effect and food security. The physical and spatial planning, addressing land use, infrastructure, urban, industrial and agricultural form, and ecosystem planning is defined by Wheeler (2004,133) as " New Regionalism" and is considered a growing trend whereby urban regions tackle global sustainability issues.

Metropolitan regions are generally responsible for solid waste management, the planning of park systems, protecting ecologically sensitive natural conserver areas, watersheds, air sheds, as well as managing regional transportation and protecting agricultural land (Oke 2001; Wheeler 2004; MVRSRI: 2011,8). Regions are responsible for delivering services to a number of municipalities, of which may have conflicting concerns and strategies for sustainable development and which may overlap with provincial and nationals planning agendas (Oke& Wynn: 2000, 264; Wheeler: 2004,137; FFDSF 2006) such as the de-regulation of agricultural land by outlying municipalities. While daily life and consumption of food, water and products occur at the local scale, production and the need for protection occurs at a local, region and a global scale. According to Wheeler,(2004,133), one of the paradoxes of planning is that social and environmental issues are best approached at a regional scale and yet, this is generally the weakest level in terms of government and public understanding.

However, the MVR has a long history of protecting the natural landscape, in what is referred to as the green zone, in the initial Livable Region Plan of 1975, while further protecting agricultural land, and collaborating with the COV to manage urban growth (Wheeler 2004). The region is unique that it also manages affordable housing and recently, added a Regional Food System Strategy and an Ecological Health Strategy to complement the Livable Region Strategy (The Sustainable Region Initiative), (MVR:SRI 2010; MVRFS 2011; MVEHAC 2011), with a high level of public participation. The case study of the CoV and the relationship and

interactions with the MVR follows in the Case Study and projects, **Section 3.9** and **Section 4.**

2.9. Rooftop Farming and Vertical Agriculture

2.9.1. Defining Green Roofs and Rooftop Gardening

Green roofs are specialized roofing systems that support vegetation growth on rooftops. Green roofs use living vegetation, not necessarily food, to help reduce heat accumulation of buildings, assist in cooling of neighborhoods (Narita et. al. 2004; Spornken-Smith & Oke 1998), and contribute to the overall greening of the city, which can lead to a cooler urban atmosphere (Voogt 2004). Rooftop Gardening refers to an agricultural practice (Kaill-Vinish 2009), that provides for an opportunity for increasing sustainable food production within an urban food system strategy. Rooftop Gardening does not interfere with other land uses and takes advantage of underutilized space as a proposed strategy to solving more than one sustainability challenge. Melding the interrelatedness of sustainability issues including the reduction of carbon, waste and protecting ecosystem services, reducing UHI effects and providing access to nature is the desired outcome of the vertical agriculture as well as the installation of intensive green roofs for the purpose of rooftop farming.

2.9.2. Green Roof Types

Extensive or Intensive are the two main types of green roofs with a third type that combines the two. The terms are used to describe the differences in construction, design and depth of growing medium. An **Extensive Green Roof** is lighter in weight with a shallower planting media or substrate measuring between 3 to 6 inches (BCIT 2011). They are suitable for flat roof buildings, low slopes and retrofits where the total structural load is required to be less than Intensive Roofs. They are ideally suited for low maintenance drought tolerant grasses and succulent plants such as sedums as defined in a BCIT study.

Intensive Green Roof, also know as **rooftop gardens**, are engineered roof systems that accept more weight than an extensive green roof. Their main purpose is functional, for storm water management, thermal insulation, and heat island

mitigation (CMHC 2006; Bass et. al. 2007; BCIT 2011), and they provide public amenity space. They have the potential to also serve to intensify local food production a recommendation made by Food Secure Vancouver Baseline Report (FSVBR: 15, 2009), albeit, the recommendation was for ground level urban areas. They can be fully landscaped, to include water capture, irrigation systems and a tree canopy and as well, have the potential as a tool for place making, to accommodate active community participation as parks, playgrounds and as a place to accommodate intensive food crops and trees. They require similar maintenance as grade level gardens (BCIT 2011), requiring substantial investment in plant care. While a deeper planting medium between 203 – 304 mm (BCIT 2011) is the norm, the Fairmont Hotel in Vancouver, installed and Intensive rooftop garden with a plant medium of 457 mm. Intensive Green Roofs can support a larger more diverse range of plant species including trees, shrubs, herbs and vegetables as illustrated in the Fairmont Hotel project example.

2.9.3. Benefits of Green Roof Systems

Buildings change the flow of energy through urban ecosystems (Bioscience 2007) potentially causing environmental as well as human health problems. According to Dunnett and Kingsbury (2004), plants, utilized in green roof and façade greening reduce the negative climate effects of urbanization by changing the buildings surface properties (Bass et. al. 2007). They provide multiple environmental benefits, including the reduction of the ecological footprint by providing local food, reducing transportation costs (Kaill-Vinish 2009). Benefits include:

1. Stormwater Management - Urban flooding from excessive precipitation, expected to increase as a result of climate change can be reduced by the installation of green roofs. Stormwater run-off reductions between 50% and 100% can be realized (Kaill-Vinish 2009) with the installation of an intensive green roof with the added potential to decrease the cost of managing a city or regional stormwater infrastructure system. Vancouver (CMHC: 2005,10) and the Metro Vancouver Region (MVR) (MVRDEHAP: 2011,11) are concerned about stormwater runoff as it accounts for 30% of the pollution of water bodies in North America (CMHC:2005,10).

2. Water consumption over and above stormwater capture -

The nutrient flow in a healthy forested ecosystem, is self-renewing (Jacke: 2005,180) as rainfall is cycled through the soil, absorbed into the roots of plants and transpiration occurs by cycling water particles, or moisture into the atmosphere, causing a cooling effect (Suzuki 1998) known as evapo-transpiration which can moderate temperatures resulting from urban heat islands (UHIs). While Vancouver receives high volumes of rain, conservation is still a concern as water molecules belong to the larger global common, (Suzuki 1998) and they find their way around the planet, even to areas where drought is a concern. As well, rainwater can be captured, stored and distributed for later use during dryer periods. Innovative roof design is integral to the capture and distribution of rainwater in urban agriculture on the ground and on the roof, while future research is needed to develop innovative solutions that optimize and ideally eliminate the use of municipal water in an urban agricultural environment. An innovative example of water capture and storage is demonstrated at the Brooklyn Grange Urban Farm (BG) in New York City. Small cups were designed within the rooftop drainage system to hold excess water during the rainy season and wick during dryer periods, keeping municipal water consumption low (BG, 2011). In addition a drip system with pressure reduction can minimize use while distributing water, as demonstrated at the BG as well as the Fairmont Hotel in Vancouver. Rainwater capture can assist in the growing of rooftop urban agriculture as 90% of rainwater can be effectively captured through rainwater collection and therefore minimize the demand for municipal water during dryer months. The City of Vancouver is investigating rainwater capture (Dory 2011), however, further research is required to measure the benefits and challenges.

3. Thermal Properties - Green roofs improve the environmental performance of buildings reducing energy costs, associated with heating and cooling, by acting as insulation in both extremes of temperature variables. A Toronto study found that the cooling load in the floor directly below the green roof was reduced by 60% (Bass et. al. 2007, 828) with the building average at 25% (Peck & Kuhn 2001), reducing air conditioning requirements, which contribute to GHG emissions. In winter, with 300 mm of growing medium, studies show that indoor temperatures will not drop below 0 degrees C with outdoor temperatures at -20 C (MVR 2005) (Peck

& Kuhn 2001). While other circumstances also contributing to the 15,000 heat related deaths in Paris during the European heat wave of 2003, Oke said (2011), " Most likely lives could have been saved in the upper floors of buildings, if green roofs were present".

4. Biodiversity - As the case study of the Fairmont Hotel, located in downtown Vancouver will illustrate, rooftop urban agriculture provides a much needed habitat for pollinators as well as other species, increases biodiversity (CMHC 2005; BCIT 2011) and increases ecological connectivity (MVREHAP 2011), by overcoming habitat fragmentation in urban areas. The relationship is reciprocal and multi-dimensional in that pollinators support the ecosystem at large and ensure the survival of endangered plant species within a twenty-six mile radius of their hive.

5. Ecological Connectivity - Green walls in combination with vertical agriculture can increase biodiversity supporting human and species health by creating linkages previously lost by habitat fragmentation in urban area (GVEH 2011).

6. Economic - While the initial installation cost of a green roof is higher than a traditional roof, the life cycle cost in relation to the building is competitive and slightly lower (BCIT 2011). A BCIT study determined that Green Roofs do not have to be replaced as often as conventional flat roofs, while a European study suggests that green roofs can double the lifespan of a conventional roof (Peck & Kuhn 2001).

Figure 2.2. Comparative Infrared photos of an asphalt roof and a green roof
"On a typical day, the Chicago City Hall green roof measures almost 40C cooler than the neighbouring roof to the right"(UHI: 2009, 22).
Source: http://scpgreenbuild.files.wordpress.com/2010/10/sadhujohnston.pdf

2.9.4. Urban Heat Island

Urbanization can cause increased temperatures as high as 10 Degrees C.. (CMHC: 2006, 10) in comparison to surrounding areas. The heat build up results from the modification of surface areas such as the inclusion of asphalt rooftops and impermeable concrete surface areas (CMHC: 2006,10). While heat islands do not exist to the same extent as they occur in other global cities such as Paris, Chicago and Toronto, Vancouver does exhibit areas of temperature build up (Oke & Wynn 2001). A reduction of heat islands is identified as one of the three key motivators in developing the CoV green roof policy (CMHC 2005), which includes managing stormwater runoff and providing public amenity space as the other motivators.

Urban forestation, tree planting and continuous vegetative cover, whether implemented on intensive green roofs, as a vertical façade, or at ground level can reduce the effects of heat islands, at all scales and at all levels (Oke 1997) as they provide shading and cooling through evaporation (BCIT 2011). Models show that green roofs reduce temperatures more effectively than reflective white roofs and are more effective than asphalt roofs as illustrated in the figure above. Why not produce food as a means to provide local food security, while also providing local climate protection?

2.9.5. History and Social Hierarchy of Green Roofs

Ornamental roof gardens were initially established by ancient civilizations along the Tigris and Euphrates Rivers and the most famous were the hanging gardens of Babylon established in the 7th and 8th century AD. (Barnes 2004).

In the 1868 World Exhibition in Paris, the first of several experimental projects began in Europe. Frank Lloyd Wright was one of the first twentieth century architects to experiment with planted terraces and roof gardens in the public realm in the early 1903 and in 1914 followed by Gropius and Le Corbusier in the 1920s.

While urban green space has always been present in cities, it is only since the 1920s, when awareness about the effects of UHIs began to surface that planners began to question the societal benefits of urban forestation and rooftop greening. Rooftops are often considered places of privilege, not visible and therefore distanced from the larger community. However, this particular social hierarchy is challenged when we consider the potential for intensification of urban agriculture, the benefits to reducing GHG emissions, reducing the EF, protecting ecosystems while maximizing the amount of underutilized space which can be made accessible for urban agriculture and forestation. The link between food and urban forestation is only just entering the mainstream as an integrated, restorative, regenerative approach to climate mitigation and to provide a secure food source as is illustrated in the CoV GCAP which links Access to Nature, urban forestry with a goal to increase of community gardens (GCAP: 2011, 15). Rooftops and walls are the final frontier to achieve fully linked systems of sustainability.

The benefits could be best realized in industrial/warehouse areas and in the CBD where nighttime CUHI temperatures are often the highest compared to urban residential, mixed rural and surrounding agricultural areas (Voogt & Oke 2002).

The 1986 opening of the Hundertwasser House in Vienna, and subsequent 51 unit social housing project brought international attention and awareness to the feasibility of building greening to a wider audience by integrating green roofing and living walls in a community and not an upper class context. More than 500 trees and shrubs grow on roofs, terraces, and balconies and in the window boxes of the two buildings designed by Hundertwasser, and there is 900 tonnes of earth on the roof surfaces to support the vegetation (Beatly & Manning 1997).

Figure 2.3 Photo Credit: V. Durant. The Hundertwasser Social Housing Project, Vienna Austria.

2.9.6. Hundertwasser House: An Organic Living Building

Hundertwasser believed it was essential to integrate nature and structure and to create seamless corridors between the organic and inorganic (Hundertwasser 2007). According to Beatly & Manning, (2000, 203) "structures such as this are a reimagining of the built environment, and are an example of "an organic living building as an integrated component of the urban landscape." Direct observation in July 2010, of Hundertwasser House, as well as the social housing structure in Vienna, confirmed the ambition and innovation of the projects. While it did not fully incorporate a food source in the planting strategy it is worthy of inclusion in this thesis. The project brought international attention to the possibility of green roof and living walls as an integrated component of urban forestation and community engagement. The City of Vienna, which competes with Vancouver as one of the most livable cities in the world, commissioned the architect to design Spittelau, the cities thermal waste treatment plant. The architect, perhaps an eccentric visionary, was able to bring about what Ruth (2006, 177) describes as "a radical pattern of change from a non-sustainable to a sustainable city pathway". Adaptive systems management which "allows newcomers with deviant ideas," to intervene in a protected transitional environment (Ruth: 2006, 177) was the planning tool utilized to transition Vienna to a more sustainable city.

2.9.7. Future Research

Further research is required to determine the optimal methods of urban agriculture and forestation for food production on intensive green roofs. Focusing on the horticultural aspect and selecting the best combination of plants, trees and shrubs is the next step in optimizing a fully integrated green roof system to provide secure and sustainable local food and providing climate benefits

A well designed forest garden system, with a combination of tree and shrub layers that are drought and shade tolerant can mitigate municipal water use, as well as optimize evapo-transpiration and contribute to the reduction of the Heat Island within the Urban Canopy Layer (UCL). GHG emissions can be reduced through the production of urban food by reducing food miles traveled and by reducing thermal loads created by heating and cooling and reduce environmental impacts on the regional watershed.

2.9.8. Policy

Retrofitting as well as requiring urban agriculture on new rooftop installations captures under utilized potential for urban agriculture and forestation in residential, commercial and particularly in industrial areas where near surface air temperatures are shown to produce higher heat islands, (Oke & Wynn: 2001, 160) in the Vancouver context. The potential to provide both food security, reduce waste and protect the ecosystem while providing a sustainable source of local food while contributing to the reduction of urban heat island effect is the desired outcome.

Green roofs are specialized roofing systems that support vegetation growth on rooftops. Green roof technology offers reduced site level stormwater runoff, reduced building energy demand and extension of roof membrane service life. Urban usage can reduce impact on the regional watershed, mitigate heat island effects, and improve air and water quality.

Figure 2.4. Sole food urban farm is located in the City of Vancouver. Vertical landscaping Increases food production by 100%. Photos. V. Durant.

2.9.9. Defining Vertical Landscaping as an Urban Farming Initiative

Continuously productive urban agriculture and forestation does not need to be horizontal, that is, grown on land or on rooftops. There is a third dimension to the process and it is the application of agriculture to vertical surfaces of buildings as well as on freestanding structures. There are a number of terms to describe the growing of vegetation on a non-horizontal surface. There are two main types of Green Walls: Green Facades and Living Walls (Irwin 2009; BCIT 2011). A green wall or vertical garden (Blanc 2008) can be free standing or attached to a building partially or completely covered with vegetation, soil or other component. CMHC (2004,6) defines "vertical gardening" as the growing of plants on, up or against the façade of a building. Biofacades are defined as "combining the natural and built environment forming a biological skin (Amir 2011)". The term vertical landscaping (Yeung: 2008,141) comes closest to what this thesis refers to as **vertical farming**, which suggests the intensification of urban agriculture, integrated with food systems, vertically in the built and urban environment. In other words, buildings do not have to be involved as freestanding vertical structures on underutilized and vacant land can produce a crop yield.

2.9.10. Innovative Vertical Farming

By this, Vertical landscaping is further refined as the term vertical farming, which defines agricultural food production in the vertical environment. to include innovative

forms of intensive agriculture, by installing in and on vertical surfaces or containers for the purpose of food production. An example of this is the small scale, vertical strawberry plantation located on the ¼ acre SOLE Food Urban Farm in the CoV. The installation of vertical strawberry "trees" (See figure 2.4) constructed of PVC piping and filed with soil has increased the productivity of the land by 100%. This was guided by the creative ingenuity of Michael Ableman, and implemented by Dory and the staff employed by the operation.

2.9.11. Vertical Farming: Reducing the Ecological Footprint

Vertical Farming reduces fossil fuel emissions, as it is a no plow system. The use of tractors, mowers or power tools is not possible in this situation.

1. Vertical vegetation can capture storm water run-off with similar benefits as rooftop storm water capture. If we look to historical agricultural systems it is the same process used in traditional terraced farming in rural mountainous regions, in order to protect from soil rainwater run-off and erosion.

2. Reduce the Ecological Footprint - Vertical farming provides a hybrid form of ecological intensification that "artificially increases the carrying capacity of a piece of (land) ground (Viljoen: 2008, 240)." The surface area of a built form can provide a façade area of up to or more than "four or five times the site area (Yeung 2005)". This could prove to be a significant innovation, which would considerably intensify the production of urban food. Increasing the carrying capacity of an urban space by growing food vertically could significantly reduce the Ecological Footprint of a city's food production without major technological intervention. When we consider that the installation of vertical planting can increase production of an urban lot by up to 100%, there is tremendous opportunity by utilizing existing and new building facades as vertical agriculture.

3. Food Security, CO2 Emissions, and Heat Island Benefits – According to Yeung (2005, 141) façade planting can lower ambient air temperatures in summer by as much as 5 degrees C, whereas heat loss during winter can be reduced by as much as 30 percent. A study in Singapore (Amir 2011) determined that wall temperatures can be reduced by 4-12 degree C depending on leaf foliage and the type of planting system and Biofacades reduce the effects of UHI's. Finally,

Amir from Blanc (2008) provided evidence that energy consumption can be lowered by the use of vertical agriculture. Wahid (2007) said, plant foliage must have a high CO2 uptake in order to reduce CO2 emission. In a recent study at the school of planning at the University of Malaysia, Amir (2011) found that dark leaved foliage possess the potential for a highest rate of carbon absorption or CO2 uptake. The purpose of the study was to determine the growth performance of legume plants to intensify food production for the purpose of food security as well as to determine the most efficient method to reduce Co2 emissions and the effects of UHI's.

2.9.12. Social Cohesion and Human Connectivity

Breaking the barriers of what Quayle (1999,100) refers to as the "landscape of social distance" is a defining benefit of the link of vertical agriculture to land based and rooftop agriculture and green infrastructure. While, the authors refer to the isolation created by enclaves such as large walled residences and cul- de-sacs which do not allow for the permeability of community and social inclusion, vertical agriculture can connect ground level food production and rooftops as one continuously productive and connected greenspace. Making the invisible present, by joining previously disconnected horizontal surfaces, through vertical food production, will not only increase food production and biodiversity, but will contribute to increased human interconnectivity by making the abstract visible in the urban environment.

Vertical landscapes can connect ground level green space to rooftops not previously noticeable by the passerby, providing human as well habitat continuity for species as well as provide other ecological, social and economic benefits, while the main benefit is increased food production providing multiple sustainability benefits.

Human Connectivity

Accessibility to nature is identified by the CoV as a key priority (GCAP: 2011,98). The goal is to develop an urban forest management plan that ensures that all residents are within a five-minute walk to a park or green space. While rooftops

may be off the beaten path, these new "gathering places" of intensive food production have multiple and expanded purposes, synthesizing systems and patterns of human social interactions (Quayle 2011). Human interaction with plants and other species will increase through the activities of composting, water harvesting, honey gathering and rigorous agricultural production, increasing life cycle awareness. Rooftops and vertical farms are socially and economically active "linking places", where interconnectivity with bio-systems, plants and species not formerly though of in the urban environment occur. They are the "making places" where the benefits of climate protection and human health and wellbeing will coalesce under the umbrella of sustainability.

2.9.13. Design and Installation Challenges

According to Viljoen (2008), the expertise required for VF suggests it best be carried out on a large scale due to the specific design and maintenance requirements of intensification of this type of implementation. In discussions with Joe Van Bellegen, (2010), the developer of the Dockside Green Community, the installation of the vertical agriculture wall was replaced initially, due to mis-management of the timing of the drip irrigation system, causing the first installation to fail. However, SOLE Food in the CoV has successfully maintained the vertical growing space on a smaller urban scale and according to CMHC (2005), there are many successful global applications of Vertical Agriculture Landscapes.

2.9.14. Green Roof and Living Wall Research Facilities

The BCIT Centre for Agricultural Ecology is a green roof research facility, constructed in 2003 at the British Columbia Institute of Technology (BCIT), in Burnaby B.C., to evaluate the performance for stormwater control and thermal efficiency of extensive green roofs and living walls in the rainforest climate of coastal B.C. Their website is a useful tool to obtain extensive quantifiable data, beyond what is presented in the scope of this thesis.

2.9.15. Global Best Practices - Urban Agriculture and Policy

Figure 2.5 Courtesy Brooklyn Grange. (BG) A Rooftop Urban Farm located on the roof an industrial building.

2.9.15.a. International Example: An Urban Farm atop an Industrial Building in New York City

Brooklyn Grange (BG), in New York is an international example of a highly productive rooftop urban farm[1]. It is spread over a 38,000 square foot rooftop, which is just under one acre, in Queens New York. The farm produces perennial herbs, eggplants, 40 varieties of tomatoes, peppers, beans and leafy greens which are in turn sold to local restaurants and through a farm stand in front of the Grange building. Although they are not certified as organic, the produce is grown using organic principles, without synthetic fertilizers, insecticides or herbicides. They produce for about nine months out of the year and use cover crops such as rye, buckwheat, vetch and clover to overwinter. This keeps the weeds down and provides organic nutrients to the soil eliminating the need for synthetic fertilizes.

A bee apiary produces a harvest of approximately 325 pounds of honey per year. They operate a CSA program which services the local neighbourhood.

[1] Information for this international example was obtained by e-mail questionnaire and communication with Anastasia, from te Brooklyn Grange Farm. More information on Brooklyn range or to contact them directly go to: www.brooklyngrangefarm.com Accessed July 25, 2011.

2.9.15.a.1. The Construction

A lightweight soil mixture called Roofline, composed of organic components and lightweight porous stones is utilized as the growing medium. The stones make the overall weight lighter and break down, adding trace minerals to provide nutrients to the vegetables, while 1.2 million pounds to a depth of 203 mm is spread over the green roof system of felt and drainage materials.

2.9.15.a.2. Environmental Sustainability

A systems analysis of the thermal properties and the storm water management of the building is not yet available. They are working toward obtaining this data; however, the structure in which the utility companies take readings in NYC has made a lifecycle analysis challenging and difficult. The reporting of consumption to end-users is an observed barrier to determining EF and CO2 emissions. BG utilizes a sustainable process of agriculture, creatively composting by including waste materials from the surrounding local area including restaurants, and have implemented an innovative construction and drip water system to manage water use. They keep a bee apiary, which supports the local ecosystem. Future research is necessary in order to obtain statistical data in this regard and a complete life-cycle analysis would be a benefit to assess the outputs and inputs of the farm and its level of sustainability. Without quantitative data, one can only assume, although quite confidently, that the project is more sustainable than an unproductive empty rooftop and that local food requirements are met without the carbon output of transporting food from distant sources.

2.9.15.a.3. Agro Ecological Process

Brooklyn Grange employ a sustainable system of intensive agricultural production. They employ crop rotation, companion cropping, intercropping during the growing season and cover crop during the off-season. There are several berry shrubs on the site, however the soil depth does not permit a full system of forest gardening.

2.9.15.a.4. Waste Management

All waste outputs, as well as food scraps and fallen leaves are collected from the local community and utilized as compost. In addition, wood shavings that are not treated with dyes or chemicals are donated by a local artisan woodworker and used in a mulching technique. Coffee chaff from a local roaster is collected to supplement the compost.

2.9.15.a.5. Water Management

Small cups within the drainage system hold excess water during the rainy season and wick during dryer periods, keeping water consumption low. They use municipal water and a drip system to minimize use. During the hottest part of the year, they have two spigots running on a pressure reduction valve for twelve minutes, four times a day to distribute water.

2.9.15.a.6. A Socially Sustainable Enterprise

The farm works with an area NGO, a refugee immigrant fund asylum help center. The help center assists immigrants seeking refugee status and the farm employs several of their members.

2.9.15.a.7. Economic Sustainability

The BG Farm is proving to be an economically viable operation although full details of profitability are not available for review. A tax abatement assisted in the initial start up and the yield per year is any where between 13,000 and 15,000 pounds.

2.9.15.a.8. Public Education and Stewardship

The Farm offers rooftop urban agriculture classes, supported by Green Roofs for Health Cities (www.greenroofs.org). Their head farmer teaches about multiple approaches to growing food on rooftops utilizing design and maintenance principles outlined above.

2.9.15.a.9. Policy

The farm holds a 10-year lease on the rooftop, which allows them the time and space to develop the project. The City of New York as yet, does not have policy in

place for rooftop agriculture although it is imminent considering the number of economically viable businesses functioning sustainably within the urban perimeter and the potential for expansion, considering the available roof top space. The farm is situated in an industrial/commercial area and the city provided a "green roof" tax abatement incentive that was helpful (2011).

2.9.14.b. Linking Food and Rooftops in Toronto

In 1999, the Toronto Food Policy Council recommended that the city develop an action plan to implement a minimum often food producing rooftops.

2.9.14.c. Toronto Green Roof Policy:

Toronto Canada was the first municipality in North America to pass a bylaw requiring and governing the construction of Green Roofs. The bylaw (section 108), adopted by Council in 2009, requires all new commercial institutional and residential construction over 2000 m2 to have a green roof. Residential development under six stories is exempt. In addition, tower roofs on a building with a floor plate less than 750m^2 is also excluded from available roof space.

Gross Floor Area * (Size of Building)	Coverage of Available Roof Space (Size of Green Roof)
2,000 - 4,999 m^2	20%
5,000-9,999 m^2	30%
10,000-14,999 m^2	40%
15,000-19,999 m^2	50%
20,000 m^2 or greater	60%

Figure 2.6 Green Roof Requirements – The City of Toronto
Source: http://www.toronto.ca/greenroofs/overview.htm

2.10. A Global Approach to Corporate Social Responsibility (CSR)

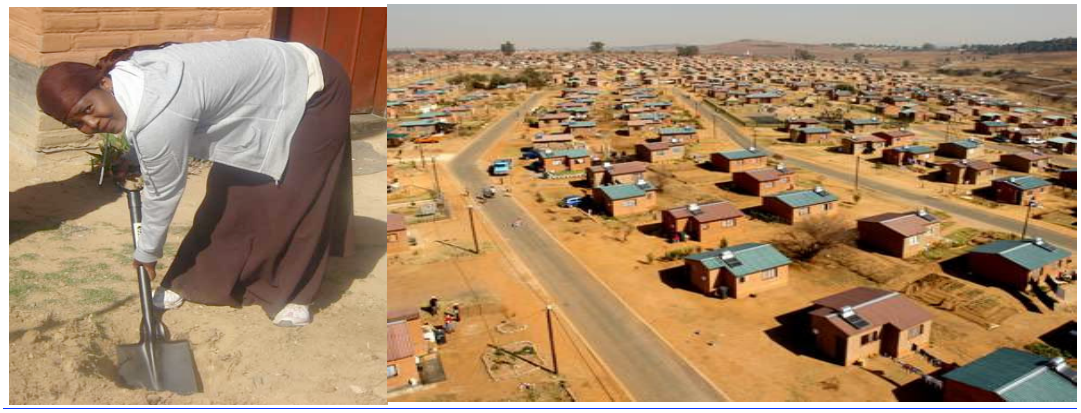

Figure 2.7. The City of Johannesburg, Community Tree Planting & Government Housing Source;http://www.joburg.org.za/index.php?option=com_content&task=view&id=1552&Itemid=168

In developed countries, social enterprise (SE) has a positive role to play in the transition to the ecological model of sustainability as the core value of planning. CSR is a sustainable business model, proving to solve social and ecological problems while maintaining economic viability as evidence presented in the Project Examples, Section 4.

In developing countries, government partnering with private corporations, through (CSR) is a common strategy utilized for implementing projects, particularly to support education and skills development. There is an increasing focus on the protection of ecosystem services, as the following example illustrates, while also providing poverty alleviation and food security as equal drivers.

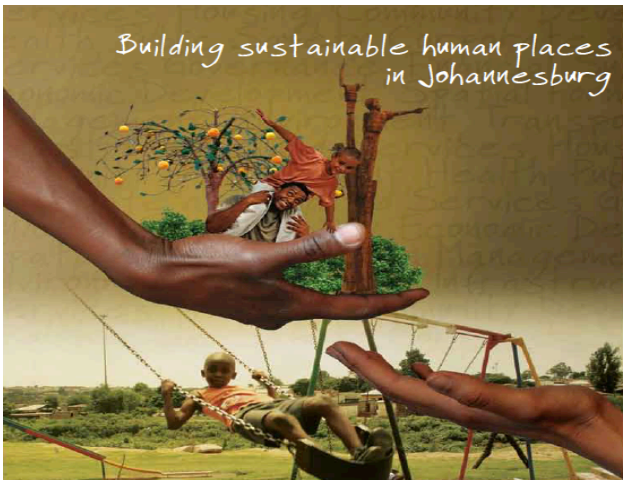

Figure 2.8. Creating possibilities in developing countries through CSR and urban agriculture and forestation. Source: The City of Johannesburg.

For example, in the City of Johannesburg (CoJ), as part of a greening project, 600 trees were planted in the township of Alexandra in which there are 1400 houses. The project is a joint venture between the municipal, provincial and national government departments, as well as the National Housing Finance Corporation (NHFC), and Absa Bank (COJ: 2011,11). In addition, Absa Bank donated over 500 fruit trees for planting in city parks. While the microclimate in the wealthy areas of the CoJ may not suffer the impacts of an UHI effect, due to heavy forestation, international UHI expert Dr. Tim Oke, commented in a recent interview (2011)“ by planting trees in overcrowded densely compacted slum areas, as well as painting roofs white, you will effectively reduce surface temperatures which will benefit human health and well being and potentially reduce the CLUHI effect.” This is an example in which a project addresses sustainability on a number of levels. The project has the potential to provide a nutritional food supply to individuals suffering from food insecurity, reduce the effects of the CLUHI at a local scale, manage storm water run-off and provide habitat for pollinators and other species. The project supports job creation and fosters a system of stewardship, education and awareness of where food comes from, protecting the ecosystem for future generations.

2.11. CPUAF: The culmination of urban agriculture: Agro-ecology, Forest Gardening, Rooftop Farming & Vertical Agriculture

2.11.1. Municipal transition toward urban agriculture and forestation

Continuously productive urban agriculture, integrated in a city's food system and forestation program as CPUAF would provide a more secure and sustainable food source, reduce GHG emissions and the UHI effect, reduce heat related mortality, protect water resources and restore human connection to the land, to ecosystems and to other species through direct sensorial experience. The introduction of interconnected urban edible greenways, that include boulevards, traffic circles, community orchards and gardens stewarded by local community groups, led by recreational facilities or community centers are the first steps toward creating awareness about growing local food. All of the above activities are becoming mainstream practice in the City of Vancouver (CoV). Furthermore, the application of intensive urban farming, incorporated through a new economic paradigm that includes Social Enterprises (SE) and Corporate Social Responsibility (CSR) and Community Supported Agriculture, (CSA) is in process in the CoV, supported by social planning while waiting for policy to catch up with innovation. The implementation of municipal policy that would encourage and support rooftop farming and vertical agriculture particularly in existing industrial areas, on vacant lots and school grounds, that could also include community center stewardship programs is a next step to provide climate and UHI benefits and a reliable source of local food. In addition, by-laws that would require green roof farming and vertical agriculture as a requirement of all new development process are all steps that will expand the process of CPUAF.

The implementation of what Capra (2003) describes as a "living systems approach", which mimics a natural system as a means to reduce a cities food production outputs, such as waste and water, will reduce the ecological footprint, reduce climate and HI effects and provide food security. CPUAF is a living systems

approach engaged in a reciprocal interrelationship with the ecosystem and is the ecological backbone to closing loops at the community and regional level.

2.11.2. Tried and Tested Systems of Sustainable Agriculture: Defining Continuously Productive Urban Agriculture and Forestation (CPUAF).

Continuously productive urban landscapes (CPUL's) as described by Viljoen (2005) and Yeung (2008, p.38), is expanded in this thesis to include self renewing, and intensively productive agriculture that integrates the sustainable application of agro-ecology, which according to Bomke (2011), "is a whole systems approach to agriculture that includes multi-cropping, to create succession over time, also referred to as poly cropping, that does not leave fallow soil, requires little or no tilling and preserves non-renewable topsoil. The system is regenerative, relying on no artificial or organic purchased inputs and preserves local biodiversity and indigenous knowledge". Bomke, professor of Agro-Ecology at UBC, extends the principle to include a participatory model in which community and farmers are equal partners (2011) in a process of co-evolution, which, in the context of this thesis, includes a new model for sustainable steady state economics that would include SE, CSR and CSA. This is the basis, from which this thesis cultivates the term continuously productive urban agriculture and forestation (CPUAF). The term is further expanded to include vertical farming in order to double crop yield on ground or rooftop applications as demonstrated in the Sole Food case study (Dory 2011) or quadruple yield as proposed by Viljoen (2005) and Yeung (2008), by utilizing vertical faces of buildings. As well, the philosophy and application of Permaculture © design, developed by Mollison (1990) and Holmgren (2009), may also be included in the process, of which the techniques, according to Ableman, (2006, 105) are inspired by the Chagga tribe in Tanzania and by the Javanese perennials gardens, and include the system of raised beds, perfected by the Chinese in the Han dynasty, and all of which include a layered approach.

Further expanding the term CPUAF, forest gardening recommends a "plant community" of edible landscaping of between three to seven layers that includes a canopy tree layer, a shrub layer and the vegetable layer, consisting of a wide variety of herbaceous and perennial vegetables (Whitefield 2002; Jacke 2005; Hart

2006). The principal of the forest garden is modeled on a natural woodland or system, applying the same principles of succession, diversity, and natural competition as agro ecology with an emphasis on the layering system, with one layer above the other (Hart 2006; Whitefield: 2002, p. xv). According to Ableman (1993, p. 102), who viewed Harts forest garden, "it is a living example of agro forestry on one eighth of an acre." The process balances light and shade, often seen as in competition with each other, a concern of Rees (2011), by layering, using the edge, and by utilizing shrubs and vegetables that are less cultivated, hybridized varieties of plants, and indigenous seeds that are more adaptive to the shaded environment, (Evans 2011; Whitefield 2002, p. 27-30). This is demonstrated and explained in more detail in the Fairmont Hotel example, **Section 4.2.**

As detailed and supported in the writing of Mollison (1990), Ableman (1993), Viljoen (2005) and Hart (2006), the systems mentioned above have historically provided sustainable food production in the rural, urban and peri-urban context, and in the global and local context in large-scale applications and in small-scale operations the size of a city lot.

2.12. Conclusion - Section 2

If "sustainability is a dynamic process of co-evolution and not a static state" as Capra argues (2003), then continuous productive urban agriculture and forestation (CPUAF) is an integral component of the dynamic process of urban life and human interaction with nature and the life cycle processes of ecosystem services. By "letting nature do the work" (Fukuoka: 2009, p. ix) natural patterns will emerge, and "we can let go of our fear of scarcity (Fukuoka 2009, p. ix)" and the expectation and fear of "lack" (Lappe, from Fukuoka, 2009 p. viii) often associated with the process of sustainability. To do "nothing" but watch natural ecological processes and reap the rewards is the true meaning of sustainable agriculture.

The tools and processes discussed in this section are a synthesis of interlinking, evidence to support the integration of agriculture and urban forestation described in

Section 1 as a roadmap (model) to assist cities in developing a multifunctional, sustainable green infrastructure to provide food security and climate resilience, while meeting the challenges of global population and urban growth.

There is substantial quantifiable evidence to suggest that urban forestation will mitigate the UHI effect with full methodology from Nowak & Crane (2002) and Rogers et.al. (2011) Further, there is a growing body of evidence that suggests cities must become their own source of food manufacturing and production (Rees: 2008, 2011; GCAP 2011) in order to become more self reliant and reduce their ecological footprint. More research is necessary to monitor the impacts of the form of edible vegetation, the potential for variances in spatial patterning of urban form to define a sustainable land use mix, that weaves urban food and forest in a tightly grained system (Alberti 1999). Urban food and forest system design which incorporates urban green building codes that mandate the inclusion of vertical agriculture and intensive green roofs for agricultural purposes is a necessity to achieve sustainability. As well, research and policy that encourages poly-culture agriculture, rather than decorative landscaping initiatives in municipal as well as private application is recommended. Finally, active and continually connected greenways, communal over community gardening with an emphasis on intensively productive urban farming and waste management, with full production and manufacturing within urban areas are necessary components of the integration of the green infrastructure in the urban environment to achieve a sustainable food and forestation system, reducing climate impacts and providing food security.

Evidence suggests that self-renewing interlinked and continuous urban agriculture (Viljoen 2005; Yeung: 2008, 38) can create sustainable urban food systems in the urban and peri-urban context. Urban resilience, ecological balance and social and economic sustainability are attainable through the establishment of regional and city based policies that represent all segments of the food system, including production, consumption, distribution and waste management as a holistic integrated policy. Finally, evidence presented shows that land use management with standards that are based on natural ecological systems, a living systems, cradle to cradle approach utilizing the design principles of closed loop living systems and biomimicry

where human practices imitate nature provide the most ecologically, socially and economically sound results.

The challenge for urban and social planners is to develop strategies and policies that minimize carbon output, reduce the urban heat island effect, by developing more sustainable resilient cities, by reconnecting people to the earth beneath their feet. Through interventions that create an understanding of the cyclical relationships in nature, such as food production in the built urban environment through visible closed loop restorative activities, such as grey water management and bio swales, and through connected green spaces including tree lined streets that provide daytime shade, edible architectural green walls, and green roofs to reduce nigh time temperatures and by creating pedestrian and ecologically oriented urban space, climate change can be mitigated and urban temperatures reduced. Taking what the World Bank (ISDR, 2009:109) refers to as "Forest mitigation activities," a role which they recommend for city planners, can be taken a step further by also providing food, security, will provide social and economic security and sustainability, along with providing the benefit of carbon sinks, through integrated urban agricultural and food security interventions in a holistic approach to urban planning and the reduction of the heat island effect.

Urban agriculture, partnered with closing loops in waste and water management practices, will improve the eco-efficiency of an urban area by reducing temperatures and ecological impacts as an outcome. Sustainable urban agriculture has the potential for climate mitigation as a heat sink, for inclusion in the development of interconnected greenways, green roofs and vertical agriculture, providing ecological health as a climate heat sink, reducing the effect of the urban heat island. Urban agriculture is a food security driver, which can serve to mitigate the effects of climate change, by reducing CO2 emissions. Urban agriculture establishes community, through a sense of place, a sense of reconnection to the ecological system and promotes human health and well being, improving respiratory and cardiovascular health; thus decreasing vulnerability to heat related mortality. This develops social capital, and promotes intricate networks of social connect ability, interaction, diversity and integration. In addition it closes waste streams of food production and reduces the intricate loops of waste management. Continuously Productive urban agricultural forestation cools the urban environment.

How the City of Vancouver (CoV) and the Metropolitan Vancouver Regional District (MVRD) interact and apply the Tools and Processes defined in the literature review in **Section 2,** is discussed in the following **Section 3.** Project examples of urban agricultural enterprise economic models of Corporate Social Responsibility, Social Enterprise and Community Supported Agriculture are presented in **Section 4.** Conclusions follow **in Section 5.**

Sustainable Agriculture & Forestation: The Edible Connected City.

Section 3

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Case Study – The City of Vancouver

"Knowledge of a place - where you are and where you come from - is intertwined with The knowledge of who you are. Landscape, in other words, shapes mindscape."

David Orr 1992

Figure 3.1. PHOTO: V.Durant "The City of Vancouver: Where I come from." 2002

3.0. Introduction - Case Study City of Vancouver

The City of Vancouver (CoV), Canada, is one of the most livable cities[1] in the world, described as one the best cities to live work, invest in and visit globally. The CoV, has developed a sustainable urban management strategy and action plan to become the "greenest" city in the world by 2020. The CoV is selected as a case study, after a review of global cities, as it is in a process of integrating local food, forestation and green infrastructure in an urban management strategy, linked with the broader Metropolitan Vancouver Regional District Sustainable Region Initiative (SRI) that values sustainability as its core operating and planning principal. The CoV is taking a one planet, local and regional approach to reduce the ecological food print, a component of its footprint (GCAP: 2011,3), to become a global climate leader by committing to the reduction of GHG emissions by meeting the Kyoto target by 2020. GHG emissions are reduced to 1990 levels, despite a population growth of 27%, an increase in jobs by 18% and in spite of the withdrawal of the National Government from the Kyoto process in 2011. The action plan is an ecological model, which outlines goals for achievement in eleven highly integrated subject areas, nested within three key areas that include carbon, waste and ecological systems (Fig. 1.9). The defined targets and outcomes included in the city action plan in the eleven key areas are interrelated (Fig. 3.2.) to include the green economy, climate leadership, green buildings, transportation, zero waste, access to nature, the ecological footprint, water quality and quantity, air, and local food. The CoV recognizes that although it is not a land use plan, density plays a key role in reaching sustainability goals (GCAP: 2011,5). Sound practices often link restorative urban forestation with urban greenery initiatives as a carbon sink and as a tool for urban beautification (ISDR: 2009,109). Rarely, however, are these initiatives integrated or linked with community agricultural interventions which have a further benefit of providing food security and a local urban food source, as well as a means to close loops in waste and water management practices mitigating the effects of climate change. It is this gap

[1] http://www.eiu.com/public/topical_report.aspx?campaignid=Liveability2011 The Economist has ranked The City of Vancouver as the most livable city in the world for the past five years, only recently surpassed by Melbourne, Aus., and Vienna, Austria. The rankings are measured according to standards within the main categories of stability, healthcare, culture, environment, education and infrastructure. http://encounteringurbanization.wordpress.com/2011/04/07/city-index-part-1/

in the literature, which this thesis investigates. It is the integration of the Regional Green Zone Initiative, part of the Vancouver Metropolitan Regional Plan (MVR), created through early community interaction that lead to further studies in the City of Vancouver to link urban Forestation and Urban Agriculture (Van: 2020: 2010, 61) to reduce the Urban Heat Island. While local food, the green economy and the ecological footprint are defined as the three key areas nested within the larger focus areas, the case study demonstrates the process of integrating local food and urban forestation in the public and private realm, through connected greenways, such as boulevard and traffic circle planting, community and communal agriculture, and more significantly, intensive urban agriculture as Social Enterprise (SE), through a Corporate Social Responsibility (CSR) Intensive Green Roof Project, and through Community Supported Agriculture (CSA), embedded within local neighbourhoods. It is this intersection where climate mitigation, urban food security as urban agriculture and forestation will have the strongest impact. The thesis concludes with recommendations for further policy and by-laws to include green roofs and intensive vertical farming, particularly in industrial areas and the expansion of intensive food and forestry stewardship programs in community center locations were a continuum of ownership can occur. While Heat Islands are not directly addressed by the GCAP with direct discussion appearing in the CoV Emergency Response Plan (2009) and the Environment Canada Report (2002), they are addressed indirectly through the CoV food and forestation mitigation strategies. Green infrastructures, such as waste and water management are outputs and inputs of producing sustainable local food and are discussed in this context. The case study provides a road map that is a useful tool to create an enabling environment in other global regions in the development of an integrated food and forestation system that addresses multiple sustainability synergies. Interviews, presented in a narratology format, field research, photography and diagrams are the methods used in this case study and cross-referenced to the literature review. **Section 3 and 4** demonstrate how the CoV utilizes the planning tools defined in **Section 2** and supports the rationale presented in **Section 1**, for why cities need to be more sustainable and the source of their own food supply and how this can be accomplished through the integration of intensive local food and forestation initiatives.

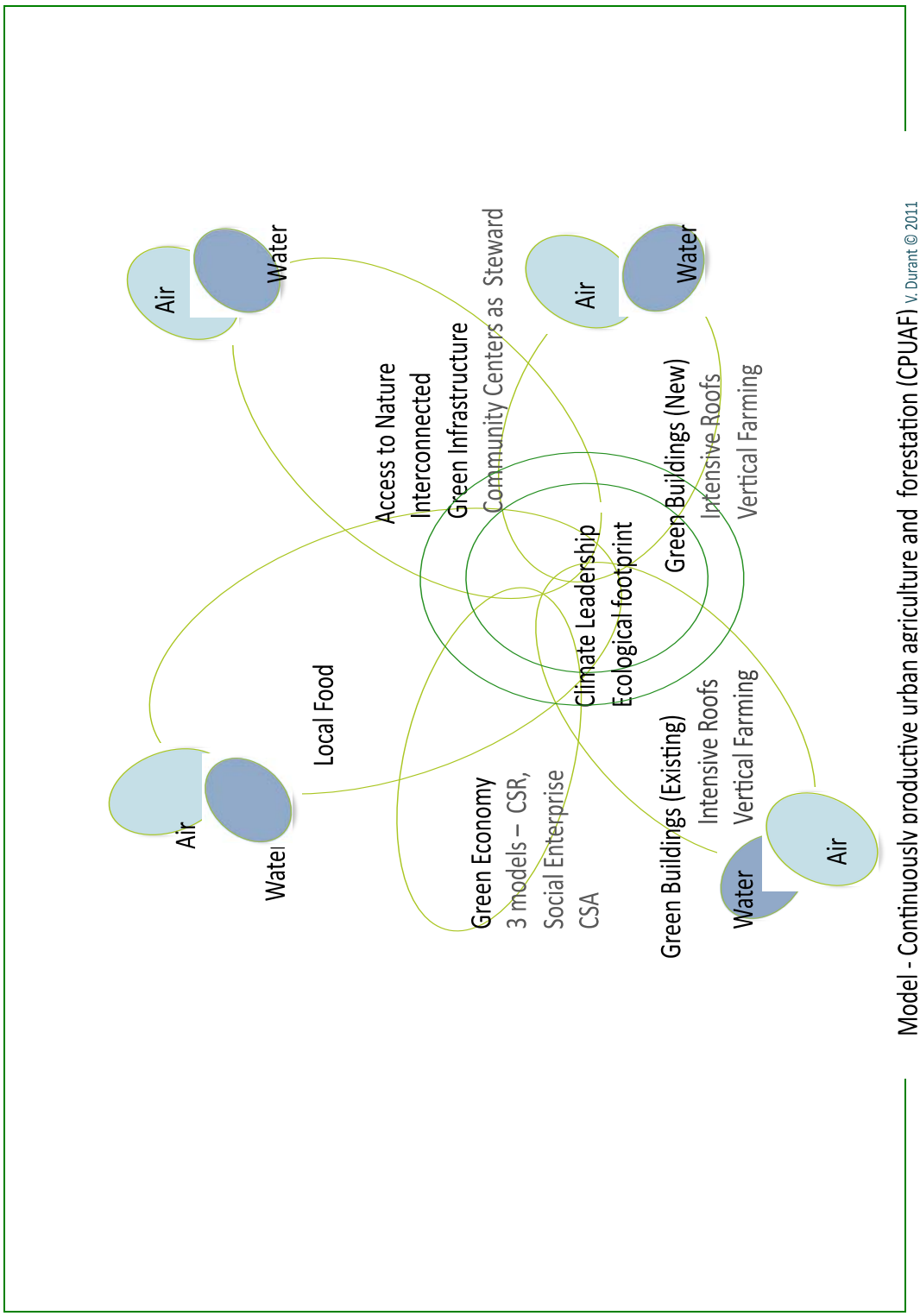


Figure 3.2. Concept Design: V. Durant**.** Interrelationships of key sustainability issues.

3.0.1. Rationale - Reconciling Global Challenges

Globally, agriculture is one of the most sensitive of the economic sectors as discussed in **Section 1**. However, according to the CoJ, (2010,64), "urban agriculture holds the potential to provide security for the most vulnerable of urban residents." Field research for the publication, The Face of Africa: Along the Road (Durant 2009)[2] supports the CoJ report. Reconciling global disparity to harmoniously address key issues is a challenge that faces planners in all key sectors of the planning spectrum and on a global scale. An ecological approach, applied at a local scale, is demonstrated by the CoV and through project examples, in **Sections 3 & 4**, as a successful approach to support human and species survival on a global scale. The approach, applied to the food and forestation sectors is integrated in all actions proposed and planned by the CoV. The purpose of this document is transferability, recognizing that system challenges are not isolated, although they possess context specific characteristics, such as microclimate adaptations and socio-economic and cultural variables. Economies, cities, regions and buildings are living nested systems located in a system that is universal to all living organisms, human or otherwise (UNHSP:PSC: 2009,121; Capra 2010; Ruth 2009), as the literature review suggests, and is further presented in the following case study of the City of Vancouver.

Furthermore, the goal is to recommend the role of urban agriculture and food production systems, beyond a few heads of lettuce and trendy front yards full of wheat grass, to implement intensively productive urban agriculture and forestation policies and by-laws to feed the ever increasing urban populations, to protect local food systems from vulnerability, and to provide local and global climate resilience.

Actions of local food production contribute to the reduction of GHG emissions by reducing food miles traveled and waste outputs. The streamlining of policy to support intensive local urban food production, integrated in all aspects of the urban fabric, will include regulation and by-laws that require a percentage of new roofs and walls in industrial, commercial and medium to high density residential development to include

[2] Durant V. (2009) The Face of Africa: Along the Road. Study supported by The Canadian Government in South Africa The International Office of Migration (IOM), Cultural diversity and the rural urban interface in Sub-Saharan Africa was investigated and presented in a number of workshops, publications and events.
http://www.alliance.org.za/05-March-2009-Exhibition-Valerie.html
http://alliance.org.za/Valerie-Durant.html?var_mode=calcul

intensive CPUAF, will mitigate local and global climate effects by reducing emissions produced by building heating and cooling systems while intensifying agricultural production (Section 1). Creating an "enabling environment, which engages citizenry and multi-stakeholders at all levels in participative and in strategic food system planning" is, according to Stanley Visser, Director of Urban Agriculture in Cape Town, RSA (2011) "recognized as the necessary approach to successful sustainable food system planning, regardless of global or regional context" (UAP: CoCT: 2007,3). Evidence of this is present in the CoV, where an educated, highly democratized community has historically informed policy makers in the shaping of Vancouver's urban form. Visionary planners, and experts applying the key tools and strategies of planning defined in Section 2, along with the input of a well informed public, have and continue to shape the livable City/Region, leading to the Greenest City Action Plan: 2020, both a legacy and a strategy for the future of a sustainable edible city.

3.0.2. Methods

Unstructured interviews with Dr. Bill Rees (2011), with three academic papers provided, led to interviews with Dr. Art Bomke and followed a chain of investigation (Yin 2011) that led to primary research at the July 2011, Vancouver Food Policy Council (VFPC) Meeting. Subsequent informal interviews followed with Brent Mansfield of the VFPC, resulting in access to the draft MVEHP, also discussed by Ann Rowan of the MVR, at the VFPC meeting. James O'Neill, Social Planner, and Ross Moster of Village Vancouver provided interviews and documentation. Dr. Moura Quayle, provided details regarding the Urban Task Force, the Greenways, the ALR program, as well as three publications and the interview led to an unstructured interview with Alan Duncan, environmental planner with the Park Board, who provided details on the Urban Forest Management Plan, Tree by-laws for the private realm and the Freesia Rooftop Garden. All of the experts, with the exception of Dr. Rees, who was not presented with the model, reviewed the draft model of integrated systems, illustrated in **Figure 3.14** and provided feedback, resulting in the outcome. Much of the data comes from a website review of the many plans and documents available regarding the processes and tools utilized by the CoV leading to the GCAP. The website review illustrates the level of transparency and public participation and education demonstrated by the CoV. Hyperlinks to websites are incorporated, for ease of accessibility as a hyperlink database, suggested by Yin

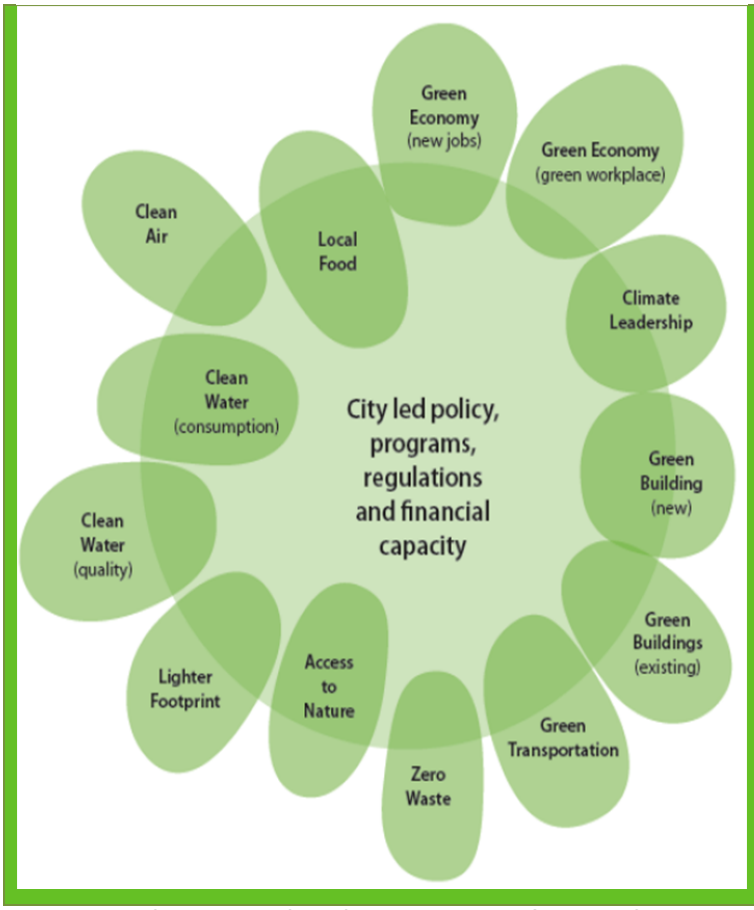
(2009) to support converging evidence, graphically highlighted in green text boxes for ease of access for the reader. The Green Boxes provide direct access for the reader linking directly to the "How" answers, addressed by the thesis question. The case study refers to the literature review and triangulate data from informal interviews, documentation, direct and participant observation during field research, photographic documentation, and observation of the physical environments, the six sources of evidence recommended as most commonly used by Yin (2008). The case study of the CoV and GCAP, **Section 3,** supports the rational for "**why we need to be more sustainable**" defined in the literature review, **Section 1**, while demonstrating the tools and processes in action, used by the CoV to implement the GCAP from **Section 2. Sections 2 and 3** cross-reference the tools and processes. For example, the Ecological Footprint described in **Section 2.1**. as a tool, is application in **Section 3.1**., "How the city applies the tool. A Narrative approach, a method recommended by Dr. Karina Landman (2011), was utilized extensively to weave in expert evidence gathered in informal interviews. An eloquent discussion by Dr. Bill Rees in his own words, is presented in **Section 3.4**, regarding the history of citizen activism in the CoV, and the value of the ecosystem, is presented in its entirety. Using flexible design to weave the story of sustainability in the City of Vancouver, uses mixed methods, provides what Yin (2008, 63) describes as "A richer and stronger array of evidence than can be accomplished by any single method alone."

The Case study of the City of Vancouver planning system, provided the background to the case studies of CPUAF intensive farms, presented in **Section 4.**
Conclusions follow in **Section 5.**

3.0.3. Background - A Strategic Administrative Ecological Action Plan - Addressing Multiple Sustainability issues

The City of Vancouver has chosen to address the issue of true sustainability, following the ecological model approach as defined by Wheeler and Orr, discussed in the literature review, **Section 1.6.7**. The CoV is striving for a one planet EF, using locally applied strategies from the B2 ICPP model (ICPP 2007), and branding their sustainable action plan as the Greenest City by 2020. "Green," is defined by UNEP, in figure 1.12, as restorative and preservative of environmental quality, while the CoV, has added "the

growing local food" to the UNEP definition. In discussions with Moura Quayle about the sustainability focus of the city, she said (2011), " There was a lot of discussion around what language they (the CoV)[3] should use for their branding; whether it should be Sustainable or Green. In the end, they stayed with "Green" as it is one syllable and sustainability is a mouthful." Simple. While it is a principled sustainability plan, it is more than "Green". The success is based on a high degree of public education, knowledge and engagement throughout a co-evolving process of participatory planning, Orr (1995) defines, the core principle of ecological sustainability as, "the paradigm, based on the concept of interrelatedness as a system of knowledge, with education of its citizenry as the salvation, as the underpinning of the ecological systems". The success of the Greenest City Action Plan by 2020 rest heavily upon the principles defined by Orr and is the understory of the planning process underway in the City of Vancouver.



The Greenest City 2020 Action Plan -
The CoV wrote a strategic action plan which the city will take in order to achieve the targets in the ten key areas noted to the left. The plan focuses mainly on environmental issues; however strong green economic development, social sustainability, and equity lenses are put on, in order to insure that critical sustainability issues are met. The GCAP recognizes that many of the actions can only be delivered thourgh city led policy and programs in relation to other levels of government and NGO's as well as with the community at large. The public engagement process as well as the integrated planning process within numerous CoV departments were and will continue to be crucial to the success of the plan (GS2020AP :4:2011).

Figure 3.3. Source: The City of Vancouver. The Greenest City 2020 Action Plan http://vancouver.ca/ctyclerk/cclerk/20110712/documents/rr1.pdf

[3] (THE CoV) was added by myself as Dr. Quayle was speaking of the City of Vancouver in the context of the conversation.

3.0.4. The Ecological Model in Action: A Focus on Environmental Issues

The progress, of the pursuit of sustainably developing through a highly democratized participatory process can be measured by means of performance indicators. The CoV is developing a transformative planning process with a means to measure the sustainable performance of the city in ten specific target areas that include Nature, Local Food Systems, and Climate Change. The process integrates the older three-legged Economic, Ecological and Socially sustainable model in a nested ecologically sustainable framework as illustrated in **figure 1.14**.

While smart land use is recognized as critical in achieving a sustainable city, the Vancouver Model is not inclusively a land use plan. While the role of density in particular is critical, in achieving climate leadership, green building and transportation targets are highly dependent upon land use decisions and are at the forefront of achieving the Greenest City Action Plan initially developed by the CoV in 2004. It is the implementation of a local food system and forestation plan that supports ecosystem services, addresses carbon and cycles waste, and which can also reduce the UHI effects, that is at the forefront of transitioning to the ecological model of sustainability. The CoV, is actively visioning and implementing a sustainable food system that minimizes dependence on global or distant food sources, increasing local production capacity as a proponent of it's Green Economy. According to Kira Gerwing (2011), Social Enterprise as a new economic paradigm, doing away with the Charity Model, plays a key role in the new economic strategy of the CoV. The city is highly supportive of social projects based on the ecological model of sustainability, such as SOLE Food, as demonstrated in, **Section 4.3**.

3.0.5. Challenges

Providing a platform for the development of innovative processes that supports intensive urban agriculture and forestation on underutilized land, buildings and rooftops, particularly in the more vulnerable areas such as the DTE's is one of the greatest challenges facing the city. The GCAP:2020 as the platform, is a climate resilient, economically viable and ecologically sound, socially equitable action plan and is a springboard for community to engage in partnership of the co-evolution of the plan.

Finally the CoV has identified and integrated the key programs, “access to nature” and” local food production” by quantifiably identifying areas of new interconnected open green space in the Action Plan and in the Urban Forest Management plan, currently in process. This includes the addition of 150,000 trees and the increase of 25% edible landscaping (Duncan 2011; GCAP: 2011, 5), that supporting food distribution and production.

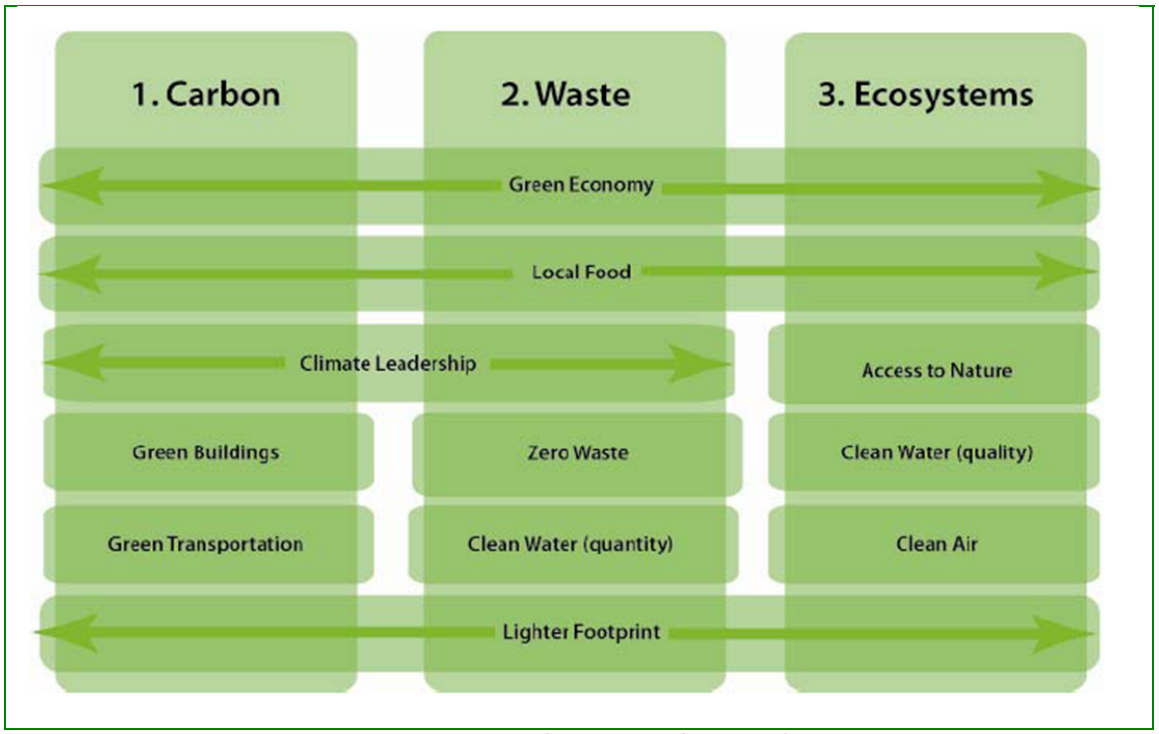


Figure: 3.4. Nested actions in three key themes. Source: The Greenest City 2020 Action Plan. http://vancouver.ca/ctyclerk/cclerk/20110712/documents/rr1.pdf

3.0.6. Nested Systems in Action

The CoV is strategically directing financial resources to the implementation of the action plan that will focus on three themes: Carbon, Waste and Ecosystems. Figure 1.14, shows how all ten targets are nested in the three focus areas:

Local food, as well as the green economy and a lighter footprint are embedded in all three of the target areas and will be discussed in the case study. Growing the *local food economy* is an integral component of the Food System Strategy. Furthermore, Access to

Nature, a component of the action plan is integrated with the greenways project and is co-managed by the Park Board and City. Together, they have a strong mandate for integrating urban agriculture, as a component of the urban forestry plan (Duncan 2011; GCAP 2011). Meanwhile, the built environment holds the potential for food production as well as waste, water and air management while addressing climate and heat island issues.

The Greenest City Action Plan by 2020 (GCAP) is a 162 page, Administrative Report presented to Council on July 5, 2011, recommending:

"A. THAT Council adopt in principle the Greenest City 2020 Action Plan (GCAP), included as Appendix 1, direct staff to begin implementation of the highest priority short term actions, and to report out on progress made against the targets every two years beginning in 2013. Staff will seek Council approval of programs and projects that require policy change or significant financial investments, and cannot be accommodated in current operating and capital budgets. " (GCAP, 2011,1)

The Greenest City Action Plan is an applied systems model (A useful tool) in developing urban sustainability, illustrating the interconnectivity of multiple systems including food and forestation across nested systems that include buildings, the green economy, waste and water management, with a climate leadership and an ecological footprint lens applied across all goals.[4]

A baseline study, as illustrated in Figure 3.6, identifies the local trajectory of GHG emissions and provides a baseline for comparison to other global cities (Figure 3.7). The goal of the Greenest City Action Plan is to have the lowest GHG emission on the planet by 2020, to become a leader in food systems planning, and to ensure that every person lives within a five-minute walk of a park, beach, greenway or natural space. The historical context and background follow in **Section 3**, with the integration of food and forest defined in Section 3.11 as a **Continuously Productive Urban Agriculture and**

[4] The complete report on how urban agriculture and forestation, as well as the other key areas are links is available at: http://vancouver.ca/ctyclerk/cclerk/20110712/documents/rr1.pdf

Forestation Model (CPUAF), with **Section 4** demonstrating applied projects within the COV. While, the CoV is on the path to sustainability as a CPUAF model, it recognizes that future work is needed.

Behind the GCAP is a history of a succession of developmental processes. A broad range of stakeholder and taskforce participation identified qualifiedly and quantifiably, the goals and focus areas of the GCAP to provide a baseline and a layering of steps in the process for intervention and a catalyst for action, explained in this section. They include local citizens, businesses, community partnerships, and multiple levels of government and departments in a process of co-evolution (Figure 3.14). Information from regional climate modeling, ecological footprint analysis and task force outcomes, inform the highly consultative, participatory process. The public, through adaptive systems management reciprocally provides feedback that influences regional and municipal management and the strategies, actions and goals, culminating in the GCAP. The process and historical background is presented as a model for cities and regions in developing regional sustainable food and forestation strategies that reduce GHG emission, reduce the UHI effect, and provide a secure and resilient local food and forestation system.

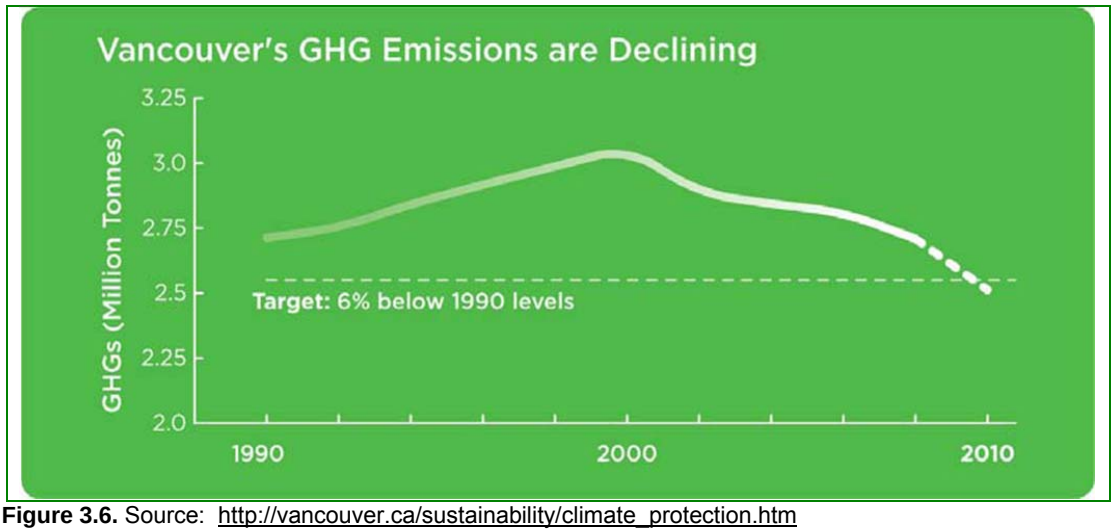
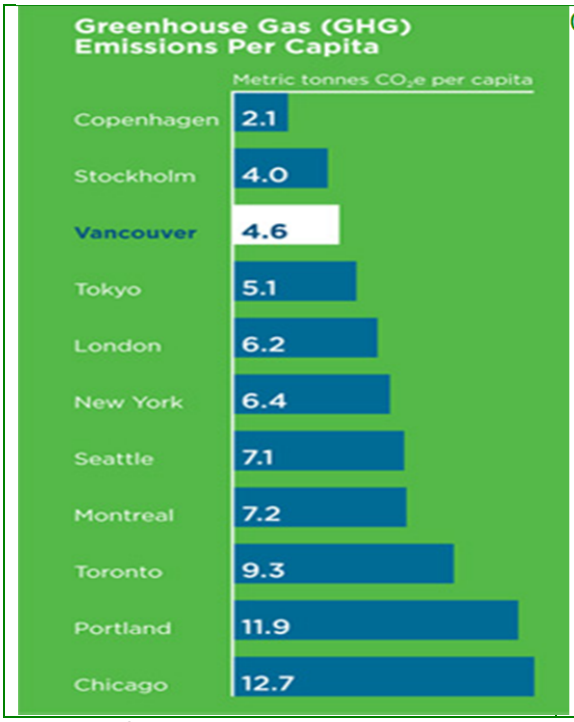


Figure 3.6. Source: http://vancouver.ca/sustainability/climate_protection.htm
GHG Emissions Baseline from 1990 to 2010. Emissions in decline.



Climate Protection Targets

2012 Reduce community emissions by 6% (on track).

2020 Reduce community emissions by 33%

2030 All new buildings are carbon neutral.

Figure 3.7. Source: http://vancouver.ca/sustainability/climate_protection.htm
GHG Emissions Baseline and Targets by action and comparison to other global cities.

Figure 3.7. Source: MVR. Vancouver and the Vancouver Metropolitan Region. The US border to the South, the Coast Mountain Range to the North and The Salish Sea (Strait of Georgia) to the West.

3.0.7. Regional Geographic and Historical Context

The land area represented by the MVR is 287,736 hectares and represents a population of 2.3 million people (Statistics Canada 2006; MVR 2011), while the CoV has a population of 578,000 (Statistics Canada 2006). Vancouver is a product of its unique geographical context, with a spatial framework edged by the Pacific Ocean and the Strait of Georgia to the West, the Coast Mountain Range, rising out of the sea to the North, and the 49th parallel, the border which delineated Canada from the United States to the South (Figure 3.4). The Fraser Valley River delta, the richest agricultural land in Canada, managed by Fraser Valley Regional District (FVRD) provides the eastern boundary. The Fraser River and Burrard Inlet dissect the region (MVR:SRI: 2010, 12) causing the pattern of development to take an unusual form based on the geographical constraints.

Vancouver is a young city, in global terms, beginning its life in the 1860's when it was first settled by British farmers and was a trading hub for the export of furs and gold destined for Great Britain (Oke & Wynn 2001). The region was initially surveyed by the crew of the HMS Plumper and on board was (my great uncle) E. P. Bedwell, the staff commander and ships visual artist (B.C. archives). E.P. was responsible for many of the early visual representations of the pristine and untouched rainforests of the region, while

many bays, harbours and inlets still hold his name. The ships crew were responsible for navigating the region and documenting the magnificent and breathtaking original natural form on behalf of HMS and much of the understanding of the ecological nature of the region comes from personal historical context and mapping (Figure 3.1). It was not long before the biophysical form of what was to be the City of Vancouver, with its protected harbour, ideally situated as a port, was altered drastically, and the land was cleared to make way for urban development. Industry sprang up around South East False Creek (SEFC) and the port, which is located north of the CBD and the DTES. Much of both of those areas remain industrial or underutilized today, and both of which have a higher near surface heat island (CLHI) than other areas of the city along with the Marpole Industrial Area, located on the North shore of the Fraser River (Figures 1.3, 1.4, 1.5). The CBD with a high CLHI, is devoid of trees while the West End, surrounded by North America's largest urban forest, sprouts a highly developed tree canopy and well planned residential density, maintains low near surface temperatures (Figure 1.3), while the density of both areas produces the lowest GHG emissions in the CoV (Figure 1.6). Despite the clear cutting of the industrial sections within the CoV and the MVR, the municipality and the MVR and the citizenry have maintained a long history and affinity for valuing the ecosystem including agricultural land, the wildlife and the waterways and the mountain views as valuable and irreplaceable resources (MVR 2010; MVR 2009; Oke & Wynn 2001). In 1990, The GVRD, (Now MVR) produced through public consultation, the Livable City Regional Initiative (LCRI) and in 2002, the Sustainable Region Initiative (SRI), with sustainability as the core principle, guiding the twenty-four member municipalities, through to 2040. In the 1920's, the old growth vegetation was replaced with abundant tree lined streets at a rate of 70 trees per kilometer (Oke & Wynn: 2001,151), and early planners situated park locations before housing (Dory 2011). The initial concerns for the inclusion of an extensive tree canopy and greenway planning are instrumental in the on-going protection of trees, through the progressive tree protection by-law (Oke & Wynn 2001; Duncan 2011). As a result of early environmentalism, the City of Vancouver has maintained the largest urban forest in North America and a tree canopy that would rival most global city regions. Future planning (GCAP 2011; Duncan 2011), proposes 100,000 new trees, in the public and private realm, and in areas where there is a shortfall and includes a plan to integrate urban agriculture within parkland, an innovative strategy only beginning to enter the global sustainability paradigm.

3.0.8. Protection of Agricultural Land and a Sustainable Growth Strategy

Forward thinking planners in partnership between the MVRD and the FVRD, protected the rich agricultural land, which is within what is considered a sustainable, hundred mile food radius (Mackinnon & Smith 2005) of the CoV, from urban sprawl and suburban development by establishing the Provincial Agricultural Land Reserve in 1974 (ALR 2011). Of the overall land area, 54,000 hectares (135,000 acres is included in the Agricultural Land Reserve (LRS: 1996,10; Stats Canada 2009)[5]. The CoV with a population of 578,000 (2006 census) is a port city, with flows of economic dynamism, which provides employment and attracts rural population in search of economic stability. There is a high level of urban poverty in the region, specifically in the urban area of the DTES and food security is identified as an area of vulnerability according to the (MVRFSS: 2010, 24), The Eco Density Charter (2008, 2) and The Vancouver Food Charter (2007, 1).

Land use planning that incorporates density, with continuously productive urban agriculture and forestation (CPUAF) is the necessary outcome to support livability through sustainability in the region. A future plan that addresses the convergence of major issues that threaten sustainability, discussed in **Section 1**, that addresses global climate change, the local UHI effect, increased global and urban population growth and that provides food security that protects vulnerable populations and economic growth is the trajectory of the Greenest City Action Plan.

3.0.9. The Future – Regional and Local Growth

According to the food secure Baseline Vancouver study, B.C.'s population growth is projected to increase by 30% by 2025. B.C. Farmers produce 49% of all foods consumed in BC while the BC Ministry of Agriculture anticipates that farmers can produce 58% (FSBV: 2009, vi) of consumable horticultural products. The threat to

5 A Detailed Map of the MVR Agricultural Land, Green Zone areas, wetlands and tidal flats can be found on Page 3 of the Green Zone Issue sand Policy Options: Strategic Plan Review Workshop. http://www.metrovancouver.org/planning/development/strategy/BackgroundPapersReports/GreenZoneIssuesandOptionsDiscussionPaper-fnl_%20Dec05.pdf (Accessed June, 28 2012).

increased agricultural production is caused by the removal of agricultural land from the Metro and Fraser ALR for the purpose of industrial and residential development. This is occurring despite protection by the ALR. Strong consideration must be given to increase growth through intensified urban agricultural production to make up the productive shortfall. This can be assisted through policy intervention, which will encourage the increase of rooftop and vertical production as well as making way for creative utilization of under-utilized space such as the SEFC area and vacant lands throughout the city and the MVR, and by encouraging the sustainable production of food products on privately owned property, particularly in industrial zones.

The intensification of individual urban agricultural production has often occurred during times of conflict. For example, in Great Britain, between 1939 - 1944 allotment, and community gardens, along with household plots, were producing half of the nation's fruit and vegetable requirements (Viljoen 2009, 101; Crouch & Ward 1988). Growing food at home intensively in urban environments builds local resilience, in times of foreign catastrophe (FSVB 2009) such as climate insecurity and peak oil depletion. However, trade decreases the potential for domestic crop failure brought about by the same issues, therefore there is always a consideration of balance and knowing your local vulnerabilities and strength.

The Tools & Processes Applied within the City of Vancouver to achieve a Continuously Productive Urban Agriculture and Forestation System (CPUAF)

The tools and processes, reviewed in **Section 2**, to integrate a climate resilient sustainable food and forest system are applied in the City of Vancouver (CoV). Unstructured interviews, and a review of municipal documentation are the main methods of data collection utilized in this chapter.

The chapter headings directly cross reference to **Section 2** of the Literature Review and provide answers to how the CoV is planning to achieve the goals of the Greenest City Action Plan by 2020 (GCAP 2011).

3.1. The Ecological Footprint

The CoV is one of many cities striving to achieve a "One Planet Ecological footprint," a measure in which all of the productive land and sea available on earth is divided evenly amongst the global inhabitants (GCAP: 2011,105) as described in detail in **Section 2.1**. The target is to reduce the per capita EF by 33% over 2006 levels by 2020, and to achieve a one-planet footprint by 2050. The CoV's per capita footprint is 5.31 global while a sustainable one planet EF is 1.8 global hectares per capita. (Global Footprint Network 2010). The CoV places an EF lens on all GCAP goals (GCAP: 2011,15) which includes food and forestation, which is linked through the increase of fruit trees, community gardens, rooftop public space and by recommending that future research must be carried out to determine the total yield potential of urban agriculture in Vancouver (GCAP:2011, 117). The results of a baseline study indicate that 40% of the EF of the CoV (Figure 3.6) results from the full production life cycle of food. The CoV links urban forestation to the EF, through the increase of shade produced by the urban forest, with a plan for an additional 150,000 new trees by 2020, projected to reduce building cooling costs, reducing energy consumption, reducing GHG emissions and the UHI effect. Further, increasing parks through linked greenways, will promote walking and cycling (GCAP:2011, 105), reducing transportation costs. Building food production into rooftop and vertical wall development bylaw for new construction and parkways will further address the interrelationship between food, forestation and building systems. The city recognizes that certain aspects of the EF, particularly food production, are not traditionally within the scope of City regulations or policies, its goal is to develop coordinated municipal food policy that promotes life style change through advocacy and public awareness, which included industrial areas and parking lots, defined by the park board (Duncan 2011; GCAP2011). It was identified that while 62% of residents had heard of the EF, only 7% could correctly identify its true meaning; therefore a public engagement campaign to achieve its goals and targets is identified as a necessity by the GCAP:2020 (141).

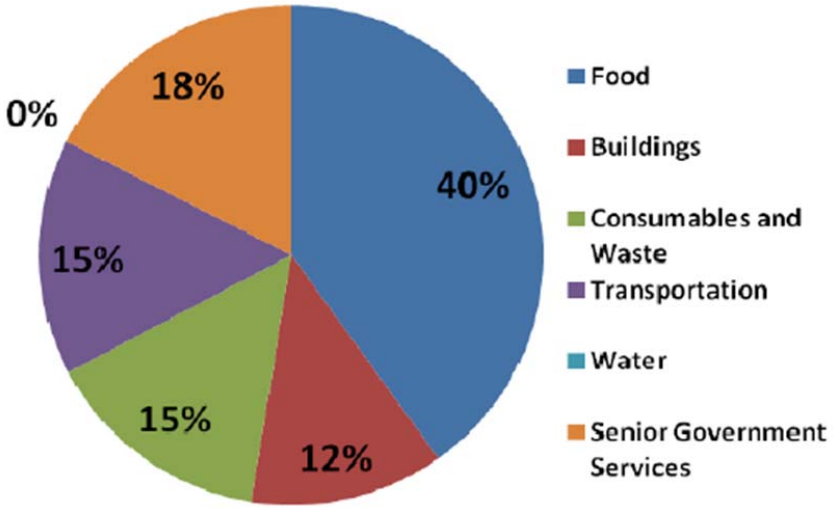


Figure 3.8 Components of The COV's Ecological Footprint (Adapted from J. Moore, 2011). The GCAP: 2011, P.106.

3.2. Climate Modeling: How it was applied within the CoV and the Regional Implications

3.2.1. Climate Change Adaptation Report - Informing the MVR: Environment Canada Regional Report on Climate Change

In June 2000, a climate change adaptation report was prepared by Environment Canada, Pacific Region, to assist the GVRD, now known as the Metro Vancouver Region (MVR) in developing adaptation strategies for long term planning (ECRRCC 2000). The report summarizes the potential impact of climate changes in the MVR, as reported in the Canada Country Study and other work completed both inside and outside Environment Canada (ECRRCC 2000). The report provides background on the basics of climate science, global climate change and greenhouse gas emissions. Furthermore, the report supports scientific analysis that the combustion of fossil fuels and other human activities are responsible for the increased concentration of carbon dioxide in the environment, as elaborated upon in the literature review (ECRRCC, 2000) **Section 1.1**.

3.2.2. Global Climate Model Scenarios

Environment Canada summarized future climate scenarios produced by two different global climate models. The two models used included:

1. The Coupled General Circulation Model developed by the Canadian Centre for Climate Modeling Analysis;
2. The Hadley Centre developed a model for Climate Research in the UK. (ECRRCC: 2000,7; HadCM2 1999), and is a model used by cities around the world to develop resilience strategies.

The MVR has an open system of interactive information gathering and reporting with the public. As a result, details on the results of experiments performed with both models can be found at the following website:
http://wwww.pyr.ec.gc.ca/climate-change/documentatin.htm

3.2.3. Measured Climate Change - Explaining the Urban Heat Island

The EC report discusses urban growth and the association with the heat island effect, causing increased temperature conditions (normally nighttime), as well as sometimes affecting precipitation (ECRRCC: 2000,7). The EC report supports Oke & Wynn (2001,159) that "large scale climate effects often mask local effects" by stating conversely that "local conditions are often excluded from regional and global climate trend analysis as they distort the larger scale climate analysis" (ECRRCC: 2000, 7). The report does not specifically elaborate on the effects within the CoV; however, it confirms that rapid urbanization, if left unchecked may seriously degrade the Lower Fraser Valley air quality (2000, 11). As a result of the EC study, the CoV and the MVR initiated further analysis of local climate effects with steps to achieve adaptation and mitigation goals. However, contrary to the recommendations of the EC report, the ALC approved the release of 178.5 hectares of prime AL in the Abbotsford Municipality, located within the FVRD, currently used for diary, poultry and raspberry production, "to meet the 20 year projected need for additional industrial land" (FF: RALR: 2006, 19). The release of AL for industrial development took place despite the local climate analysis by Environment Canada in the FVRD. Further research is required to determine the outcome of

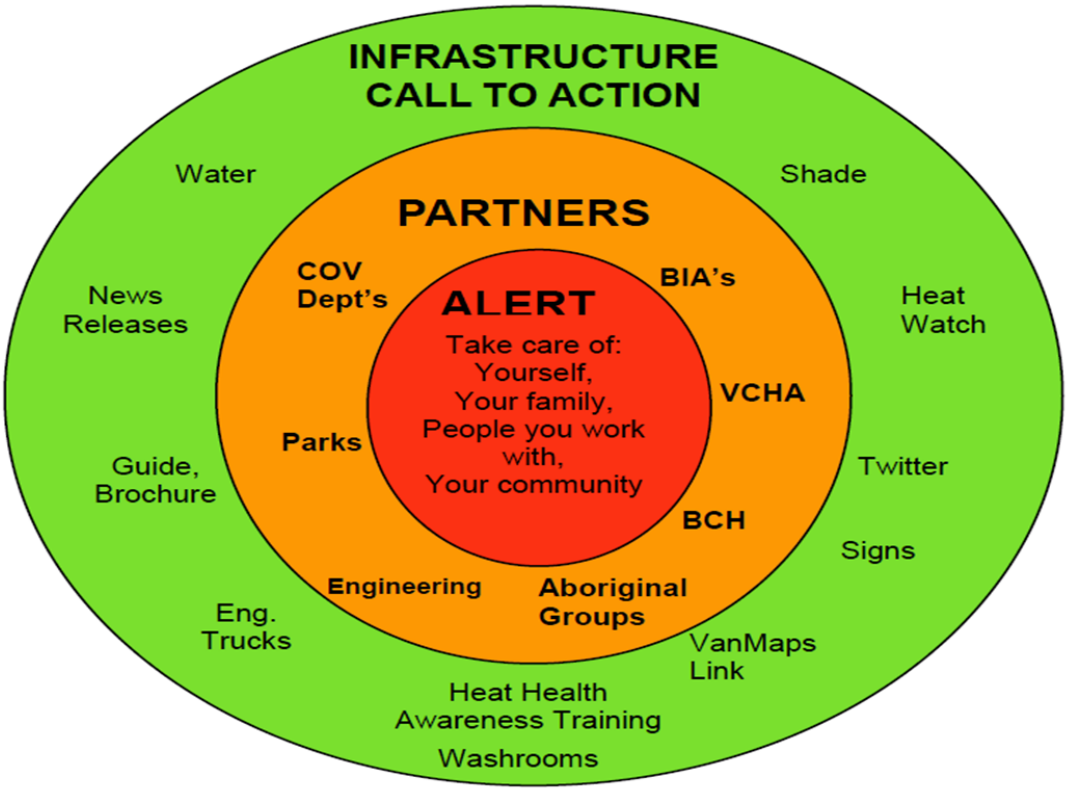
industrialization on the local UHI, in an area identified as potentially facing future climate degradation. Based on the initial EC climate assessment, urgent intervention in the planning process, particularly in the Metro and Fraser Valley Regions is recommended to implement intensive green roof and vertical farming bylaws in industrial zoning, as well as reduce parking requirements and increase tree canopy to address the removal of agricultural land.

3.2.4. CoV - Extreme Hot Weather Response

In Vancouver, future rainfall is predicted by EC (2002) to increase, resulting in higher humidity and an increase in temperatures. According to a study by Smoyer-Tomic, et al. (2003), a temperature of 30 degrees C in Vancouver would be considered highly anomalous and could exact a great toll on human health. Such an extreme did occur in the CoV in August 2009, when temperatures spiked for 5 days to an average of 38 degrees, with three days over 40 degrees C. The extreme in temperature, the hottest in recorded in history, resulted in a well-publicized death of a homeless member of the population. According to a global climate modeling scenario produced by PICS: Vic (2008), the majority of Canadian urban areas will experience extremes in temperatures of between 3 – 5 degrees. Preparing for extremes, even in cites which do not normally experience regular heat waves is necessary and as a result, the CoV developed an emergency preparedness response.

In June 2010, the CoV adopted an extreme hot weather preparedness response plan for vulnerable populations, in response to the death of a homeless man on one of the hottest days in Vancouver's recorded history as well as in response to the EC Report. The CoV is following the lead of other major cities such as Toronto, Chicago and Phoenix, in order to mobilize and educate community groups and citizenry during periods of extreme hot weather. The strategic plan mobilizes community groups in the first phase (Figure 3.7), while the second phase calls for a comprehensive implementation plan with a mitigation strategy, that links vulnerable areas within the City with activities such as tree planting. [6]

[6] The complete report *Review of Preparedness and Response Services During Extreme Weather* is available at: http://vancouver.ca/ctyclerk/cclerk/20100706/documents/rr1.pdf



An Extreme Hot Weather Alert will be called when hot weather conditions are deemed severe enough to present a substantial threat to the life or health of vulnerable persons.

Figure 3.9. Credit: City of Vancouver – Action Plan for Extreme Heat Events

3.2.5.Conclusion

The effects of UHIs are expected to be less extreme in the CoV and MVR by comparison to the occurrences in Europe and in other regions. However, the data found concerning climate uncertainty and temperature anomalies suggest they will occur. Integrating food and forestation planning, an ecological approach taken by the CoV, is shown to reduce climate effects, is recommended to reduce heat island effects, and is a useful model applicable in any global city or region.

3.2.6. Regional Response

While according to Global Climate Assessments (Figure 1.1.), The MVR, in which the CoV is situated is a lower risk area (UNHSP: 2011, 4) compared to other regions, the food supply comes from around the globe, with the bulk of fresh produce imported from California, Mexico and Florida, (FSBV:2009, 79), all of which are expected to experience high risk climate effects (See Figure 1.1).

As a result of the EC study, the MVR was able to assess future risks that suggest temperature and precipitation increases as well as prepare a response to the report which suggests that impact of climate change will affect food production and food security (Environment Canada 2000)[7]. The result of climate modeling led to climate scenario storytelling, a process recommended by the ICPP (2007) which is utilized by the CoV as a local approach to mitigating climate change and addressing food security challenges.

3.2.7. CoV Response – Steps in the Process

The Initial EC Climate Report informed the GCAP while there are a number of processes, which occurred leading to the outcome and targets. The following steps contributed to the development of the GCAP:2020:

a. Cool Vancouver Action Plan

In 2003, council approved the Cool Vancouver Taskforce, which brought together a diverse group of experts from a wide range of stakeholders, including educators, builders, environmentalists, corporate leaders and government. The Task Force recommendations, completed after a year and a half of planning, resulted in The Community Action Plan and The Corporate Climate Change Action Plan. Both reports present “a comprehensive and systematic approach to the challenges of climate change”

[7] The entire Environment Canada report is public information, available to anyone who wishes to view it on the MVR website at: http://www.metrovancouver.org/planning/ClimateChange/ClimateChangeDocs/ClimateChangeImpactScenarios.pdf >

(CCCAP, 2005) and were intended to address municipal operations and community – wide emissions within the CoV.[8]

b. Community Climate Change Action Plan (CCCAP)

In 2005, Council approved The Community Climate Change Action Plan.

They developed a detailed GHG Reduction Plan, drawn from a broader context of polices and programs to support it from all levels of government. Many levels of government are involved in the hierarchy of addressing climate change. [9]

c. Corporate Climate Change Action Plan

Relates to the operations of city facilities and city owned lands and fleet. The first reference to food waste is contained in this report as a source to fuel City owned fleet vehicles. This has led to the SOLE food proposal to harness food waste as a component of a waste capture proposal in 2011 discussed in **Section 4.2**.[10]

The (Greenway) Urban Action Task force and the Provincial Agricultural Commission produced outcomes that influenced the GCAP alongside, and interwoven with regional and municipal climate action initiatives.

d. The Urban Action Task Force (UTF)

In 1991 and 1992, Moura Quayle chaired the original Urban Task Force (UTF) at the request of the mayor and council (Quayle 2011). Following the same processes as the Cool Vancouver Task Force, The UTF consisted of a diverse group of individuals old and young. According to Quayle, "the concepts crystallized quickly with the participation of city staff." The recommendations lead to the Greenways Program that far exceeds the traditional concept of trails through parks or along waterways. Instead this is a comprehensive vision of linear public corridors for pedestrians and cyclists that connect parks, nature reserves, cultural features, neighbourhoods and retail areas. In 1995, City

[8] The background, discussion and the steps in the process are available on the CoV Environmental Policy Report The CoV Environmental Policy Report http://vancouver.ca/ctyclerk/cclerk/20030624/rr1.htm
[9] The hierarchy of levels of government involved in the climate change discussion is available on the CoV website at : http://vancouver.ca/sustainability/documents/CommunityPlan.pdf
[10] See Section4.2)(Dory 2011;GCAP, 2011). The Full Corporate Climate Change Action Plan is available at: http://vancouver.ca/sustainability/documents/corp_climatechangeAP-1.pdf

Council adopted the Vancouver Greenways Plan, which has two major components: City Greenways and Neighbourhood Greenways, which came with an implementation strategy.[11]

e. Provincial Agricultural Land Reserve – Local & Municipal impact

In 1973, the Provincial Agricultural Reserve (ALR) was established to protect prime and irreplaceable agricultural land. Prior to inception, it is estimated that 6000 hectares (15,000, acres) had been lost to development (Quayle 1998). Of the entire geographical land mass within the province of B.C. only 3% is capable of supporting agriculture. This finite and irreplaceable land is responsible for sustaining an economic sector, ranked one the largest in the province (Quayle: 1998, 1). The Fraser Valley Regional District (FVRD), which is within a 100-mile radius of the CoV, has the richest agricultural land in the Province.

In 1994, the Agricultural Land Commission (ALC) Act was changed to promote the significance of local municipal government in agricultural planning. The delegation of power in decision making to local governments was relegated, so long as agricultural plans and bylaws supported agriculture within municipalities (Campbell 2006).

In 1996 the Provincial Government introduced the Farm Practices Protection Act that brought change to the Local Government Act. In consultation, **"The Right to Farm,"** was implemented in order to prevent local municipalities from restricting farming within their boundaries. As a result, the noise, the odors and what was previously considered the "messy aesthetic" of farming activities by urban residents has gained growing acceptance within the CoV as demonstrated by the number of community and communal gardens, guided by Park Board Policy,[12] and the increase in productive urban farming businesses and farmers markets supported by the CoV, demonstrated in **Section 4**.

The CoV's long term goal to become a global leader in urban food systems and to

[11] Details about the Greenway Program is available at:
http://vancouver.ca/engsvcs/streets/greenways/index.htm
The City Greenways Plan shows the Network of Connected Greenways:
http://vancouver.ca/engsvcs/streets/greenways/city/documents/CoV_Greenway_Plan_2011.pdf
[12] http://vancouver.ca/parks/parks/comgardn.htm (Accessed November 2011)

increase city and neighbourhood food assets by a minimum of 50% over 2010 levels through the implementation of land use policy and advocacy is well documented on the Talk Green to US website and within the GCAP:2020 Action Plan. The Right to Farm, is a powerful legislative support mechanism that is the underpinning of support for Urban Agriculture and The Vancouver Urban Food System.

Currently 80% of the ALR (FSBV vii) is in production and another 6% is underutilized as hobby farms or not in production. According to K. Merke, a Maple Ridge urban farmer, households located on ALR property receive an 80% property tax reduction if their property is utilized for farming purposes. Further research is underway, according to Ann Rowan[13], (2011), and a survey of ALR is in the process to create an inventory of farms in the Metro and Fraser Valley Regions.

3.3. Complex Adaptive Systems Planning & Transitional Management

A key element of the process of complex systems planning is the participatory model (Quayle 1998; Ruth 2006; Quayle, 2011; Visser 2011), which engages a broad range of stakeholders, who identify qualifiedly and quantifiably, the issues and provide a baseline for intervention and a catalyst for action. They include local citizens, businesses, community partnerships, and multiple levels of government and departments in a process of co-evolution. Information from regional climate modeling, ecological footprint analysis and task force outcomes, inform the participatory process. As well, the public, through adaptive systems management reciprocally led aspects of regional and municipal initiatives. Examples of this are Sole Food and the Fairmont Hotel, demonstrated in **Section 4.1 and 4.2.**

In the CoV context, the process is highly evolved, and the Urban Landscape Task Force ensured that the public realm was viewed as an integrated whole and not as separate streets, and parks, schools or engineering processes. “Adaptive Muddling” according to Quayle (2008, p.464 from De Young and Kaplan, 1988), resulted in the process far

[13] Ann Rowan, Policy Analysts with the MVR, presented information and discussed the MRV Regional Food Policy at the Vancouver Food Policy Council Meeting in July 2011, which I attended.

exceeding the mandate of separated departments as an outcome. As a result, the Greenways Details on how the process is implemented follows in the case study of the CoV, **Section 3.3.** while the formation of the Urban Task Force and the Provincial Land Reserve are described as steps in the process in the preceding chapter.

3.3.1. The Outcome: The Greenest City Action Plan

The culmination of climate modeling, task force processes, and a long history of public engagement and interaction with the Metro region resulted in the Greenest City by 2020 Action Plan.

In May 2009, Council received the GCAT Quick Starts report, which recommended early actions the CoV could take to become the Greenest City by 2020. This evolved from the earlier Urban Task Force as well as the 2000 EC Report, the Cool 2003, the Cool Vancouver Taskforce as well as a process of multi-stakeholder consultations including the MVR Livable Region Strategy. Concurrently and through consultation, The Provincial Agricultural Land Commission was created resulting in the ALC Act, which is a significant factor in the support and outcome of agricultural planning in municipalities that include the CoV (Campbell 2006).

3.4. Public Participation - The Unobstructed flow of Information and Knowledge

Increased urban population and development contribute to increased temperatures in urban areas. Urban forestation and urban agriculture contribute to heat alleviation according to the experts and was identified in the ECCCR (2002). The information was disseminated to the public in a number of forums resulting in Vancouver's Eco-Density strategy, a Climate Action plan launched in 2007. The report stimulated contentious debate through extensive public consultation on densification as a positive contribution to mitigating climate change, as well as address multiple sustainability issues (EDC: 2007, 8) (Figure 1.8). The outcome of the public, citywide initiative resulted in the identification of green systems that use energy, water and materials more efficiency, resulting in Re-zoning and Building Code changes, By-laws and the introduction of new

policy that supports resource efficiency (EDC:2007, 3). Further, the concept of urban agriculture was introduced to the public to reduce "food miles" (the distance it takes to get food to home), and to strengthen local food security (EDC:2007, 3). Eco - Density, successful within the city boundaries, has initiated mind set changes and "actions outside the city core" (EDC: 2007, 3). Arguably, it is a catalyst providing feedback, reciprocally, at the Regional level and influenced the MVRD Strategic Regional Interventions (MVRD: SRI, 2011). However, the systematic process that led to the development of the Eco-Density Charter was informed by the ECCCR prepared for the MVRD and the numerous consultative processes described in the previous two chapters. A systematic approach to informing the public on the facts lead to their understanding and acceptance of the realities of climate change and the need to increase density in order to optimize land water and protect ecosystems and agricultural resources. However, the process which stopped the implementation of a freeway, in the 1960's in the CoV was a catalyst for a continuum of citizenry power, and is a defining moment in its history of civil activism within the city (Rees 2011; Oke & Wynn 2001). The details of the history of democratized public participation and social activism follows, as defined as a Social Change Model, in **Section 2.5**. According to Rees (2011):

"Many, many factors were involved here, but the major factor goes back to the defeat, back in the 60's of the freeway proposal. Mike Harcourt, (who went on to become Premier of the Province and Mayor of the CoV) a young lawyer at the time, led the citizens' activism, worked with the citizenry to defeat the highway proposal. People loved their city and they didn't want a major freeway. They could see what was happening to the city of Seattle (just south of us), which was losing its character because of the automobile. They defeated the highway proposal and we got a small viaduct in the proposal. That gave the citizenry a lot of power, and confidence in what they could do in influencing the development process. They were somewhat leftist leading people who had in mind the public good, and what is lost in so much planning, particularly in the US is the notion that there is a common interest in so many things: transportation, common space, unless you have strong voices to support the public good and put it on at least equal footing with the private sector, its not going to happen. That is what has happened in other cities. The private sector has won out. They want to develop every square inch of the land, the public interest is pushed out, and that is where you get the UHI effect. For example, Toronto is a harbour front city but you would never know it because they

have done so disastrously in terms of the harbour land. Completely the opposite in Vancouver where you can walk 50 kms along the waterfront around the city. Now that is good planning. Every time a house came up for sale along the waterfront the city bought it, for many kilometers. It required determined focus on what was good for the average citizen of the city. In the end, even wealthy developers concede that this is the best thing that could have happened. It makes their existing developments even more valuable (Rees 2011)".

Strong Leadership and superb planning by Ray Spaxman Larry Beasley and others, along with a history of tough negotiations between the private sector and the city has led to well designed density (Rees 2011; Duncan 2011), that supports not only neighborhoods but also "neighbourliness" in its participatory planning agenda (Oke & Wynn: 2000, 262). Urban development that is densely compact with increased tree canopy, as discussed in **Section 1.3.5**, successfully reduces surface temperatures, is a result of a social change model **(Section 2.5)** that includes smart density and democratized public participation. The city/region is unique to North American and to metropolitan regions around the world as 25% of its land base is conserver and aesthetic (MVR:SRI 2010) and "which aspired to become a place in which human activity enhanced rather than degraded the ecological system (Oke & Wynn: 2000,264)." The city is a place with its history, its leadership and its citizenry firmly grounded to the natural surrounding, providing for the possibility of a nurturing environment to support innovation and the cultivation of CPUAF.

3.5. Model of Social Change - A Social Media Campaign

Public Consultation pertaining to the Greenest City by 2020 Action Plan was kicked off on the warm summer evening of June 23, 2010, at a special "Pecha Kucha[14]" event. Over 2,000 Vancouverites were in attendance at the sold out event at which thirteen

[14] Pecha Kucha Derived from the Japanese word for Chitchat. It is a presentation technique in which 20 slides are presented in 20 seconds by each presenter. Pecha Kucha Events took place in cities around the world with the CoV utilizing the event to launch 2020. http://www.pecha-kucha.org/ Accessed June 8, 2010.

inspirational speakers discussed the topic of sustainability and Vancouver's ambition to be the Greenest City on the planet by 2020. "Greening Our City" is the branding concept and the social media campaign is titled, "Talk Green to Us." Over 35,000 people have participated in the social media campaign, as well as through a host of public engagement tactics (GCAP: 2011, 6-7). According to Quayle (2011), "the campaign seems to have gotten legs, especially with the younger generation," while the city acknowledges "access to nature actions are best delivered in close cooperation with local residents and community groups (GCAP; 2011, 99)".

Details regarding the interrelationship between food, the urban forest and the greenways initiatives and the interrelationship between all key goals are available on the highly accessible Talk Green to Us website, where public response is received, reviewed, implemented and reported as outcome in the GCAP:2020[15]. Food Systems and Urban Forestation are discussed in detail in **Section 3.11**.

[15] Web links to Talking Green and the Greenest City Action Plan: 2020:
http://talkgreenvancouver.ca/
http://talkgreentous.ca/

Figure 3.10 View of the West End. Potential for Green Roofs & Vertical Lost Lagoon –Stanley Park Agriculture retrofits of Existing Buildings. .© Durant 2010

3.6. The Making of Place - Vancouverism – History of Density & Livability

The coastal location, with a protected inland harbour, was ideal as a port and remains the largest port on the West Coast of North America (ACPA, 2011). The physical geographical constraints, and proximity to the US border, limit the land within 50 kilometers of the city center to 18,000, square kilometers, compared to Toronto at 40,000 sq. km. and Montreal at 80,000 sq.km. If the City was to grow, the only place it could go was up, which it did in syncopated rhythm, scale and form with the natural surroundings. The scale of towering cedar trees, the mountains rising directly from the sea to 1128 m (3700 ft.) and the vast expanse of the Burrard inlet lent themselves, and are harmonious with, the intensification of high rise residential towers, which has become know as the Vancouver Model, an ideology referred to as “Vancouverism.” More recently, the ideology was integrated with the Eco-Density strategy and further incorporated into the Greenest City Action Plan for 2020, which supports smart growth and multi- modal transportation efficiency that includes bicycle lanes and connected greenways for walking and cycling. The city has expanded its plan for increased density in residential areas of the city to allow homeowners to develop laneway houses in areas previously reserved for garages. According to Alan Duncan (2011), “there is a net increase in the tree canopy, in correlation with the increased density”. The replacement rate of trees is attributed to the tree by-law, which protects trees, restricts removal and requires replacement planting, supporting the documentation in **Section 3.4**. that smart density is good for the environment as well as the economy.

Retired Director of Planning, Larry Beasley is largely responsible for shaping the urban form of the city of Vancouver and creating what is now know as “Vancouverism.” “Vancouverism” is an Urbanism that is vibrant, livable and highly integrated with the natural environment, with a high-rise forest piercing through the urban and natural forests and vegetation that surround and intertwine with the Downtown and West End residential area. The West End is bordered by the largest downtown garden and natural reserve on the North American continent: (Boddy; 2004, 2), Stanley Park, which is 400 hectares (1,000 acres). By the 1970’s The West End became the highest density neighborhoods in North America (Boddy, 2004). It is known for its mixed use, and its planners who carefully developed “view corridors”, to secure views of the North Shore Mountains and Burrard Inlet. The view corridors, accomplished with a well planned mix of high and medium rise buildings, function as urban wind canyons, and in concert with a high proportion of mature green canopy, contribute to reducing the UHI as described in Section 1.2. Vancouver has successfully achieved livability with the perfect balance of density, vibrancy and open connected green space with lower GHG emissions per capita than in other less densely populated areas of the city (figure 1.6.), proving again that well planned urban densification and forestation is ecologically sustainable. Place-making, smart growth, densification and a superb urban form, as described in **Section 2.6** are demonstrated in the CoV to reduce GHG emissions in higher density areas (Figure 1.8).
In addition, increased UHI temperatures, according to the evidence gathered in the Oke sampling (2000) (2011) are higher in medium density warehouse areas than in the high density, heavily canopied West End. It is most likely, according to the experts (Oke2011)(Duncan 2011) that a well proportioned mix of medium and high rise buildings, with well placed wind canyons in combination with mature urban street trees contribute to the lower urban temperatures.

3.7 Stewardship

Figure: 3. 11 COV Traffic Circle Photo Credit: The City of Vancouver

The CoV (GCAP, 2011) encourages neighbourhood stewardship in the Green Street program, while integrating agriculture in the living environment, makes present and visible the life cycles of nature (**Section 2.6**). The program offers the community the opportunity to volunteer in programs by sponsoring and maintaining traffic circles or corner bulge gardens. At the July 2011 Food Policy Council meeting, James O'Neill, Social Planner, introduced a list of food items and guidelines for the planting of food items in the edible landscape, to include boulevards (O'Neill 2011).

Planting city boulevards is a program managed jointly with engineering and planning and landscape guidelines, planning tools are found on the CoV website.[16]

Stewardship of community orchards and communal gardens in recreational facilities, according to Duncan and Quayle (2011) can increase urban greenspace and urban agricultural production. The city is not in the business of growing fruit for the public, and often there are ebbs and flows in community involvement that according to Quayle (2011), requires a new way to program public landscape, gardens and orchards more

[16] Edible Landscape Guidelines and Planning Tools:
http://vancouver.ca/engsvcs/streets/greenstreets/index.htm
http://vancouver.ca/engsvcs/streets/greenways/pdfs/list3.pdf
Edible Landscape Tool:
http://vancouver.ca/commsvcs/socialplanning/initiatives/foodpolicy/tools/pdf/EL_Info_06Mar.pdfhttp://vancouver.ca/commsvcs/socialplanning/initiatives/foodpolicy/tools/pdf/EL_brochure.pdf
Drought Tolerant Plants:
http://vancouver.ca/engsvcs/streets/greenways/pdfs/list3.pdf

productively. Community Centers, currently responsible for leading recreational programs could extend their leadership to steward community orchards, programs already underway on existing park land GCAP; 2011, 18). Leasing of City owned land, such as the SOLE proposal for the SEFC land, will privatize stewardship, on underutilized public land, in the same way that the SOLE DTE urban farm utilized private land through a tax incentive, (**Section 4**). The Fairmont Hotel rooftop garden and the Freesia Apartment Rooftop garden, built under the new relaxed building code, are examples where corporations and private business steward agricultural production within the COV. The GCAP (p.p. 99-101), goal is to acquire and build new parks, and convert street right-of -ways, incorporating food production, through stewardship initiatives.

3.8. Regional and Municipal Collaborative Process – Food, Forest and Ecosystems

Regional Planning, discussed as a tool for planning in Section 2.8, is the scale least represented by government institutions (Wheeler 2004). Yet, it is the level of planning that is cross-cutting in its ability to address air sheds, watersheds, food sheds, food and water pollution, transportation, bio-regions, and affordable housing as these issues cross the geographical demarcations of cities and towns, peri-urban, agricultural reserves, and in the case of British Columbia, protected forested areas. The MVR has a long history of leadership and collaboration with the CoV as well as other municipalities, in the area of sustainability, climate resilience, ecosystem management and recently introduced food system policy to the mandate.

The 2010 Metro Vancouver Regional Sustainability Framework (MVRSF) clearly articulates its framework by placing "the concept of sustainability at the center of its operating and planning philosophy" (MVR;SRI 8). The Regional District is a political body and corporate entity, operating under Provincial legislation, representing 24 local authorities, which includes the City of Vancouver within the metropolitan regional area. The responsibility of the MVRSF containing the Strategic Regional initiative or SRI, is to deliver vision, mission, values and sustainable imperatives and principles through three interconnected roles. They include providing 1. core services to the Region, such as the provision of drinking water, sewage and solid waste management; 2. secondly, providing policy development through spatial planning, strategies and regulations, and 3. thirdly,

providing through leadership, a political forum of outreach, advocacy, education and collaboration (SRI:8). Food Systems, Ecological Health and Parks and Greenways are integrated component of Planning, Policy and Regulations. See Figure 3.12.

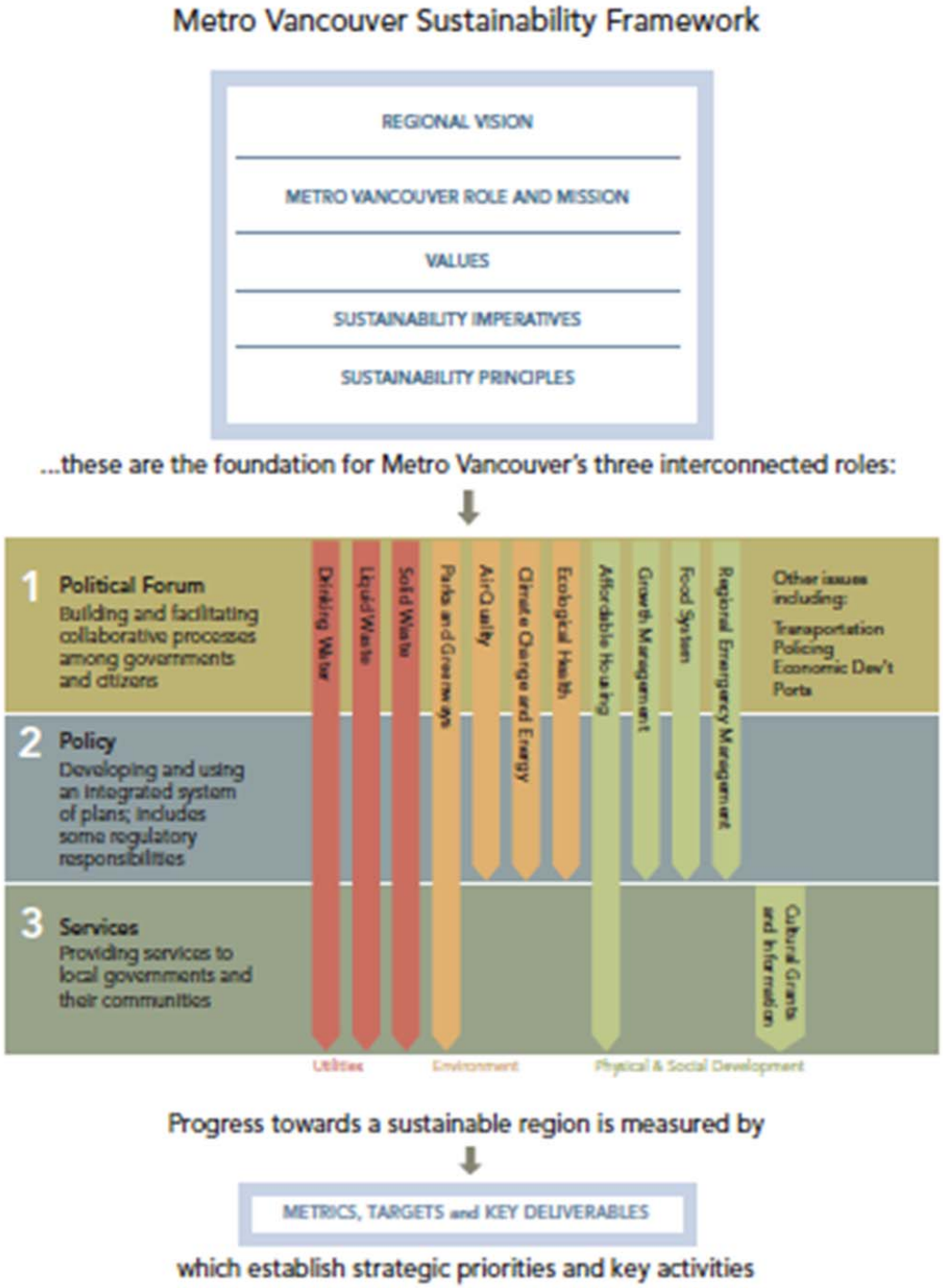


Figure 3.12. Metro Vancouver Regional District (MVRDSF) Sustainability Framework

3.8.1. Integrated Land use Management and Transportation Plan: "A Liveable Region Strategic Plan"

The Metro Region is currently in the process of finalizing a regional growth strategy, part of a four year intergovernmental consultation process in which, early in the process, the public rejected the existing "business as usual strategy" which was subsuming agricultural farm land through development (ALRC 18). As a result of public consultation, and feedback from the City of Vancouver as a result of intensive public consultation, as well as participation with MVRD member municipalities, federal and provincial governments, First Nations and private organizations, the draft policy now includes an integrated land use and transportation plan. The goals of the draft plan entitled "A Liveable Region Strategic Plan " or LRSP, are to:

Create a compact urban area based on high density mixed use
Support a sustainable economy
Protect the Green Zone
Develop climate resilient communities
Support sustainable transportation choices

Of significance to this report is the Green Zone Policy, statement 4.4:

"Which will seek through partnerships, the viability of agriculture through enhanced planning for agriculture as part of the region's economic base, improved communication of the importance of agriculture for the regions livability and other actions" (LRS: 1996, 20)".

The LRS, consulted, throughout the process and engaged early on with EC to produce climate model projections that identified a potential impact of climate change, were by "Agriculture could expand in the lower Fraser Valley and new, higher value crops could be introduced (EC:1997,10)". The Greater Vancouver area has a "remarkable natural heritage" and contains agricultural land that is already of the highest quality and is among the most productive in the country. (LRSP: 1996,10). Further, through the early community participation process, citizens identified the value of the eco-system services and accepted the concept and principles of urban densification, rejecting existing master plans in order to protect the Ecological and Economic assets of the Region. All

members of society engaged in mutual respect to maintain their valuable asset. The concept of the Green Zone," arose out of the visioning and participatory process and as a result, provides the foundation for "Vancouver 2020: A Bright Green Future: An Action Plan for Becoming The World's Greenest City by 2020", as well as provided inter-linkages with the Vancouver Food Charter.

3.8.2. Regional Food Systems Strategy

In September 2010, The MVRD issued a Draft Regional Food System Strategy, which supports a collaborative approach to addressing food issues in the region. According to their website,[17] "the draft reflects input on the private, public and non-government sectors on how to make regional food systems, sustainable, resilient and healthy." The new framework (Figure 3.9), includes Food Systems in the category of Plans, Policy and Regulation, which allows for a more sustainable and integrated approach to addressing food security, ecological and human health and climate issues. Parks and Greenways fall under a separate mandate from Food, unlike municipal parks and greenways, in which urban food policy is integral.

3.8.3. Vision, Goals & Objectives of the Regional Food Systems Strategy (RFSS)

The RFSS Vision is to create: "a sustainable, resilient and healthy food system that enhances the economic prosperity for the region, and conserves natural systems while improving the health of all residents". The goal is to "Produce food close to home and encourages urban agriculture." This draws a direct link to the recognition that urban agriculture is a desired outcome of sustainable City and Regional planning that reinforces that the Vancouver Food Charter was instrumental, at a grass roots level, in influencing the Regional Food System Strategy. The RFSS acknowledges that the CoV is "leading urban agriculture initiatives in the region" (RFSS:2010, 20).

The MVR is building on the LRI, by adding the Regional Food Systems Strategy (RFSS) and the Ecological Health Action Plan (MVEHAP), which advances green infrastructure, and links human health and well-being with the health of ecological systems. In 2011,

[17] http://www.metrovancouver.org/planning/development/RegionalFoodSystems/Pages/default.aspx

The Regional Growth Strategy, was adopted by all local governments within the region, as a framework for sustainability and livability.[18]

3.9. Rooftop Farming and Vertical Agriculture

Rooftop Building Code for New Development

Community Services - Green Roofs - Role in CPUAF

The COV Green Roof Administrative Report April 17, 2007, pertains to rezoning and development permit applications which include green roofs. Although a bylaw is not yet in place, the Administrative Report states "The Director of Planning will deal with applications on a case by case basis, due to limitations set forth by warranty insurers until such time as this issue is resolved." [19] The city support development projects including planting on roof levels for the purpose of providing gardening opportunities for residents as well as to provide shared community space.

The city recognizes the benefit of green roofs in order to achieve environmental sustainability objects including:

- Storm water management
- Habitat for birds insects
- Reduce the Urban heat island effect

The GCAP (2011, p. 148) recognizes there is a strong potential for the integration of urban agriculture into new building design, enabling inhabitants of residential

[18] The Link between the Regional Growth Strategy and Agriculture is available here: http://www.metrovancouver.org/planning/development/agriculture/AgricultureDocs/AgricultureBackgrounderMarch09.pdf The Regional Growth Strategy is a 30 year sustainability framework adopted under the Local Government Act, as By-Law No. 1136. http://www.metrovancouver.org/planning/development/strategy/RGSDocs/RGSAdoptedbyGVRDBoardJuly292011.pdf

[19] The CoV Green Roof Policy: http://vancouver.ca/ctyclerk/cclerk/20070417/documents/a7.pdf (Note when opening document go to quick view as the PDF on the worldwide web is flawed.) https://docs.google.com/viewer?a=v&q=cache:gODs04G0OmAJ:vancouver.ca/ctyclerk/cclerk/20070417/documents/a7.pdf+http://vancouver.ca/ctyclerk/cclerk/20070417/documents/a7.pdf&hl=en&gl=ca&pid=bl&srcid=ADGEESg-zRrSfkgOMMSRs5a6nWdmBsKfCnryppYeJEuodfzUusrYeovah

commercial and office development access to green roofs and garden plots. To date however, the city, unlike Toronto, does not have a mandatory green roof By-law. Toronto was the first in Canada to implement a Green Roof By-law as discussed in Section 2.9.14.c. The CoV does however; "encourage" intensive green roof development.

It is within the development of innovative policies and regulations, through experimentation that the City of Vancouver recognizes that "an edible landscape policy" must provide new building code regulations to include at least 25% edible landscaping on green roofs, for example" (2020, 61). When a strategic plan is not integrated with a regulatory aspect of a planning system, adherence or discontinuing of the plan is the usual outcome according to UN Habitat (2009, 61), an aspect that the City of Vancouver acknowledged and is currently in the process of regulatory integration of 2020 Action Strategies into the building code and zoning ordinance to ensure a more sustainable city.

Relaxation of Height to Encourage Green Roofs – In 2009, council approved an easement on heights in order to enable roof mounted energy technologies that included the installation of Green Roofs. The by-law requires that extensive green roofs, must have 50% of the roof planted. For intensive green roofs, at least 25% should be planted [20].

[20] Details of the Height Restriction Relaxation by-law is available on the COV website: http://vancouver.ca/commsvcs/bylaws/bulletin/R007.pdf

Figure 3.13. Source Levenston. City Farmer . The Freesia Rooftop Urban Farm

Residential Development

The first residential building, constructed in the downtown that implemented a green roof was the Freesia (Duncan 2011)[21]. It is a high-rise building with eighty-one (81) individual garden plots, measuring one meter by one meter, on the rooftop of the sixth floor. According to Duncan (2011) , "the take up by the residents was so low that the rooftop was rented to City Farm Boy, a local urban farming company. The assumption that everyone wants a plot, is not necessarily the case". However, the conversion for use as an urban farm, is not only environmentally sound, it is economically viable as well as provides tenants and restaurants with access to healthy local food. In addition, the benefit of enjoying the enhanced public green space is provided by the stewardship component, maintained by the urban farming enterprise. While a lifecycle analysis is not completed, it is assumed that the thermal properties provided by the growing medium are beneficial to the building owners.

The benefits of vertical farming, Defined in **Section 2.9.10, 2.9.11 & 2.9.12** (Figure 2.3) is demonstrated in the project example of SOLE Food urban farm, described in in **Section 4.2.**

[21] Information on the Freesia Urban Agriculture Green Roof http://www.cityfarmboy.com/
A Report by Mike Levenston of City Farmer, http://www.youtube.com/watch?v=ksbUO8vrZB4
http://www.cityfarmboy.com

In a city wide call for ideas to improve air quality, the public responded on the Talk Green to Us website by listing making green roofs and living walls mandatory as one of the top five suggestions (GCAP;2011,136). The response demonstrated that air quality, is one of multiple sustainability issues, which can be addressed through intensive green roofs, vertical wall agriculture, and urban forestation. Furthermore, they can be integrated in greenways in a continuously productive process.

3.10. Economic Models for Urban Food & Forestation

Social Enterprise (SE) has a vital role in a new ecologically sustainable economy, as a component of a CPUAF model and is supported by the COV, illustrated in the SOLE Case study **Section 4.**

Project examples of CPUAF agricultural economic models that include Social Enterprise (SE) as well as include Corporate Social Responsibility (CSR), and Community Supported Agriculture (CSA) to achieve multiple sustainability objectives integrating food and forestation, are presented in **Section 4**.

3.11. The Greenest City Action Plan – Linking Urban Agriculture and Urban Forestation as CPUAF

The Greenest City in the World by 2020:
"The Greenest city in the world will be a vibrant place where residents live prosperous, healthy happy lives, with a one planet footprint, so as not to compromise the quality of life for future generations or people living in other parts of the world."

- **Vancouver 2020: A Bright Green Future, page 11.**

Vancouver 2020: A Bright Green Future, is an Action plan for becoming the World's Greenest City by 2020. The action plan is oriented toward a planetary solution that engages citizens, through wide public consultation and through strategic partnerships

with businesses, other levels of government, First Nations, universities and NGOS (GCAP, 2011). The GCAP is a road map for achieving the goals (Figure 3.3. & Figure 3.4.) supported by measurable, achievable by the year 2020. The strategic plan acknowledges that a healthy community is a wealthy community and although the city has the smallest footprint in North American and is one of the most livable cities in the world, the goal is to lighten its global ecological footprint and its GHG emissions by the year 2020. An integrated GCAP utilizes a systems approach to facilitate the development of sector specific action and targets, recognizing that patterns of land use that include density, buildings, connected greenways encompassing the urban forest, parks, rooftops, the urban food system, waste, water, air management and transportation are all components of larger regional as well as global systems (2020: 25). Furthermore, while the COV, cross-references, all the goals in the action plan, for the purpose of this thesis, the links between food and forestation as CPUAF, **Goal 10, Urban Food Systems Leadership,** and Urban Forestation, described by the COV as **Goal 6, Access to Nature,** are discussed in the following chapters of this section.

The following chart is a quick guide for readers, indicating the cross-references between all ten GCAP:2020 goals, discussed throughout the literature review sections, the case study and the project example sections of this thesis.

Box 3.1. Cross – References GCAP Goals

Goal 1 The Green Economy (1.4) (1.6.3. to 1.6.10), (2.1), (2.10), (3.10)(4.0)

Goal 2 Climate Leadership (1.1.) (1.3)(1.5) (2.2) (2.9),(3.0).(4.0)

Goal 3 Goals 2 & 3, Buildings Systems as Rooftop Farming and Vertical Agriculture (1.2), (1.3), (1.5)(1.7)(2.6), (2.9)(2.11)(3.9) (4.0).

Goal 4 Transportation (1.1.6), (1.2.6.)(1.3.5.) (4.0)

Goal 5 Zero Waste (1.1.) (1.6)(2.1), (2.9), (3.0) (4.0)

Goal 6 Access to Nature (FORESTATION) (1.1.3) (1.2)(1.3), (1.5.)(1.6.)(1.7),(2.0) (3.0), (4.0).

Goal 7 The Ecological Footprint (1.6.8), (2.1)(3.1.), (4.0)

Goal 8 Clean Water Quality and Clean Water Quantity

Goal 9 Clean Air (3.9)

Goal 10 Urban Food Systems (1.1.2.)(1.2.)(1.3)(1.4.), (1.5)(1.6.)(1.7)(2.0)(3.0) (4.0)

3.11.1. Global Food System Leadership

Goal 10: Become a Global Leader in Urban Food Systems

Target One: Increase City and Neighbourhood Food Assets by a Minimum 50% by 2020 [22].

Local Food is administered by the Department of Social Policy, and supported by Engineering and Parks. The complete list of external advisors and the staff working group is available on pages 148 – 149 of the GCAP.

The City of Vancouver identifies in the GCAP, that a resilient local food system is central to the goal of sustainability of a City, nested in the three target areas of **carbon waste and ecosystems** (Figure 1.1.4). The CoV recognized that the production, processing, consumption, and distribution of food are the largest source of GHG, emission produced by a City; and while historically, cities have not included food in their GHG profile, the CoV is taking a lead in this area (GCAP: 2011,141). The processes of food production as a baseline were identified as composing 40% of the CoV's ecological footprint EF, (Figure 3.4.). Defining "Local " as a means to reduce the EF, by reducing transportation and production costs, still ongoing, which includes reducing fossil fuel outputs **(Section 1.5)** by producing local food organically, is defined in the context of the goals of the GCAP (141).

The GCAP, Goal 10, builds upon the Vancouver Food Charter (VFC), prepared by the Vancouver Food Policy Council (VFPC) completed in January 2007 (GCAP: 2011,61) in the desired goal to lead policy and actions globally.

3.11.2. The Vancouver Food Charter (VFC) Historical & Policy Context

Food policy cannot simply be added on to existing processes to be effective and require mainstreaming in all aspects of the plans as the CoV and the MRD history of integrated planning demonstrates. Evidence suggests that linkages with regional, Provincial and National government processes create stronger systems of administration. (DBSA:2009,

22 "Neighbourhood food assets include: community kitchens. Farmers market. Pocket markets, community food composting facilities, garden plots, community orchards, urban farms, and food hubs." GCAP, 2011, 17)

38; Visser 2011). The GCAP integrates the outcomes of the previously discussed task force outcomes with that of the VFC.

On July 23, 2002, CoV Council adopted definitions and principles for environmental, economic, and social sustainability to guide future City actions and operations presented on April 15, 2002; they included;

Vancouver Energy Strategy 1979 □· Clouds of Change 1990 □· City Environment Policy and Action Plan 1996 □· Solid Waste Management Plan 1994 □· CityPlan1995 □· Vancouver Transportation Plan 1997.

On July 8, 2003, A Food Policy Task Force was initiated;

On May 11, 2004,City Council approved fiscal expenditures associated with the Action Plan;

On July, 2004, the Food Policy Task Force elected members of the Vancouver's affiliated Food Policy Council (VFPC) (VFC, 2011, 2).

3.11.3. The Vancouver Food Policy Council

The mandate of the VFPC, an arms length advisory body, (GCAP: 2011, 141) supports the development of a sustainable food system. As many as twenty-one members sit on the committee, and are appointed by council for up to 3 years. The VFPC has a number of working groups that include Food Strategy, Food Waste, Research, Neighborhood Level Food Security, Food Resiliency, Institutional Procurement, Youth Engagement and Urban Farming.

Box 3.2. A Food Policy Council Meeting

Attendance in July 2011, at the suggestion of Art Bomke and Brent Mansfield (2011) was a good summary of the policies and projects taking place in urban food and agriculture in the COV. A wide range and diverse group of policy board members, the general public and representatives of other levels of government, including the MVR, discussed food issues, including urban agriculture in the public and private realm. Some of the participants included:

James O'Neil Social Planner (2011), presented the staff report, discussed recent grant approvals, as well as introduced the edible landscaping guidelines for boulevards, traffic bulges and circles.

Ann Rowan, (2011) presented an overview of MVR Regional strengths and areas where future research is planned. The presentation included discussion around the visions and goals of the MVR Food Systems Strategy, as well as strategic interactions taking place between the City and Metro around food and parks.

Aaron Jasper, Park Board Vice-Chair represented the Park Board, introduced Alan Duncan's Urban Agriculture Update (February, 28, 2011) and the current shift toward growing food on public land. He emphasized rooftops and the need to make rooftop space more usable for urban agriculture, as well as considering the introduction of UA on Community Centre Roofs including Marpole and The West End Community Centre, during upcoming public consultation.

Helen Speigelman discussed the proposed COV Food Scrap Diversion Program and San Francisco's by-law, making food waste illegal.

Ross Moster the VFPC, "Food Resiliency" Working Group Lead, discussed pilot compost programs, and discussed his involvement with Transitions Canada and upcoming events and projects underway with Village Vancouver, a bottom up, citizens group.

Attendance at the meeting led to future interviews with Ross Moster, James O'Neill and Brent Mansfield as well as Chris Thoreau regarding sustainable urban farming and policy development in the COV.

On February 15, 2007, Mayor and Council unanimously adopted the **Vancouver Food Charter (VFC):** prepared by the VFPC. The charter sets out actions to establish a coordinated municipal policy, on the path to a just and sustainable food system. The Charter promotes education, real projects for a healthy economy, a healthy ecology, and a healthy society through a process of collaboration and participation (VF:2007, 2). The

Charter recognizes that "our current food system is an industrial model that is unsustainable," The document supports the literature review in that environmental degradation through use of chemicals threatens species diversity and human health, while reducing the ecosystem's ability to support a sustainable food system. The charter support local based food and agriculture policies to support sustainable agriculture by reducing transport, a key source of GHG emissions (VFC:2007, 3). Full Details about the VFC, context and background, as well as the VFPC mandate are structure are available on the CoV websites. [23]

On February 3,2009, Council approved a motion to establish a Mayor's Greenest City Action Team (GCAT);

On May 5, 2009, Council received a quick start report from the Greenest City Action Team (GCAT) with 44 recommendations on immediate actions to achieve the goal of becoming the Greenest City in the World by 2020. The recommendations included a grants program for sustainability initiatives; including those proposed by SOLE food urban farm, described in **Section 4.2**;

On May 2010, the strategic long-term environmental goals recommended by the GCAT in their report Vancouver 2020: A Bright Green Future, was adopted by council, with the directive to develop an implementation plan, which included a grant program;

On January 20, 2011 Council adopted the Greenest City 2020 targets and goals that include the green economy, climate change leadership, green buildings, green mobility, zero waste access to nature, a lighter footprint, clean water, clean air and local food.

There are dynamic forces within all planning systems that challenge the planning process. However, the key element to democratic planning success, is an adaptive

[23] http://vancouver.ca/ctyclerk/civicagencies/foodcouncil/index.htm
http://www.vancouverfoodpolicycouncil.ca/
http://vancouver.ca/commsvcs/socialplanning/initiatives/foodpolicy/tools/pdf/Van_Food_Charter_Bgrnd.pdf

systems model, identified as transparent, open with reciprocal participatory partnerships, engaging all levels of society at a local and international level to accomplish place making and future planning outcomes. Many levels of government in Canada support the need for sustainable food systems, guided by United Nations covenants and guidelines. Partnerships have developed with the MVR Livable Region Strategy ALC to protect farmland close to the city from removal from the ALR. As early as **1976,** the Government of Canada ratified the United Nations Covenant on Social, Economic and Cultural Rights, (UNCSECR) based on the World Food Security Plan, endorsed at the World food summit in **1996** (VFC, 4). As illustrated though out this document, food policy is a growing concern in municipal planning and policymaking, and the City of Vancouver has taken a leading role, brought about through the actualization of The Food Policy Council and the Vancouver Food Charter.

The history of the evolution of the CoV food system and its context is briefly described in the previous chapter, while the following diagram (Figure 3.14), attempts to illustrate the key planning participants, partners and Influencing systems, which have contributed to the formation of the integrated food and forestation systems within the CoV. The process and actions taking place at a local municipal level have over time been influenced by a international, national and regional policies. The interrelationship of the various partners and influencing systems is illustrated in the following diagram and described in the next subsection of chapter 3.11.

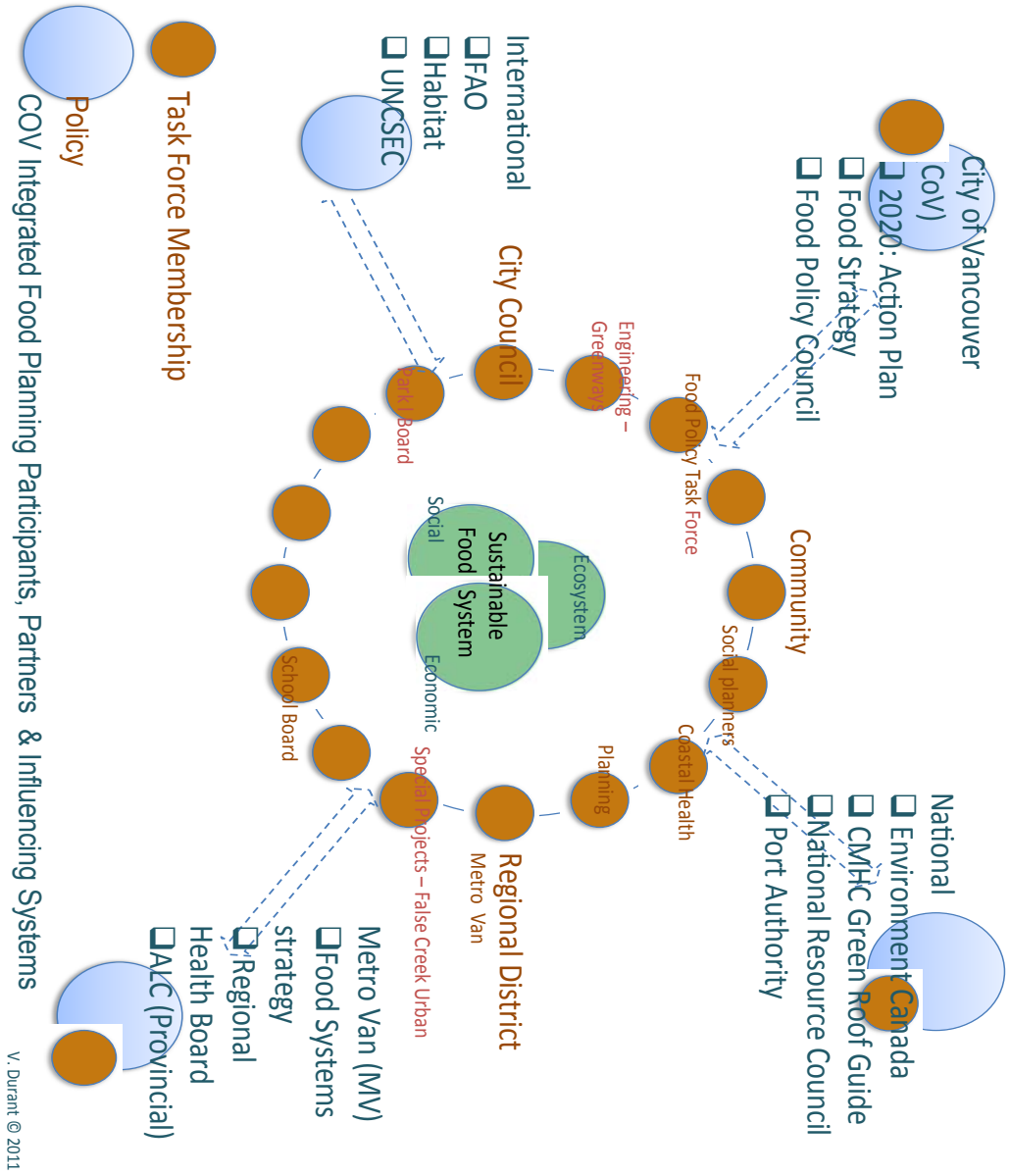


Figure 3.14. Diagram Conceptualized & Illustrated by V. Durant © 2011 .
The model illustrates the planning participants, partners and Influencing systems, which influence and participate in an integrated Food and Forestation System locally, regionally, nationally & globally.

Figure 3.15.a.b. Photos. City of Vancouver. COV Greenways Project. Crown St. Stormwater Infiltration & Traffic Calming.

3.11.4. Access to Nature

Goal 6: Vancouver residents enjoy incomparable access to green spaces, including the world's most spectacular urban forest (GCAP: 2011, 14).

> **Target 1: "Every person lives within a five-minute walk of a park, beach, greenway or other natural space;**
> **plant 150,000 additional trees in the city(GCAP: 2011, 99). "**

Access to nature is administered by the DG of Parks and Recreation and the Director of Engineering. The complete list of external advisors and the staff working group is available on page 102 of the GCAP, and include members of social policy and the general public.

3.11.5. The Urban Forest – Background

Trees play a significant role in the history, the ecological health and the livability of the City of Vancouver. Until the 1850's, majestic 1000 year old, 300 feet tall old growth cedar and fir forests, originally covered the land which is now the urbanized area of the city (Oke & Wynn 2001). For over a hundred years, the majority of the old growth forest was replaced with the urban forest, which is recognized today as a striking feature of

the city and is one of the largest human made forests in the world. The GCAP discusses the role of nature, the ecosystem services (1.3.5.) as cleaning the air, intercepting rainwater, and tempering temperature extremes. According to O'Neill, (2011) "the UHI is not in the lexicon of the language used by the general public." therefore a less complex description is used to describe the terminology defined in the Literature Review, **Section 1.3.** Despite the lack of definition or discussion by the GCAP of the UHI, variables in microclimates, is considered by the CoV in their Urban Forest planning. The GCAP refers to connecting people to the cycles of life, referred to as sensory reciprocity and connected behavior in **Section 2.6**, of the literature review as a component of place making and a benefit of close proximity to nature.

The CoV has established a baseline for intervention, with an inventory of 220 parks on 1,300 ha of land, recognizing an uneven distribution of natural space due to historical acquisition and development (GCAP 2011)(Figures 1.6, 1.7), which most likely contributing to higher temperatures, in less treed zones, noted in Figure 1.5, confirming the UHI correlation.

3.11.6. Tree By-Law For the Private Realm

The Department of Development Services, Community Services, CoV, administers land development bylaws, under which the protection of trees on private land is managed. The CoV recognized that trees contribute to the social, economic, environmental viability and sustainability of the City. The Community Services Website, states "the urban forest conserves storm water, and providing habitat and food for wildlife". Of significance is the statement, "**The urban tree canopy also cools the city**", stating that "Urban trees moderate temperatures"
http://vancouver.ca/commsvcs/planning/treebylaw/TREEIDXJ.HTM (Accessed June 1, 2011), which is a mitigating factor in reducing the effects of UHI's. Furthermore, the document states that **"Fruit and nut trees provide a source of local food"** while beautifying neighborhoods and increasing property values. The website document confirms that the role of trees maintain a healthy ecosystem, reduces the UHIe, by cleaning the air and acting as a carbon sink. The website links urban agricultural forestation as a means of providing local food security as well as protecting the ecosystem.

The COV provides for the protection of trees through the implementation of an enforceable and detailed By-law. Provisions for the replacement of removed trees were first included in the Zoning and Development By-law in 1991. These regulations became the basis of the Private Property Tree By-law that was adopted by Council in 1994.

The Protection of Tree By-Law (By-law 9958) http://vancouver.ca/bylaws/9958c.pdf , adopted in 2009, allows for the preservation, protection and strengthening of the CoV urban forest, while providing some flexibility for tree removal during property development and maintenance. The updated By-law clarifies details regarding tree removal and replacement processes and improves the City's powers of enforcement. So strong is the city's commitment to protecting trees, before issuing a tree removal permit, they review plans in all cases of tree removal, not just when site development occurs.

While the city is planning to meet its goal of 150,000 new trees by 2020, support from the private realm is instrumental, where the goal of 54,000 new trees is required. A key action, identified by the CoV is the revision of landscape standards for industrial and commercial zoning districts to require tree planting in parking lots (GCAP 101). While this is difficult to accomplish in existing warehouse and industrial areas, it is not impossible, though civic engagement and education (Duncan 2011). The implementation of by-law amendments to reduce parking and increase planting as well as including rooftop and vertical agriculture requirements, are areas, which the COV could and should pursue.

3.11.7. The Role of the CoV Park Board in Public Tree By-Law

A Street Tree Planting Inventory and Report was first compiled in 1990.[24] Currently, the CoV is in the process of developing an updated Urban Forest Management Plan to achieve the goal to plant 150,000 trees by 2020, identifying the need in the following:

- 45,000 new street trees

[24] The full Tree Planting Inventory, and report can be found at: http://vancouver.ca/parks/info/strategy/streettreemgmtplan/1990StreetTreeManagementPlanExecSummary.pdf (Accessed June 1, 2011).

- 45,000 new trees in parks
- 6,000 new trees on other public land
- 54,000 new trees on private land (See 3.11.7.)

Alan Duncan, the staff lead on GCAP:2020 who was instrumental in the planning and implementation of the original tree protection by-law, (2011) stated, “While the city is working on a current inventory of urban trees; the priority is not counting trees, but rather adding innovative ways to increase the tree canopy within the urban boundary while integrating a productive food system in the planning”. The Park Board is cognitive of the biomass layers and will include it in the implementation, to ensure that all municipal public forestation will require 25% edible landscape by 2020 (Duncan 2011) **(Section 1.2).** The program is integrated with the Greenways initiatives (Figure 3.12), an outcome of the UTF, **Section 3.3d**, and resulted in the edible landscape guidelines (p. 130). The Urban Forest Management Plan (Duncan 2011), which calls for the inclusion of local, is a component of the overall objective to reduce CO2 emissions. **(1.1.7)** . The action of converting street right of ways into 4 to 6 mini-parks, and the development of 2 to 3 new parks in areas experiencing a shortfall in the first three years of the GCAP, will incorporate community orchards and community gardens.

3.11.8. Linkages - Food and Forestation Actions

The GCAP (pp. 101 – 102; 144-148) cross references Food and Forestation in the GCAP:2020 (2011), clearly showing the interrelationship and linkages in order to address multiple sustainability issues. In the GCAP2020 document, Access to Nature, cross-references to Urban Food Systems Leadership “priority actions within three years,” as follows:

1. Create 5 to 6 community gardens per year;
2. Enable 3 new urban farms. Supporting urban farming on City land is underway with an action for lease to Sole Food Farm **(Section 4.3**);
3. Adding public fruit trees into new and existing parks and edible landscape located in other public green space such as boulevards, traffic circles. See **Section 3.7** for Green Streets, Edible Landscape Guidelines and Tools;
4. Create Guidelines to Encourage Bee-keeping, which will reciprocally support Ecosystem health and a healthy Urban Food and Forest System. See **Section**

4.1 on "How to implement the policy, and how it function in the Fairmont Case Study";

5. Curbside pick up of food waste, as diversion strategy, returning throughputs To Urban Farms, Community Gardens, and the Urban Forest .See **Section 4.2** on "How to Structure food waste management at a neighbourhood level;
6. Support Food Business Incubator. Vancouver Urban Farming Forum, **Section 4.3.4** on how to run a food policy forum;
7. Support a Food Hub where local and regional farms can connect to buyers, increasing economic growth of local/regional food systems; For details on the (GEZ) see **Section 4.3.4;**
8. Provide Grants for Neighbourhood projects. For funding process see **Sections 4.3.6 and 4.3.12.**

Longer term goals include rezoning to build food growing spaces, not limited to community gardens, supporting the location and licensing of urban farms, and supporting the role of urban agriculture as a public amenity (GCAP:2011,145). Finally, the GCAP, recognizes the strong connection between food production and sustainable buildings, with a goal to enable building development that provides green roof with urban agriculture opportunities (Duncan 2011;GCAP; 2011, 148), an area where the CoV could look to global best practices detailed in this report, particularly at the City of Toronto Green Roof By-law **2.9.15. to 2.9.16**. Finally, the Urban Forest Action plan cross references the EF (102), by recognizing that shade produced by the urban forest will reduce energy outputs of buildings, also operating as a climate mitigation strategy. The diversion of food waste supports the ecosystem, and is returned to the local urban agriculture and forest system as compost, discussed in the case study of the Fairmont Hotel and Sole Food in **Sections 4.1 to 4.3** is both a short and long term strategy.

3.11.9. Lost Opportunity in the urban food system in Public Health and Assisted Housing

The City of Vancouver, Department of Social Development in the Community Services Group is involved in the management of 153 Community Care Facilities in CoV for people with mental illness or recovering from addiction and who need assisted housing support. Social infrastructure projects for the homeless, include a project located at

Dunbar and 17th to house fifty-two homeless individuals in a middle class residential area. The project achieved LEED ® Gold and the CoV is the development partner with the funder, BC Housing, a Provincial Department (DPSCR 2008). This is an example, of a lost opportunity in which an intensive green roof could have supplemented and provided access to healthy local food for low income residents, the most vulnerable members of society, while reducing GhG emissions, the CUHIe, and the EF, as a CPUAF model. Although the project was constructed in Vancouver for Vancouver residents, the Province, who manage B.C. Housing and provide funding have goals and strategies that are not yet aligned with the high level of sustainability required by the CoV. It is imperative that the Municipality and the Province, work toward Climate Leadership goals at a local level, as a municipality can only accomplish goals and targets, which they themselves can administer. As well as providing a carbon sink to mitigate the effects of climate change and address urban reforestation, closing loops on waste streams, this is exactly the type of project that could go be yond LEED® as explained in **Appendix 2,** to address multiple sustainability issues, while forging deeper ecological connections for healing community and the planet at large.

3.12. Conclusion

Section 3 presented the background, the multi stakeholder engagement, the steps, processes and tools that led to the Greenest City Action Plan by 2020 and the cross referencing of food systems and urban forestation. Section 3 illustrates “How” the CoV is working toward a more sustainable climate resilient city that integrates food and forestation. The CoV recognizes that “many of the strategies and goals are transferable” (GCAP: 2011, 19) to other regions, while they are also looking at innovative best practices from international cities. Transferability requires an environment (Visser, 2011) that engages public and multi-stakeholders regardless of global or regional context, which for the most part, the City of Vancouver demonstrates.

The following **Section 4** presents projects that demonstrate the application of Continuously Productive Urban Agriculture and Forestation (CPUAF) to illustrate how the City of Vancouver policy has created an enabling environment.

Sustainable Agriculture & Forestation: The Edible Connected City.

Section 4

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Local Project Examples of Urban Agriculture and Forestation in the City of Vancouver

4.0. The Transformation of Economic and Institutional Structures for Societal and Ecological Benefit

Forward thinking corporations are considering the larger global impact of their economic profiteering on the environment and society and are stepping to the forefront to make a difference, sustainably by producing food locally while contributing to the continuously productive urban forest that mitigates climate change and reduce the effects of the urban heat island. The economic approaches use an Ecological Model, integrated in the Urban Management System of the City of Vancouver (CoV), that supports society and the ecological system as the core principal of sustainability.

Case studies of Continuously Productive Urban Agriculture and Forestation (CPUAF) functioning models from the CoV are presented in this Section. The first example is that of an international corporation, The Fairmont Hotel (FH), which applies principles of **Corporate Social Responsibility (CSR)**, and the second case is a **Social Enterprise (SE),** SOLE Food, both situated within the City of Vancouver, both of which are providing economic, ecological and social benefits to the inhabitants of the CoV by producing food locally. The first is an example of a CPUAF model, situated on an intensive green roof in the Central Business District (CBD). The later is an intensive ground level farm in the mixed-use industrial area of the Downtown Eastside (DTES). CoV planners support both operations and both reciprocally influence CoV policy as innovators in food system, urban forestation and green infrastructure planning. The thesis also briefly looks at the structure of **Community Supported Agriculture (CSA)** within SOLE food and other local farming operations, with the potential to expand to the rooftops in industrial areas where the tree canopy is lowest (GCAP) and CUHI's are highest (Oke 2001). A study of Dockside Green in Victoria B.C. is the first LEED ND® development in North America that goes beyond LEED® to incorporate complete sustainability into it's planning process, is a subject for future research, due to the constraints of this thesis; however, information about the project is available for further reading at <wwww.docksidegreen.com>. Finally, a look at Vancouver's Green Roof Policy, and the installation of a six acre (2.4 hectare) LEED® Platinum intensive roof on the Vancouver Convention Centre is discussed and embedded in the Fairmont

Case study as is a discussion of the CoV's GCAP, goal of zero waste by 2020 and the relationship to Food waste, with Vienna's best case waste management plan embedded in the Fairmont case. Finally, a proposal by Sole Food for an Urban Farm, located on the city owned SEFC site is reviewed with recommendations.

4.0.1. Methods

Informal Interviews with Alan Duncan (2011) of the CoV and Dr. Art Bomke of UBC (2011), led to primary field research on location at the SOLE Farm, which was suggested as an ideal case subject, applicable to the research topic. An interview, on site with Sean Dory, the project manager, led to an interview with Kira Gerwing, Economic Planner with the CoV as well as Michael Levenston, by phone, and Sharon Slade at City Farmer, on site at the Vancouver Compost Demonstration Centre (VCDC). Extensive photographic observation of SOLE Food Urban Farm and The VCDC is a component of the research methodology. Dory provided the initial project plan, also available on-line, providing updates, and Gerwing provided background that supported the CoV Administrative reports as to how the funding process was approved and the rational and background for the actions which refer back to the COV Case study, **Section 3**. Dory provided background on Jevons and bio-intensive agriculture and information about Michael Ableman, which led to the purchase of his book, From the Good Earth, to supplement an already extensive literature review. On-going discussions with Dr. T. Oke regarding the UHI effect and the SOLE site specifically, lead to mapping, cross-referenced in the Literature Review, Sections 1 and 2 and to the GCAP and the COV case study, Section 3. The case studies refers to the literature review and triangulate data from informal interviews, documentation, direct and participant observation during field research, photographic documentation, and observation of the physical environments, the six sources of evidence recommended as most commonly used by Yin (2008). The case study research supports the rational for "why we need to be more sustainable" defined in the literature review, **Section 1**, while demonstrating the tools and processes in action, used by the CoV to implement the GCAP from Section 2 and applied in **Section 3**. A Narrative approach, a method recommended by Dr. Karina Landman (2011), was utilized extensively to weave in expert evidence gathered in informal interviews. The method most utilized relies on the primary source of evidence provided by the experts in the informal interview process. Hyperlinks to websites are

incorporated, for ease of accessibility as a database, suggested by Yin (2009) to support converging evidence. Using flexible design to weave multiple cases, using mixed methods has provided what Yin (2008 63) describes as " a richer and stronger array of evidence than can be accomplished by any single method alone." The Fairmont Hotel case study, evolved from the interview with Alan Duncan (2011), using the methods described above. A site visit led to a phone interview with Graham Evans (2011) and Duncan, Evans and Dory, recommending visiting the VCDG, as a source of research for this thesis. Rees, Bomke, Quayle Duncan, Evans and Dory (2011) provided information during informal interviews, with regard to the VCC Green Roof, and as a result, using a flexible method a critique chapter (4.1.9) on Rating Tools and Green Roofs, Roofs was added to the study, embedded in the Fairmont **Section 4. 1**. Previous informal interviews in 2010 with Peter Van Bellegan, the developer of Dockside Green in Victoria B.C. And Bill Reed, Visionary Planner from the US, in Cape Town in the early stages of the research, provided date to enrich this section. As well, a site visit to Vienna Austria (2010), in the early stages of the research, provided the data on the Spittelau Thermal Waste Plant as a global best practice example.

4.1. The Fairmont Hotel

The Fairmont Hotel, (FH) uses the power of business to solve ecological problems, and is economically sustainable while providing indirect social benefits by improving awareness through education about ecosystem services while supporting the greater ecosystem. The Fairmont provides, long term benefits to the local community through ecological projects such as bee keeping and CPUAF, which contributes to the reduction in GhG emissions, and most likely contributes to the reduction in the CUHI in the CBD of the CoV and surrounding area. It was the first green roof located in the MVR (CMHC: 2005,41) to produce food, for it's own use and for sale to the public. While there are several examples of LEED® accredited green roofs within the city, they do not produce food. The Fairmont did not apply for LEED® accreditation as it is a retrofit, yet it goes beyond LEED® to meet multiple sustainability issues.

Figure 4.1 Six hives are home to 400,000 bees. A View of The Vancouver Convention Center (VCC), & Burrard Inlet in the background. Photos © V. Durant.

4.1.1. Corporate Social Responsibility & Environmental Stewardship

The Canadian chain of the Fairmont Hotel and Resorts pioneers a green partnership program, started in the 1980's with a goal to minimize the hotels' impact on the planet. According to Graham Evens, the Sustainability Manager of the Vancouver Fairmont, (interview 2011), the corporation maintains "a philosophy of sustainability as a core value of the company". The Vancouver Fairmont is an example of substantially and sustainably improving the eco- system services in the CBD of Vancouver and beyond, where the hotel is located. They accomplish this by providing a home for 400,000 bees atop a bee friendly roof top garden, which provides a local home base for the much needed pollinators. According to Evans (2011) "the bees travel a radius of 26 miles to pollinate and they are instrumental in sustaining the indigenous plant population in the area, located in Stanley Park and North Vancouver, significantly impacting and changing the landscape". The diverse, intensive and continuously productive rooftop garden provides fresh herbs, fruit and vegetables to the hotel, and is an example of CPUAF, with at least three layers of planting, reducing food miles traveled, thus reducing transportation costs, GHG emissions, contributing to the reduction of the EF. Although a detailed analysis is not concluded, Evans is confident that the garden contributes to reducing the ecological footprint (EF) of the Hotel's operation on the environment (Evans 2011). In addition to the long term ecological and social impacts, the hotel is ensures that healthy organic local produce is available to feed the hotel guests providing a sustainable source of local food for the corporation. Furthermore, as tree planting is cited as the most effective way to improve ecological health in a non-forested area (MVR: EHR 2011), this one project is an example of what could be achieved on a larger

scale in order to improve the urban metabolism as well as increase the yield potential of agriculture within the CoV (GCAP 2011). While it will take many rooftop gardens to have an overall effect on the BLUHI (Oke 2011) discussed in Section 1.3.4.a. it is a starting point for the potential of future projects. The roof is not LEED® certified, however, the project goes "beyond certification" in its approach to what Reed (39:2009) describes as " a whole integrated systems process cycle". While LEED® Intensive Roof projects have failed as they are not "tended" under a stewardship program after installation, as demonstrated by the SEFC Community Centre Roof (Fig. 1.4), The Fairmont rooftop is well maintained under an ecological stewardship program and is an active "place making" location as Figure 4.2 illustrates.

Weekly tours of the garden, lead by the head chef and Evans, are available to all members of the local and regional community as well as to hotel guests, which increases awareness by place making, through direct corporeal experience, about intensive agricultural production and the need to support pollinators which in turn support the larger ecosystem.

4.1.2. Environmental Sustainably makes Good Business Sense

According to Evans, who led the installation of the garden and the bee keeping operation (2011), honey is marketed at $10.00 per pound and yields approximately $17,000.00 in sales per annum. While, the garden does not provide the entire food supply for the hotel, it does produce over sixty varieties of herbs, fruits and vegetables, thus reducing costs to the hotel by producing on site. Furthermore, rooms with a garden view, garner $80.00 CAN more per night than other rooms. All of this proves that ecological and social sustainability can also be more economically sustainable than the "business as usual" model.

According to a CMHC Report (ND), the hotel spent $25,000.00 CAD to install the rooftop installation, whereas, it saves the hotel between $25,000.00 and $30,000.00 per annum in herb costs alone (Evans 2011)[1].

4.1.3. Pollinators and the Green Infrastructure – Linking Initiatives

[1] Further details and a full case study about the intensive green roof is found at:
http://www.cmhc-schl.gc.ca/en/inpr/bude/himu/inbu/upload/Fairmont-Waterfront-Hotel.pdf
http://www.seattle.gov/dpd/cms/groups/pan/@pan/@sustainableblding/documents/web_informational/dpdp017822.pdf

According to the *Draft Metro Vancouver Ecological Health Report* (MVREHR, 2011, 22), "up to 90% of all plants and a third of our food supply relies on pollination services provided by nature". Further, a global decline in pollinators, which include bees, butterflies, hummingbirds and bats "poses a serious threat to our food supply" (MVEHR: 2011,22) as well as the natural food webs, which support other species and trees. Evan's is passionate about his bees and goes further to say (2011), "Without the ecosystem services provided by bees, 80% to 90% of all crops would vanish", referring to a mathematical regression study in which he stresses (2011), "Civilization would be gone after four years without bees"'. This is supported by the MVREHP (2011), which confirms that the loss in pollination is attributed to many factors including degradation of habitat in urban areas, resulting in a reduction in floral diversity as a result of hybridization of plant material. Climate change and the use of non-specific pesticides are having a negative effect on local (MVREHAP 2011) (Section 1.5) as well as global systems. So serious is this decline in pollinators on a global scale, that the UNEP Executive Director, Achim Steiner said (UNEP 2011), "Rio+20 is an opportunity to bring the often invisible, multi-trillion dollar services of nature, including pollination from insects such as bees, into national and global accounts". In other words, bringing the visible life cycles and systems in nature to the forefront of human consciousness and awareness is a key and valuable tool in place making (**Section 2.6.)** to protect human and species existence.

According to Evans, "Unusually low temperatures and increased rain during the spring, when bees should be active reduces pollination and production substantially, (Evans 2011; Merke 2011). The Fairmont Bees normally produce around 600 lbs. of honey, where the yearly yield is down to 200 pounds. This effect happened across the board in the Metro Area according to MVR walnut farmer, Ken Merke who stresses (2011) "that climate change, with increased precipitation and lower spring temperatures is having an impact on the food production in the region". A local "B2" (IPCC, 2007) response to alleviate these ecological, social and economic impacts, according to Evans (2011) and Sean Dory of SOLE food, (2011) is to intensify urban agricultural yield, which both organizations have undertaken as key objectives. On a larger scale, the CoV, through the implementation of the GCAP and the MVR under the Ecological Health initiative, plan to improve urban and rural public landscapes by increasing tree coverage, which

expands pollinator populations, while increasing on-site rainwater infiltration and retention. Both levels of government encourage private development such as the Fairmont project, as well as other publicly initiated interventions (GCAP 2011; MVREC 2011) as they suggest that larger scale and individual projects have important synergistic benefits. The Fairmont has achieved the multiple linking of sustainability initiatives and synergies by solving more than one problem (Berry 1981) through the implementation of a CPUAF model, applying a business leadership CSR model toward sustainability.

4.1.4. Regional and Municipal Collaborative Process: How does the MVR plan to implement an Ecological Health Plan (EHP)?

Much of what the MVR hope to accomplish in their EHP[2] involves increasing ecological connectivity in the region and overcoming habitat fragmentation by linking natural landscapes with urban and rural areas. Their comprehensive plan hopes to accomplish the linking of "Green Infrastructure, by increasing tree coverage, expanding pollinator populations, and reducing the application of pesticides (MVREC: 2011, 22). The report states "tree planting is the single most effective way to improve ecological health in non-forested areas" noting that storm water run-off accounts for the 30% of the pollution of water bodies across North America."

While this is a very useful tool for city/regions in developing an Ecosystem Strategy, The Fairmont demonstrates through CSR, the systematic implementation of the MVR EHP in action and in private enterprise. While there is increasing awareness about the benefits of intensive green roofs and the benefits of interrelatedness of multiple synergies, it is not likely that all corporations will follow, regardless of the economic benefits. While this project took place in advance of public policy, in response to an adaptive urban management system, municipal bylaws are required to mandate the requirement for new

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[2] Full details on how the MVR plans to implement the EHP & the rational for the proposal it is available at:

http://www.metrovancouver.org/boards/Environment%20and%20Energy%20Committee/Environment_and_Energy-July_12_2011-Additional_item-Draft_EHAP-5.1_Attachment.pdf (Accessed Aug. 9, 2011).

The process arrived at through public consultation and during webinars, an open house and through written input detailed on the MVR Website at: http://metrovanwatch.wordpress.com/2011/08/04/heads-up-metro-vancouver-ecological-health-action-plan-ehap-public-input-needed-now/ (Accessed Aug. 9, 2011).

development to implement green roof agriculture. A green roof bylaw would bring to the forefront; the economic and ecological benefits that exceed the business as usual model.

4.1.5. Reciprocal Influence on CoV Policy – Adaptive Systems Theory

The Hotel's program has influenced food policy in the CoV according to Evans (2011), "As the city did not have a previous language for bee keeping prior to 2005." This required an amendment to the Health Bylaw and as a result, bee keeping is now a component of the City of Vancouver's food policy.[3] This is a very good example in which management of the city as complex adaptive systems receptive to a transformative change presented as new concept by an outsider brings the city into a more sustainable state (Ruth; 2009, 165).

Figure 4.2 Two examples of a CPUAF Installation with 3 layers of intensively productive urban agriculture. Photo © V. Durant.

4.1.6. Continuously Productive Urban Agriculture and Forestation (CPUAF)- The Model in Action

The Vancouver Fairmont Hotel is the first, to install an intensive green roof, with over sixty cultivars that include fruit trees, shrubs, herbs, vegetables and perennials along with a Honey Bee Apiary. The rooftop garden integrates the sustainable application of agro-ecology, with a community of layered horticulture, a forest layered approach, using

[3] More information on how to structure an Urban Apiculture policy, see the following CoV websites: http://vancouver.ca/ctyclerk/cclerk/20050721/documents/pe3.pdf and http://vancouver.ca/commsvcs/socialplanning/initiatives/foodpolicy/projects/beekeeping.htm (Accessed, July 25, 2011).

organic practices in a rooftop setting. It is a successful demonstration of CPUAF in practice, which produces food sustainably to supplement the hotel's food supply.

Installed in 1994, the roof was converted from an ivy garden to a 2100 square foot (195.1 m2) herb and culinary garden, which exceeds the standard for an Intensive Green Roof as specified by CMHC (2005,1) in their manual for Policy Makers. An intensive green roof can support complex landscaping features, irrigating systems and a broad range of planting media, such as trees, shrubs, ponds and waterfalls. The rooftop garden is located on the third floor of the 20 stories, 489-unit hotel, and is a culinary and herb garden, which is one of the largest edible roof gardens in the city. Upon review, it uses a system of planting (CPUAF) as detailed in the writings of Jacke (2005), Whitefield (2002) and Hart (1997). Further, Ableman (1993, 109) who commented after visiting Harts forest garden, " It is a model that can be reproduced in urban gardens and individual yards". It is modeled as a natural woodland, in that it has three layers of vegetation: trees, shrubs and herbaceous plants. The tree layer contains fruits and nuts, and it contains very few annual vegetables, the ground layer is diverse, with many perennials and herbs. What distinguishes a forest garden "is that they are all grown together on the same piece of ground, one above the other "(Whitfield: 2002, xii), also a principal of Permaculture. The Fairmont organic garden is edged by box hedges and produces over sixty varieties of herbs, vegetables, and edible blossoms, including alpine strawberries, lovage, calendrum as well as apple, nectarine, pear plum apricot, and five fruit cocktail trees as well as bay trees using this method. The garden is continuously productive, producing, almost all year round. Evans is conscious to plant bee friendly plants, such as clover, chives, lemon balm, fennel, rosemary and thyme, which are medicinal for bees and are carried by the bees to pollinate in other areas. Evans has (2011) "Let go of the reliance of industrialized seeds" and plants heirloom tomatoes, an old style plant that is not necessarily round but tastier than the hybridized product we are accustom to on supermarket shelves. No pesticides are necessary as a system of intercropping and companion planting, improve plant vitality and "Confuse unwanted pests" (Ableman: 1993). The beneficiaries of these tastier products are the hotel guests as well as the ecosystem at large, as pesticide pollutants do not contaminate the stormwater from the hotel. The bees and the honey they produce are much healthier as well.

Evans (2011) is also conscious of planting endangered species such as the Orca bean which are at risk of extinction simply because no one plants them anymore. One of the problems they have had to contend with at the Fairmont is that the bees are not only providing pollination to a broad area but they are returning with grass and weeds picked up during their travels. Evan's is optimistic that (2011) the "Hotel's bees will win the battle against invasive grassed and weeds, and in turn convert other locally planted grass roofs and landscapes into sustainable indigenous food systems."

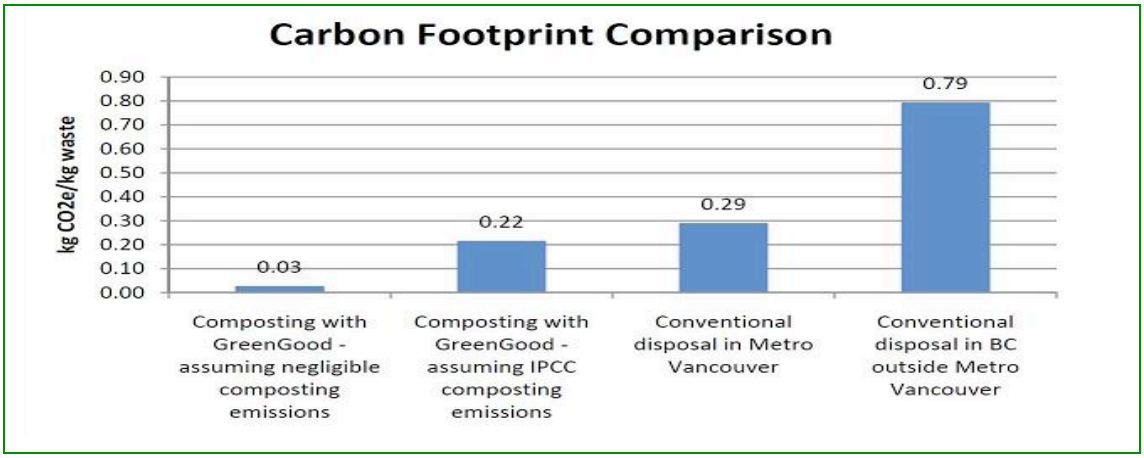


Figure 4.3 Solid Waste Management and Greenhouse Gases: A Life-cycle assessment of emissions and sinks EPA, 2006. Source: www.greengoodcomposer.com

4.1.7. The Fairmont Hotel Food Waste Management

Reducing Co 2 emissions produced by food waste is an area under review by the Hotel in its quest to close waste streams and protect ecological health through sustainable food systems management. Composting is a challenge, as the potential odor produced by food waste is not conducive to the configuration of hotel rooms, which overlook the garden. As a result, the hotel is investigating the installation of a commercial aerobic composting system for food waste recycling. The product produces low levels of GHG emissions, and dramatically reduces the production of methane gas, common in conventional food waste disposal. Although the product under review utilizes small amounts of electricity, disposal minimizes water consumption, typical of standard agricultural composting, reduces fuel consumption used in the transportation of waste to the landfill, and based on preliminary studies indicated below, the system, albeit not carbon neutral, is significantly more sustainable than the conventional means of waste management (Fig. 4.6). The high temperatures produced by the composter safeguards

against e-coli and salmonella, producing low levels of harmful bacteria, (www.greengoodcomposter.com/articles/24-hour-cycle-time/) a serious consideration in a commercial hotel environment (Evans 2011). While it takes nine weeks to convert food waste to useable soil by conventional methods (Metro Vancouver.zerowaste.org), the composter under review by the FH, as well as by SOLE food as detailed in the next case study, converts waste to soil in 24 hours.

Although technology is by no means, the solution to carbon neutrality or "The pathway to a sustainable ecological footprint" (Rees: Interview 2011), in a commercial application, the offset from the combination of sustainable measures may well be as close to or exceeding current levels of sustainability, as one is to find in a commercial urban agriculture setting. Further research is necessary to assess the viability of this alternative to traditional composting or diversion as outlined in the Metro and CoV Zero Waste strategies. As well, the Life Cycle Assessment measures Co2 emissions and is not an EF analysis. While The GCAP Zero Waste strategy states that "Managing the transition to full producer responsibility (for waste) will take many years", the Fairmont is one example of a corporate approach that may provide an interim step in toward zero waste management as a component of the sustainable food system.

4.1.8. Conclusion: Fairmont Hotel CSR - Meeting Multiple Sustainability objectives through applied CPUAF principles

The rooftop is a retrofitted space which does not qualify under LEED ® standards. While the hotel is not a LEED ® [4]recipient as this was not the desired goal of the management, it is safe to assume, although further research is required, to quantify the data, that this is a project that is on the right track in meeting multiple sustainability issues and contributing to the desired outcome of this thesis.

Although, there is little quantifiable evidence, such as an EF lifecycle analysis of the Fairmont Intensive Green Roof and the benefits of the CPUAF installation, in terms of the ecological footprint EF, GHG emissions, thermal properties, storm water reduction,

[4] Appendix 2. Details regarding the 2.4. Hectare, Vancouver Convention Centre Roof, as well as the background and limitations of rating tools, as they apply to Urban Agriculture is provides as Appendix 2, in order not to interrupt the flow of the Fairmont story. As well, background on Vancouver's Green Roof policy as it evolved for the development of the SEFC Area is discussed.

and the reduction of the CUHI effect, Evans (2011), is confident that these offsets are made present, by the production of local food, for use by the hotel, as well as the benefits to the local ecosystem as a result of the bee apiary. Economic evidence presented suggests these benefits are present.

Could the hotel be doing more? Perhaps, it could increase the intensity of its production, although the diversity of the CPUAF garden supplies horticultural products to both humans and contributes to the survival of the local bee and indigenous plant species through careful plant selection and a balanced system. Water conservation is high on the agenda as drip irrigation is utilized to minimize water consumption. Future water harvesting is considered, when the city approves water-harvesting processes, which is a process compatible with urban agriculture and a topic for future research. A contribution to reducing GHG emissions could be measured with further research, while the reduction to the CUHI is a small contribution which would require a concerted and sustained effort by multiple building owners in the CBD (Section 1.3.4.), with policy and by-law support from the CoV, in order to have a significant impact to the local climate, or reduce the impact on the BLHI.

The Fairmont Hotel is a corporate entity, applying principals of the ecological model **(Section 1.6.7),** contributing toward a more sustainable food system, striving for a one planet EF, using locally applied strategies from the B2 ICPP model (2007). The hotel rooftop food garden, applies the principles of a CPUAF project described in **Section 2.11** on an intensive rooftop (**Section 2.9**), going beyond a rating system, while recognizing the interrelatedness of all systems. As an outcome, the Fairmont contributes sustainably to the greater MV Regional ecological system, supporting human health and well being by supporting pollinators, and providing local food. The Hotel is in the process of achieving zero waste, cycling not only garden but Hotel food waste back into the immediate system. It is a leading example of a CSR program, to which the GCAP: 2020 refers to as a desired outcome in transitioning to full producer responsibility. The Fairmont is in the process of partnering with the Port Authority, (PA), a Federal Department, to experiment with UA on a vacant industrial lot, on the waterfront near the Hotel, and the SOLE Food urban farm. This thesis recommends the Fairmont, the PA, triangulate a partnership, by engaging SOLE Food, to expand UA, to leverage CSR and SE within the local community to provide further climate protection and food security

benefits, through waste management and other partnerships.

4.2. Food and Organic Waste Management in relation to Food Systems

As urban green space and food production continue to increase within the CoV as a result of the implementation of the GCAP initiatives, organic waste will increase. The output of food waste is exponentially linked to population demographics, projected to increase in the CoV (GCAP: 2020,130), following the global trend toward urban growth (UN Habitat: 2009, 8). Organic waste outputs[5] from the production of food and from increased urban trees and vegetation, which are not composted in a life-cycle process, on site, will require integrated waste management solutions.

The CoV has considered waste and the interrelationship to food production in the GCAP: 2020. Four of the key target areas are linked to the integration of food systems and waste management and apply to urban forestation and local food. In the CoV, they include the integration of food and waste in an incubation strategy for sustainable economic development located in the Green Economic Zone (GEZ) (South East Creek, SEFC, Strathcona and the DTES) with climate leadership as the driver (CoVAR: A1, 2010). The reduction of (EF) is embedded in the system (Figure 1.9) (GCAP 2011). The CoV is exploring the integration of light industrial uses in industrial and mixed use neighborhoods that support local waste management recycling initiatives and integrated urban agriculture opportunities (CoVAR: A1 2010), (CoVAR: A5 2011) through the Neighbourhood Grant Fund. Managing large-scale waste is a Regional initiative guided by the MVR principals of sustainability, (ISWRMP: 20110, 19),[6] and they are committed to developing policy and bylaws which will assist municipalities in achieving a consistent

5 Organic waste from agriculture refers to the non-consumable parts of edible landscaping. Such as non-edible leaves, twigs, stalks, branches and trimmings. The same also applies to the leaves, twigs, branches and trimmings from increased urban vegetation.

6 http://www.metrovancouver.org/about/publications/Publications/ISWRMP.pdf
Accessed July 25, 2011. The MVR ISWP Report is available at:

outcome. Appendix 3 discusses the management of organic waste, and the following sub-chapters discuss other local examples, which link The Fairmont and SOLE Urban Farm as sustainable contributors to the management of waste through mid-scale productions.

4.2.1. The Greenest City Action Plan Goals and Targets as relating to Food, Forest and Waste -

Goal 5: Create Zero Waste.

> **"Target One: Reduce total solid waste going to landfill or incineration by 50% from 2008 levels (GCAP, 2011,17)".**

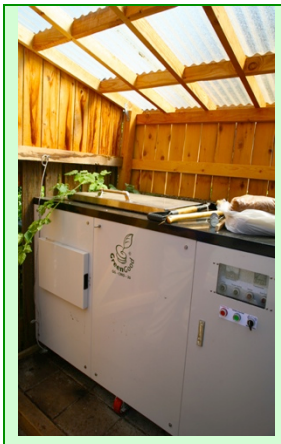
According to the CoV GCAP (2011, 75), "Canadians produce more solid waste than any other country in the world". In the MVR, which manages waste for the CoV, 55% is diverted to composting or recycling, with 480,000 tones per year ending up in the landfill site or incinerated (GCAP: 2011, 75), while food and yard waste make up 33% of garbage collected. The GCAP (2011,75) states "climate change, deforestation, species extinction and pollution – these and other issues stem from over-consumption and waste." There is a tremendous opportunity and need to reduce food waste "at source" which is the strategic approach taken by the CoV. As urban agriculture and the production of local food increased within the city, the priority becomes greater as more food waste is produced and the cost for diversion to a regional location has climate impacts (Fig 4.6).

Goal 2: Climate Leadership of the CoV's GCAP 2020 (2011, 36) is to eliminate dependency on fossil fuels (long term) with a **target** to reducing community based greenhouse gas emission by 33% from 2007 levels by 2020. This relates to the goal of achieving zero waste. The CoV's strategy is to reduce compostable materials in the waste stream, and secondly, to capture and utilize methane arising from the landfill. Thirdly, the goal is to indirectly reduce emissions from the production and manufacturing of goods. In this context the intensification of the manufacturing and production of food will require at source waste management, a process underway in Case study examples including the Fairmont and Sole food and through local composting initiatives.

Goal 10: Vancouver will become a leader in Urban Food Systems.

Target One 2020:

(2011,17) The goal is to increase city and neighbourhood food assets by a minimum of 50% by 2020. By increasing food assets it is necessary to address waste management more efficiently. As urban food production increases and is integrated in the realm of the urban forest management process, the need for innovative solutions for waste management are required.



"Neighbourhood food assets include: Community kitchens, farmers markets, pocket markets, community food composting facilities, garden plots, community orchards, urban farms and food hubs (GCAP: 2011, 17)".

Figure 4.4. City Farmer Compost Demonstration Facility. Photos © V Durant 2011.

4.2.2. Demonstration Centre Combines Composting & Intensive UA

The City of Vancouver has a long history of encouraging urban agriculture and an established culture of recycling of compostable materials. In 1982, the city funded the establishment of the Vancouver Demonstration Food Garden, operated by the NGO, City Farmer, which provided hands on experience and training, using intensive agricultural cultivation to city residents. In 1987, they expanded to provide a horticultural therapy center, known as the Ability Garden, staffed the location with therapists and provided assistance to seniors with Alzheimer's, quadriplegic children and people with MS (Duncan 2011;Slade 2011). In 1990, the CoV began a recycling program, and as a result, the site was transformed into the Vancouver Compost Demonstration Garden (VCDG). Through the demonstration facilities in Kitsilano, city residents can directly experience and explore the benefits of composting, water harvesting, as well as gain knowledge and experience on intensive urban agriculture. The facility tests commercial composting bins and the gardens are an example of a small scale CPUAF landscape

with trees, shrubs and bushes. The recommendation of Sean Dory at Sole Food, and Alan Duncan at the Park Board, resulted in a site visit, to investigate the composting equipment under investigation by both the Fairmont and SOLE food and experience the garden first hand. Both the Executive Director Michael Levenston and Sharon Slade were helpful in answering questions pertaining to the thesis inquiry. This small, quiet garden has reached hundreds of thousand of interested people, and it's tremendous benefit to the City of Vancouver in the pursuit of urban agriculture and sustainability, an outcome that cannot be measured by data alone (www.cityfarmer.org) (Duncan 2011). The organization has adapted to the changing needs of the community at large, while providing a stable source of information to the public. Information about City Farmer and How the City Structured the Composting and UA Demonstration Centre go to http://www.cityfarmer.org/ >

4.2.3. Local Neighbourhood Pilot Projects Address COV Waste Management

One of the actions (GCAP: 2011, 14) proposed by the COV is to allow residents to add food waste material to their yard waste recycling. Yard waste is currently collected every two weeks and the city proposes collection every week. Concerns that individuals may give up the long established process of recycling compostables by combining their food scraps with yard waste were raised by Slade (2011) at the Vancouver Compost Demonstration Garden VCDG and was a topic of discussion during the VFPC meeting in July 2011. Village Vancouver (VV)[7] a Transitions organization is addressing the issue

[7] **How to Start a Transition Community - The Transition Movement**

The Transition Movement is a global network of local communities responding to climate change and peak oil by re- localizing and re-shifting production and consumption patterns to regional geographic limits that can be sustained without the use of fossil fuel. The initiative began in Totness England in 2005 by Rob Hopkins, author of the Transition Handbook, in order to re-build local resilience and reduce Co2 emissions through coordinated action at the neighbourhood level. Information on where Transition Villages are located and how to start one is located at: http://www.transitionnetwork.org/

Village Vancouver – A Transition Community

Village Vancouver is a transition community with thirteen (13) coordinated neighbourhoods within the city. Their mandate is to organize and facilitates individuals, neighbourhoods and organizations to collaborate in taking actions that build sustainable and resilient communities, cities and bioregions. An example of how the movement is working in Vancouver is located at: http://www.villagevancouver.ca/ http://www.villagevancouver.ca/group/villagevancouverfoodworkinggroup

through a city-funded project, by providing free composters to urban residents in several target neighbourhoods (Moster 2011). In addition, the VCDG is informing the public who attend the demonstration garden and compost center of the necessity to continue recycling (Slade 2011). While local scale projects are taking place, it is recommended, that a larger-scale public awareness campaign inform residents of the continuing need to compost personal food and organic waste. Mid-scale food waste recycling is proposed by SOLE food and the Fairmont Hotel, and aligns with the GCAP:2020 described in the case studies. Meanwhile, the CoV, which has installed a thermal generation plant on the SEFC site, is considering other sites for large scale waste management (Gerwing 2011) within the city limits. The objective is to reduce transportations costs of transporting waste. **Appendix 3** provides a global best practice example of an innovative and sustainable waste incineration and thermal heat generation plant, located in Vienna Austria.

4.3. Sole Food – Project Example - Toward Sustainable Social Responsibility while Saving Our Living Environment

Sole Food (Saving Our Living Environment) located in Vancouver's Downtown Eastside (DTES), is an intensively productive urban farm and an example of a Social Enterprise (SE), providing skills training and employment to local residents. The project demonstrates climate leadership by reducing food miles traveled, contributing to the reduction of the ecological footprint (EF) and reduced GhG emissions, by producing healthy food, locally and organically. The farm is situated on an underutilized parking lot in a mixed used industrial, commercial area on the edge of the CBD in close proximity to the Port of Vancouver. The enterprise is an example of continuously productive urban agriculture and forestation (CPUAF) within the City of Vancouver (CoV), which employs an innovative vertical growing strategy that suggests a tree canopy, which doubles the growing capacity of the property. SOLE addresses and aligns multiple sustainability objectives, by providing a sustainable local food source and food security, while improving human and ecosystem health and wellbeing. Furthermore, the project links urban forestation and urban agriculture, through creative land use planning in industrial

zones, as an objective of the Green Economic Zone (GEZ) criteria of the City of Vancouver (CoV) and the Greenest City: 2020 Action Plan. Furthermore, although the UHI effect is not a criterion for action by the CoV, higher temperature zones do exist as this thesis demonstrates (Figure 1.5)(Oke 2000)(Oke 2011) and the project contributes to climate reduction and UHI mitigation strategies (Oke 2011) by deflecting solar radiation (Ruth 2009) on an incremental scale. This example, along with Section 3 and 4, answers the thesis question, "How can a city can link Urban Agriculture and Urban Forestation as an integrated sustainable urban management solution to address global climate change and local heat island effects and provide local food security?" SOLE Food aligns a powerful local initiative with the CoV sustainability objectives.

4.3.1. Introduction

SOLE Food, was established in October 2009, by United We Can (UWC) in partnership with other community organizations in order to bring agricultural production to the inner city in response to local food needs. As a model Social Enterprise (SE), SOLE contributes to social equity, economic development and human health and well-being within the community it is located, all of which are fundamental desired outcomes for food security and subsequently, food self-reliance, as detailed in the *Food Secure Baseline in The City of Vancouver Report* policy framework model (FSB: CoV: 2009,4). The project, is one of the first of its kind in Canada, providing benefits to the ecological system, reducing GHG emissions by producing food locally thus reducing food miles traveled. As well as producing agricultural products sustainably, using organic methods, this Social Enterprise (SE) addresses on principal (Oke 2011) the soil, surface and canopy heat island effects, problematic in Industrial areas of the city identified in **Section 1.3.4** (figure 1.3). This is an example of an innovative land use approach within an Industrial mixed use zone that is a first step to closing the gap in the urban green space in the private realm, by linking urban forestation and urban food production as a component of the city's urban forest management plan (Figures 1.6 and 1.7). While further research is required to quantify the data, indicators suggest, that the intensification of agricultural productivity through vertical farming, contributes to the reduction of the ecological footprint of the CoV. This is further accomplished through a traditional system of intensively productive agriculture, modified and applied to the urban environment by Michael Ableman, Co-Director and organic farmer, who applied methods from traditional farming outlined in **Section 2, Chapter 11**. With big plans for

sustainable growth, SOLE Food Urban Farm is currently one small quarter acre with a very big heart and a whole lot of SOLE.

4.3.2. Background - United, We Can Save Our Living Environment

SOLE Food originated in 1990 by street level recyclers (referred to as "binners")[8] to alleviate urban environmental degradation in response to the need for a bottle return system in the City of Vancouver (CoV) (CoVSFPP: 2010,3). SOLE opened United We Can (UWC)[9] Bottle Depot in 1995 and was the first bottle-recycling depot in the Province. The concept culminated on the ground at a grass roots level by the local community. Led by Ken Lyotier, who eventually received a Governor General Award for his service to the people of the Downtown Eastside, they soon, expanded their operations to the recycling of old bikes, e-waste, added plant rescue and opened the SOLE Food Urban Farm. UWC is considered "a model social enterprise (SE), generating 2.5 million dollars a year for the DTE's community, employing 150 local residents and recycling over 20 million containers a year (CoVSFPP: 2010,4)." SOLE is a non-profit organization, focusing on job creation in the green economic sector for and by inner city residents. UWC is a registered charity, created in 1996 to support SOLE initiatives, with the power to raise and distribute funds for employment directed specifically to alleviate environmental degradation (SFPP: 2010). SOLE is an example of an organization that embraces the core values and goals of the ecological model of sustainable planning described in **Section 1.6 & 1.7** (Fig. 1.4.). SOLE illustrates that by embracing ethical values that support people in their living environment at a local level with the green economic systems embedded as a subsystem of the larger social and ecological systems, it is possible to create a more equitable, just and less complex **(Section 1.1.3),** more sustainable society.

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[8] **Binner (Bin-ner):** Someone who works scavenging through the garbage bins with the prospect of finding reusable and recyclable items that **can** be exchanged for cash. (UWC, ND).

[9] How United We Can started as a grassroots organization:
The full history and background about United We Can and SOLE food is available at (UWC.ND): http://www.unitedwecan.ca/ABOUT.html (accessed September 11,2011).

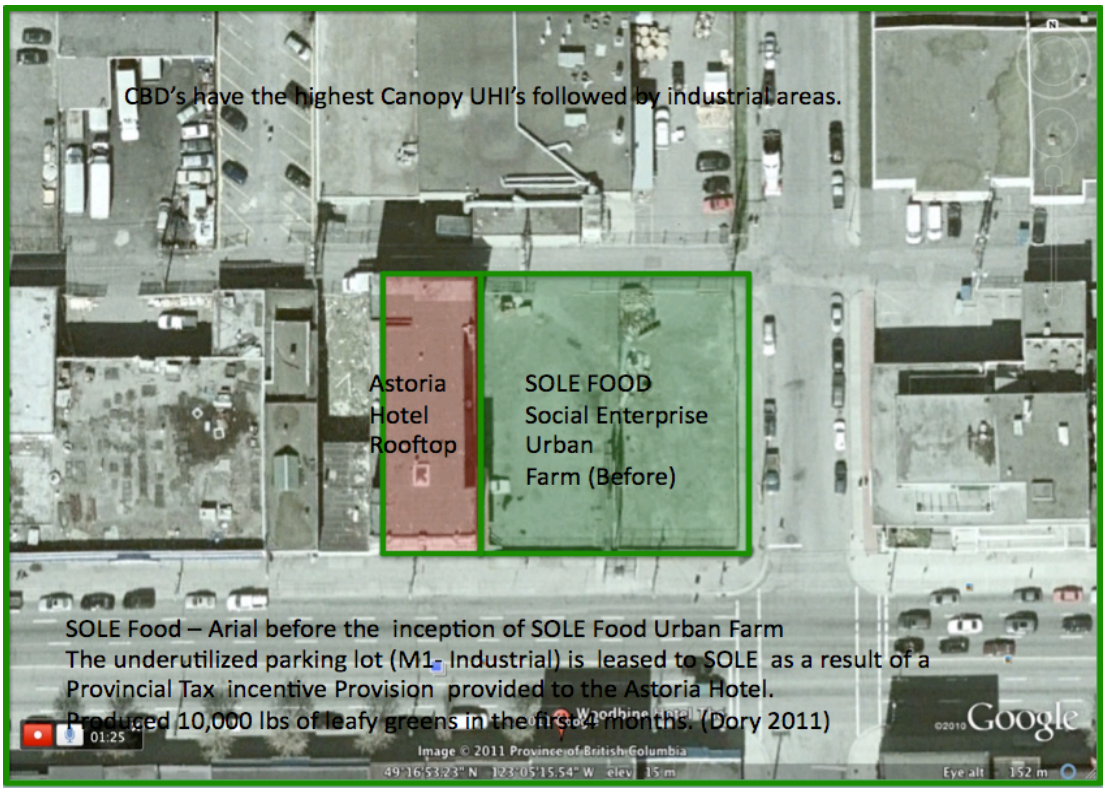

Figure 4. 5. Google Map modified to indicate SOLE Food Location. Source: Google Earth.

4.3.3. Land Use – Creative and Flexible Zoning and Policy Adaptation

The ¼ acre SOLE Food Urban Farm is situated on the corner of Hawkes at 769 East Hastings on an underutilized asphalt parking lot owned by the Astoria Hotel. The site is located in the DTEs neighborhood, with the CBD to the West, the Port of Vancouver three blocks north, and Historic China Town and Strathcona, the proposed area for the Green Eco-Zone to the South. The inception of the project was made possible on October 31, 2009 when the B.C. Provincial tax office allowed building owners, such as the Astoria, an option to convert underutilized underdeveloped space to community garden land use, zoned as Park Land, and in return, provided an 85% tax cut to the property owner as a result. SOLE food was the beneficiary of the tax break, paying the yearly property tax, in lieu of rent. SOLE has negotiated a one-year lease on the property with a renewal option for five years (Dory 2011).

Figure 4. 6. Land Use Signage Requirement. Photo: V. Durant.

The original zoning of the site, is M-1 Industrial District (CoV Zoning Map) and permits industrial, commercial and other uses, not generally compatible with residential use. Much of the land in the area is mixed use with heavy industrial-use zones (CoVAR; 2011, 1), which provides the DTE's, according to Gerwing (2011), "with a unique asset to foster adaptive and flexible re-use, suitable to incubate a currently undefined local green economy and foster green job creation". The City identified the Green Economic Zone (GEZ) to include the DTES, The South East False Creek Flats and Strathcona to link the local food economy, which is the largest Green Economic Sector in the Green Cluster, with food processing and manufacturing, linked with waste management as the key sectors in the zone (GCAP: 2011,23). Dory (2011) highly regards economic and social planners, Kira Gerwing and Wendy Mendez as having the creative foresight to champion the project through the bureaucratic and political process, where policy (not yet developed) and urban agriculture use is non-conforming. With the assistance of the forward thinking planners, the land was zoned as parkland, which requires the farm to be open from dawn to dusk and requires signage, notifying the public of the operation (Fig.4.10). In reality, the operation is a business, keeping business hours and does not adhere to the community garden regulations (Dory 2011). The business license allows for sale of produce as an amendment from a community garden where sales of produce are not normally permitted. According to Gerwing (2011), a community garden, is not a "for profit" venture, however a retail component can be ancillary to the garden; further, it can be "not for profit" if it is for charity. Clearly, while there is no rule or system currently in place to foster social enterprise (SE), or for that matter, urban farming, the process is breaking new ground, supported by the City and Council, as an adaptive transitional

model, a tool defined in Section 2, that supports innovation and new comers in the system. Meanwhile, the CoV, through the Department of Social Planning, with the input of urban farmers, is in the process of developing land use policies, by-lays and business licensing to provide a legal framework to support the business of commercial urban farming. According to Chris Thoreau (2011), owner of My Urban Farm, the City provided funding for the Vancouver Urban Farming Forum, engaging the public, stakeholders and urban farmers in a two day workshop that included analysis of global best practices and policy from the Cities of Seattle, Victoria and San Francisco.[10] Of significance is that the conversion to park land for the SOLE food project aligns with the CoV's GCAP: 2020 Goal **6, Access to Nature** (GCAP: 2011,98) to expand green spaces in the public and private realm in areas that do not meet the target of proximity to connected green space defined in (Figs. 1.6, 1.7.) and defined in the Greenways objectives. Further, SOLE is a working example where the expansion of urban green space expansion cross references to the incorporation of new and existing parks, to provide local food and local green employment (GCAP: 2011,98) (**Section1.2.4**), integrated into the community in which it is located, defining the gap in this thesis Policy. Finally, by-laws are in the process of development and the CoV is moving forward to meet goals, and targets defined in the GCAP to meet climate and food security objectives, through adaptive land use and strategic planning.

Figure 4.7. Vancouver Urban Farming Forum Website. http://ufnforum.wordpress.com/registration/ (Accessed December 12, 2011). Source Vancouver Urban Farming Forum

[10] To review full details of the urban farming forum visit their website at http://ufnforum.wordpress.com/registration/ Accessed December 5, 2011.

4.3.4. Defining A Sustainable Urban Plot: A perspective on Urban Typography

Getting closer to answering the question as to what an ideal "sustainable typography" of urban agriculture looks like is explained by Dory (2011): "Achieving economic sustainability requires three acres of urban farm land in order to support a Social Enterprise (SE) Model, which provided support through training to low threshold employees, while using bio-intensive agriculture or agro ecology processes. With three acres, you can rest the soil, through crop rotation; whereas with ½ an acre you need to rest the land as well as provide a cover crop, making it unsustainable." However, smaller privately operated farms, or Spin Farms as discussed in Section 1.2.5. Can operate on smaller areas of land. The SOLE food lot, through the use of Vertical Farming, has doubled the carrying capacity of its current 1/4-acre site to produce the equivalent of 1/2 acre of produce by utilizing vertical agriculture. The installation of vertical strawberry "trees", (Fig 2.4) constructed of PVC piping and filled with soil has increased the productivity of the land by 100%. Therefore, utilizing this method, a 3-acre site could produce the equivalent of 6 acres (2.42 hectares) of horticultural product. Dory recognizes that the vertical PVC tubes create outputs during the manufacturing process (2011), which negatively impact the EF. However, vertical farming (A tool described in Section 2.10) provides a hybrid form of ecological intensification as it "increases the carrying capacity of a piece of ground (Viljoen: 2008,240)," reducing the EF to meet multiple objective in sustainable urban planning. As well as vertical farming as a means to increase the output of the farm, SOLE engages in intensive urban agriculture under the stewardship of Executive Director Michael Abrams, author and long time urban farmer, owner of Foxglove Farm on Salt spring Island, (Dory 2011)"who has an aggressive growth strategy for the expansion of SOLE food", to meet sustainability objectives.

4.3.5. Funding process and Economic Sustainability

Dory (2011) estimates that SOLE food will be economically sustainable once fully established in three years, while taking on a trajectory of growth and increased capital expenses for up to four years. He said SOLE "has a project plan to expand operations from one to nine farms and to have 13 sites in operation by 2013, with six acres by year four." Initially, SOLE required start up funding in order to begin operations, and was

assisted with grants, donations and volunteer support in the start up phase. They were successful in obtaining an EnviroFund™, grant of $44,000.00 from VanCity Credit Union, which has a long history of support to local initiatives addressing local environmental issues https://www.vancity.com/ (accessed August 9, 2011). In, addition, the CoV leveraged the VanCity funding by providing a neighbourhood grant of $50,000.00 in 2009 and a second in 2010 for a total of $100,000.00 (Details - **Appendix 4**). This was made possible by the Mayor's Greenest City Action Team Priority recommendation established to support sustainable economic development for vulnerable populations (CoVAR: A1: 2010 (1), CoVAR: A8: 2010 (2). These, as well as other grants provide necessary capital to support the purchase of equipment and infrastructure. While productivity is the goal of most urban farms, Soles objective is job creation, making high yield agricultural production an imperative if it is to obtain economic sustainability.

Planners such as Gerwing see Urban Agriculture (UA) as a catalyst (2011) "to shift from a charitable based model to one in which entrepreneurial partnerships become the norm in social innovation for the DTES." By this Gerwing is referring to the proposal of investors, even the City, providing not just a capital grant but receiving equity shares in the property or the business ownership." While embracing an ecological model of innovation, not fully formed or completely realized, it is agreed (Dory 2011; Gerwing 2011) that SOLE alters the paradigm of the Charitable Model, as a slow growth process toward sustainability.

Figure 4. 8. SOLE Food Urban Farm. An example of an employee working in the field. Seann Dory and employee demonstrate to students, through the stewardship model, the benefits of an UA SE model. Photos: V. Durant.

4.3.6. Social Enterprise

The farm provides training and job creation for vulnerable individuals who reside in the local DTES community, an area of the city with a high level of poverty, drug addiction and mental illness. SOLE employs 5 staff as well as one full time manager and according to Dory (2011) " is the first ever training program of its kind in Canada". While according to Gerwing (2011), " SOLE is a defensible case, as it employs people dependent upon welfare." SOLE plans to employ between 50 to 100 staff, once they are operating at full capacity with a sufficiently sustainable amount of productive land. **Goal 1** of the GCAP: 2020 is Green economic growth while Local Food is **Goal 10**. SOLE Food SE meets multiple objectives of sustainability, by producing food locally, providing green collar jobs in the emerging local green economy, and by contributing as a model of CPUAF, to the expansion of the many layers of an urban forest, as well to the care and protection of trees and vegetation defined in **Goal 6 of the** GCAP (2011, 102).

4.3.7. Stewardship and Place making - Neighborhood Morphology & Social Cohesion

While the required signage and the "actual" land use are not yet aligned, Dory more than makes up for the "dawn to dusk" requirement of the community garden land use requirement. As Figure 3.13, illustrates, he is very giving of his time, and in addition to meeting for a lengthy interview, he scheduled a visit by local biology students, interested in the SE UA farm model. There are multiple benefits, as the employee, to the left of Dory in Figure 3.13.illustrates. He has an opportunity to practice his knowledge with the students while assisting with the interview, as well as gain on-going information and education about the SE to which he is employed. During working business hours, the farm is an active place and a center of community cohesion. While this is a high crime and high poverty area with a potential for theft and vandalism, local residents are respectful of the farm. According to Dory, (2011) "it is the university students, who frequent the bar next door, who are responsible for cans and cigarette butts ending up on the farm". SOLE provides a local "picking patch" and a daily box containing free produce outside of the perimeter fence for local residents. Dory attributes these actions contribute to the respect the local community holds for SOLE food within the fabric of the community. Stewardship and place-making, discussed in **Section 2.6 and Section**

2.7 contribute to repairing the fabric of social cohesion, by providing a "linking place," evolving the morphology of the DTES into a "vibrant sustainable neighbourhood" described by Jacobs, (1989, 14) and detailed in Section 2.6. Furthermore, increasing awareness about food production, demonstrates greater respect for the ecosystem and the property it occupies.

Figure 4. 9. SOLE Food Urban Farm. A. An example of interplanting, with taller vertical strawberry trees in the background. An example of CPUAF. B. A white, hothouse cover extends the growing season and reduces Co2 Emissions by 2% (McPherson: 1994, 154). Photo Credit: V. Durant.

4.3.8. CPUAF - Sustainable Agriculture - an Ecological Model

The Farm consists of a system of raised beds and vertical growing units, intensifying the production of the ¼ acre to a yield of ½ acre. A whole systems approach, incorporating principles of intensive and diverse inter-planting, succession and poly-cropping is applied (Figure 4.13a)(**Section 2.11**). Dory explained that" radishes take 26 days to harvest and the spinach, planted at the same time, fills in after." Spinach, basil, peppers, kale arugula, cucumbers and strawberries are just a few examples of vegetation, carefully selected to produce a high intensity yield, provides ecological, economic and social sustainability as an outcome. A no dig method is used, and the growing season is extended using low-tech white hothouse covers, keeping the soil productive throughout the year. Further, the white covers, which extend the growing season, without energy inputs through electrical consumption, are estimated to reduce carbon emissions by 2% (McPherson: 1994, 154) as described in the literature review,

Section 1.2.2. A winter cover crop is planted to amend the soil, keeping it continuously covered, contributing to climate protection and ecological viability.
The farm was designed under the guidance of Michael Ableman, and is managed by Sean Dory, who conceptualized the Sole Food Model to produce food organically, and intensively for the local market employing local people. Dory describes the type of agriculture (2011) "as bio- intensive agriculture developed by John Jeavons, a California systems analyst and urban farmer, to produce maximum organic yield while improving soil in the process and which prevents soil exhaustion". The process, developed after a European model, incorporates the science of Agro-ecology as well as Forest Gardening, and ancient sustainable food production practices of raised beds perfected by the Chinese in the HAN dynasty *(***Section 2.9.9**). The farming practice integrates multiple processes and systems of sustainable agriculture described by Ableman in his 1993 book, *From the Good Earth (*Section 2.9.9). Furthermore, the application of vertical farming, described in **Section 2.9.9**. (Fig. 2.3) to intensify agricultural production, provides a good example of what this thesis refers to as a model of CPUAF, described in **Section 2.11**. SOLE food farm intends to be economically sustainable due to high yield outputs, and ecologically sustainable, cycling it's own, as well as local waste. Within the first 4 ½ months the farm produced 10,000 lbs. of produce for sale to local restaurants, meal programs and the local farmer's markets. What is astounding is the weight count, as there are no beans, potatoes, legumes, and mostly just lightweight leafy greens. According to Dory, (2011) farmers markets, which abound in the City, "provide the opportunity to retail produce directly to the consumer' without the wholesaler," increasing economic viability.

4.3.9. Food security

The DTES is not food insecure' according to Dory: however, he reports, "there is a lack of healthy food and this is the gap which this project addresses". This supports data from Food Secure Vancouver Baseline Report (FSVBR) that while there are a number of charity based food organizations in the CoV, they are an indicator of the (FSBCoV: 2009,70) "failure of the food system to distribute food to all members of society". As well, much of what is distributed is in the form of snack food including donuts and coffee; thus not providing healthy nutrition food choices. Local control over food quality and source are relevant indicators of food security and are essential to protect urban centers

such as the CoV and Region, from disruption from food supply due to extreme climate events, or global geo-political unrest.

Figure: 4.10. a.b. A sustainable means of urban food delivery Save-on-Meats on East Hastings Street. Photos: V.Durant.

4.3.10. Reducing Transportation Emissions

Sole supplies produce to local markets, the potluck catering organization, local restaurants, and food banks, all within minutes of the farm. At present, all products are currently transported by vehicle to the local purchasers, reducing GHG emissions, through reduced transportation costs by producing food locally and not outside of the city or abroad. However, Dory expressed concern about the use of fossil fuel, as the farm currently delivers by truck, and he is investigating the prospect of transporting by a more sustainable means. Chris Thoreau, a local urban sprout farmer and sole proprietor of Myurbanfarm, www.myurbanfarm.ca, delivers all the produce he produces by bicycle (Figure 14.a). As well, in partnership with another urban farmer, the two of them provide CSA delivery services throughout the city.

4.3.11. Waste Management

SOLE initially purchased recycled, Eco-Soil from a local manufacturer from the Richmond Delta, located 20 km from the DTES. As the farm is sited on an asphalt parking lot in an industrial area, there was no opportunity to utilize the existing soil; however they are currently waste neutral, utilizing their own waste to produce compost and amend the soil for the raised beds. As a component of their expansion plan, SOLE

intends on starting a mid-scale compost collection, processing and distribution center in the basement of a local meat market, Save-on-Meats (Figure 4.11.B), located five blocks from the SOLE Farm. They are looking at a separate site from the farm, as rodents are a significant issue in the area due to the close proximity to the Port of Vancouver and the plant to expand waste collection to local restaurants. The proposed project leverages local waste by reducing waste outputs in the DTEs, a strategic goal of the CoV's GCAP. At Dory's recommendation I visited the VCDG, as discussed in the previous case study of the Fairmont Hotel, as both operations are investigating the purchase of a commercial composter, currently tested at the Demonstration Garden. Details on "How the CoV funds UA and Waste Projects", appears in **Appendix 5.**

4.3.12. Water Management

Concerning water management, Dory said, " Drip irrigation, is used to minimize water consumption and the desert method, and is applied, which starves the plants, increasing the sugar content. It costs $5000.00 CAD to have our own commercial water line installed so we pay the landlord, the Astoria Hotel, for water consumed." As much as SOLE would prefer to use a method of rainwater capture, "the city does not permit it, because of the concern about bird (Avian) disease. This policy can be changed, as it was for the Olympic Village Development, which captures storm water and utilized it for landscape irrigation." http://vancouver.ca/olympicvillage/faq.htm - water (Accessed December 9, 2011). This is an area for future research by the city and requires a by-law for implementation.

4.3.13. Public Participation

United We Can, which started from the ground up by local downtown east side (DTES) resident "binners" engaged in the process of development from inception. Dory, who is a strong proponent of public participation and employee involvement, says " he regrets moving forward with SOLE food without a high degree of local participation and as a result, they lost twelve employs in the startup phase. They made a mistake thinking the jobs could be handled by low threshold employees, which was not the case, we needed higher skilled staff." He indicates they would have discovered this if they had initially involved the community and followed a consultative model of public participation, which

they will do in future, endeavors. Regardless, a high degree of public participation concerning urban food is evident in the participation and attendance at Food Policy Council Meetings. Furthermore, one simply has to type in a Google search "Talk Green to us" and a host of options is available, providing information on the GCAP targets as well as an opportunity to provide feedback to the City in the key areas. This includes the Greenways program, which identifies areas within the CoV where urban green infrastructure and connectivity is needed. http://talkgreenvancouver.ca/

Figure 4.11 a. Fresh Roots Urban Farm. Granville Island Public Market. Photos: V. Durant.
Figure 4.11.b. Photo: V. Durant. Local Economic exchange
Many choices for Vancouver residents to purchase food

4.3.14. CSA's: A Partnership Model of Sustainable Urban Agriculture

Throughout the CoV, urban residents are giving over their lawns and flower beds to serious local farming organizations such as My Urban Farm, (Thoreau 2011) and Fresh Roots Urban Farm (Lablow 2011). These companies are operated by young, agro-ecologists, mostly trained under the leadership of Dr. Art Bomke, at the University of B.C. (UBC) and who have the expertise to farm sustainably on small urban lots and once barren gravel covered schoolyards (Figure 4.15.A). They are committed to the intensive production of local food, which is distributed through an economic model referred to as Community Supported Agriculture (CSA). A CSA program is a shared risk between farmers and eaters, who pre-buy food and in return, receive a weekly allotment during the growing season (Bomke 2011). SOLE Food has a slightly different variation on the CSA, which allows an eater to pay a pre-determined amount of their choice of produce, picked up at weekly farmers markets and not delivered to their door.

Regardless of the variation on the CSA business model, urban farming as described, provides a diverse polyculture of continuously productive vegetation, that protects soil, providing climate protection and improves heat sinks, therefore improving the CUHI microclimate as described in Section 1.2 4. While detailed life cycle analysis is not completed on any of the local farms, the farmers are confident, that they are reducing the **Ecological Footprint** of the City based on the methods of food production at the three operations surveyed (Lablow 2011; Thoreau 2011; Dory 2011), indicating that the CSA model, either with a SE component or as a private business enterprise, addresses urban farming, sustainably.

4.3.15. Future Projects

4.3.15.a. Green Roof Initiative Sole Food is exploring the feasibility of the expansion of their operation to the rooftop of Save on Meats located at 43 West Hastings Street, eight blocks west, toward the CBD (Fig. 4.14). The CoV approved funding to leverage contributions by other donors to conduct a feasibility study on the viability of the project. The project will include a rainwater capture and irrigation system, biodiesel generation utilizing cooking oil from the local restaurants, closing waste streams at many levels. According to the CoVAR: A5: 2011, (4) report, the project "addresses food security, provide employment and a model of environmentally sound urban farming practices." The project is not only a SE, but also demonstrates CSR, engaging with community, government and local businesses.

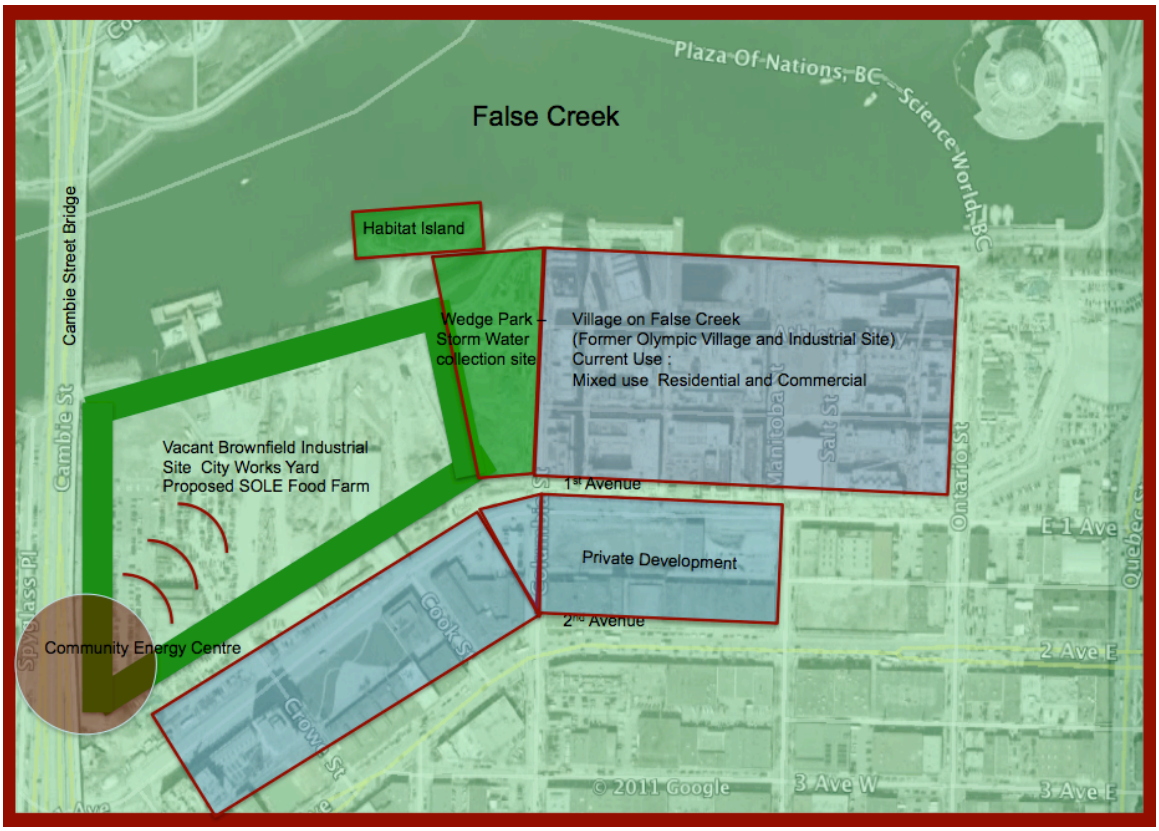

Figure 4.12. Drawing: V. Durant. Map of SEFC Village and potential UA SOLE Food Urban Farm Development

4.3.15.b. South East False Creek – Potential for CPUAF Large Scale SOLE Farm

South East False Creek is an area within the city of Vancouver which has undergone considerable land use change over the course of Vancouver's history. The boundaries are defined by Main Street to the East, Cambie Street and the Cambie Street Bridge to the West, First Avenue to the South and the False Creek waterway to the Downtown and to the North. The original environment of the flats included flora and fauna associated with an estuarine wetland (SEFC: UAS, 2002). According to Oke and Wynn (2001, 161) "it is difficult to find a site which has undergone, as much change in the course of 40 years, from a pristine forested coastal inlet, to a disgusting industrial mess, almost devoid of nature, and to swing back in the course of 20 years to a sought after residential and recreational area". It is the SEFC land, once a hub for sawmill operations responsible for the destruction of the ecosystem in the area that is proposed as

(Gerwing 2011) “having the potential area for intensive agricultural development.” SOLE food is in the early engagement phase with the COV to consider conversion of the remaining SEFC works yard to an urban farm. It is an ideal area for short-term agricultural production while waiting for future housing demands to increase and catch up with the market.

Land use has changed over the course of history in Vancouver, and the area was highly industrial up until the 1980’s when Expos 86 took place on the Northern Shore. The Olympic Village was constructed for completion in 2010, on half of the city owned site of approximately 50 acres, (20 Hectares) (SEFC: UAS, 2002, 20). The development resulted in a mixed use, residential and commercial low to midrise density typography of 14 to 16 stories within a tightly woven urban form, released for resale after the 2010 Olympics. According to the official website “the buildings are a showcase of sustainable development,” attaining a minimum of LEED® Silver standard http://vancouver.ca/olympicvillage/greenbuilding.htm(accessed October, 2011).
The official website and video at http://vancouver.ca/olympicvillage/index.htm
(Accessed October, 2011) describes the transportation linkages, walkability and numerous sustainability benefits that include urban agriculture, green roofs a high degree of permeability, as well as the habitat wetland construction, the stormwater collection site and the community energy center, recycling sewage waste as heat generation located on site.

While recommendations in the SEFC Urban Agriculture Strategy (SEFC UAS: 2002, 34) suggested, through a broad participatory process, a number of opportunities for food production, including land zoned specifically for agriculture, none are yet realized. An informal survey of the site in July 2012, as research for this thesis, found no landscaped areas or rooftops or balconies containing agricultural production of any kind. Alan Duncan (2011), who participated and assisted in the initial SEFC UA study, attributes the lack of implementation to the shifting of gears from a mixed-use, mixed-income development to a high-income development, with little or no social or mid range housing. Instead, an un-stewarded green roof, as illustrated in Figure 1.4 indicates a lack of community involvement and a roof that likely according to Oke (**Section 1.3.4**),

contributes little to the thermal properties of the building.

West of the development is a vacant area of City owned land measuring approximately 25 acres (10 hectares). The area is identified for future housing development, with an estimated uptake of ten years for development (Gerwing, 2011). In the meantime SOLE, (Dory 2011) is in the process of negotiation with the COV, proposing the site as a SOLE Food farm enterprise. It is a recommendation of this thesis, that the area is highly suitable for SOLE food expansion to their operation for the following reasons:

1. Contributes to the Economic sustainability of the Enterprise by expanding the amount of food produced.
2. Contributes to the Economic sustainability of the City, by providing a secure and reliable local food source.
3. Contributes to Social sustainability by providing employment to vulnerable citizens, by producing healthy (organic) produce.
4. Contributes Ecological sustainability, through the increasing of the amount of food produced within the in the COV, reducing transportation emissions reducing the ecological footprint and GHG emissions (Goal 2, 4,7).
5. Restores Ecological function, through increasing vegetative cover, as agriculture and parkland space, as a CPUAF project.
6. Potential to reduce urban temperatures by increasing vegetation as a CPUAF model by providing soil coverage, improving the microclimate by reducing the CLHIe by increasing evapotranspiration. This is a Brownfield site, a former industrial area identified by Oke in the 2000 study (Figure 1.5), and Oke & Wynn (2001), as having higher CLHI temperatures in direct correlation with the area identified by the CoV in the GCAP as an area of the city with a park deficiency (Figures 1.6).
7. Stewardship of the land, demonstrating to the public, the viability of local urban food production, beyond community gardens and small-scale private production.
8. Soil Study potential - Very little is know about the effects of increased vegetation on soil temperature variables in relation to the SLHI Section

1.3.4.c. Increased wetness, and shade through the implementation of urban agriculture and forestation initiatives within the canopy layer will likely decrease surface temperatures and soil study could verify similar results.

This is a tremendous opportunity for future study to analyze the before and after effect of a continuously productive urban agriculture and forestation (CPUAF) model, within the core of a city on a brownfield industrial site. Further research is necessary to determine if there are benefits to the thermal heating plant and the location in close proximity to a farm as well as the potential for impacting the SLHI. It is likely that the proximity of the storm water collection to the proposed farm could provide water for the operation. A complete life cycle analysis would provide valuable insight into the application and resolution of multiple sustainability issues.

Figure 3.13.a Innovative and Flexible Land use containers. Photo: V. Durant.
Figure 3.13.b. Sole collaborating with Patch on the site utilizing re-cycled sails from Canada Place Source: **http://letspatch.com/?page_id=105**

4.16. Challenges easily overcome

It is known that carbon sequestered in soil may be released as CO2 emissions when agricultural practices change and the amount of released carbon depends on the previous land use and the soil type (Young: 2003, 168). While the SEFC site soil is environmental safe to produce food due to an environmental clean upon the site (Duncan 2011), SOLE is developing innovative solutions for short-term land use for this and other potential urban farm applications (Figure 3.17). SOLE constructed

transportable raised beds, which can be situated on an existing impermeable surface. The potential for this type of portable agriculture permits the installation in any situation where impermeable surfaces exist allowing for ease of relocation at the end of a short term lease, reducing material costs and thus the EF. Melisa Iverson (2010) a student of Dr. Art Bomke produced a useful tool for assessing Brownfield sites for community gardens in Vancouver as her master's thesis, which could be useful as a tool in this application. Albeit, the SOLE proposal is not a community garden but rather, an intensive urban farm, the tool may be useful in assisting in the assessment of the South East False Creek as well as any location where urban agriculture is proposed.

4.3.17. Further Recommendations

Consider a collaborative CSR partnership between the Fairmont and SOLE Food SE. Sole Food is in the process of investigating the expansion of their own waste management projects, in which they propose the feasibility of collecting food scraps from restaurants in the Downtown area and recycling at a composting facility in the basement of the Save ON Foods Site on East Hastings Street. If the project is successful, this could be the solution to the Fairmont's food and organic food production waste management issue, align with the CoV's food waste diversion goal, as well as contribute to the viability of the SOLE Food proposal. Proximity to the potential EGZ in the DTES proposed by the CoV is considerably more sustainable than transporting food waste to the existing Waste Treatment Plant outside of the CoV.

4.3.18. Conclusion

The green economic zone which supports the creation of food infrastructure as food hubs that include jobs related to production, processing, storage and distribution of food and food waste has the potential, through SE, to move to what Kira Gerwing (2011), the economic planner for the DTES, describes as "a hybrid economic model", beyond profitability to a humanitarian approach to economic development. This is further elaborated upon by Alan Duncan the environmental planner, Park Board, when discussing SOLE Food, who said (2011) "Integrating urban food production within the

social fabric of a community, treating it as a serious function in an urban environment, is what the future of urban food production should be". SOLE Food, a SE, is an exceptional global example of Continuously Productive Urban Agriculture and Forestation (CPUAF), on an underutilized parking lot in an industrial area that integrates multiple climate, ecological, economic and social benefits. As well, the organization has the potentially to expand food production on city and federally owned vacant industrial property in the Port and on the undeveloped SEFC lands with the benefit of harnessing multiple synergies to reduce Global GhG emissions, the EF, and contribute to the reduction of the UHIE's. SOLE currently contributes to the goal of achieving local food security and local economic development, utilizing a hybrid ecological model of economic and social development.

A full summary of findings and recommendations are presented in **Section 5.**

Sustainable Agriculture & Forestation: The Edible Connected City.

Section 5

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Summary - Recommendations - Future Research - Conclusion

5.0. Summary

Section 1 of this thesis reviews literature to determine why cities need to become more sustainable and the source of their own food supply. The research determines that a local food system strategy, integrated with urban forestation, that is continuously productive, with policy and bylaw interventions that support UA on public and private land, in the built environment, incorporating urban food waste management, integrated in the planning strategy of cities, will contribute to resolving the challenges facing humanity today. The gap in global definition and policy that connects the two systems is reviewed in order to understand the necessity to address multiple issues within a nested system. The amalgamation of food and forest planning, as a regenerative, reforestation model, defined as Continuously Productive Urban Agriculture and Forestation (CPUAF) is demonstrated to reduce global GhG emissions, reduce the ecological footprint of food, reduce the urban heat island effect, and repair ecosystem health while providing healthy and secure local food. Further, the tools and processes, reviewed in **Section 2** demonstrated as a necessary component of CPUAF, are applied by the City of Vancouver, the subject of the Case Study Research, described in Section 3. The tools and processes are identified as a necessary component of an integrated food and forestation system. The project examples in **Section 4** of local intensively productive urban farms, as SE and CSR projects, and CSA programs, not only illustrate the integration of the tools and processes of adaptive food and forestation planning, they demonstrate the application of the transition to the ecological model of sustainability as the core value in planning. **Section 1** and **Section 2** provides the theoretical background. **Section 3** and **Section 4** answer the thesis question by describing ” How the City of Vancouver” has developed an Action Plan that links urban agriculture and urban forestation as a means to become more self reliant, by producing food locally and integrating it with urban forest planning. Establishing a baseline for intervention and a strategic plan with measurable outcomes, with a timeline for implementation is demonstrated as key elements to achieving the goals identified. The challenge of local UHI’s, not as great a concern for the City of Vancouver, as it is in other regions, requires the same approach as addressing multiple synergies within the nested system. The CoV, which has a goal to become a global leader in food systems planning, and is home to one of the largest urban forests in the world, encompassed many of the features

defined by this thesis as a CPUAF model. However, the CoV recognizes that there are areas for improvement to achieve their goals. Therefore, a summary of recommendations follow in **Section 5.2,** as well as a matrix of a CPUAF model (Figure 5.1), developed from the CoV and MVR as well as other City/Regions best practises, and which may be adapted to any global city/regional. Taking a whole systems approach, using the process of adaptive planning and transitional management and establishing an enabled environment (**Section 1.5.5**) in which all members of society can participate while allowing for an unobstructed flow of information (**Section 2.4)** is necessary for the success of this and any planning strategy to succeed. The thesis recognizes that this can only occur in a protective stable democratic system in which diversity and flexibility within the system will allow for innovation and creativity to flourish and grown organically. By asking "what is land" and by implementing land use policies and bylaws that incorporate innovative vertical surface and rooftop UA production, that go beyond LEED, as a normative approach to municipal and regional land use planning, a City can begin to address the multiple issues and challenges identified. What was found in the City of Vancouver is an ideal starting point, for adaptation globally, using the strategies, the tools and the processes presented.

This thesis provides evidence that suggest extreme weather events, as a result of climate failure, have a high probability of occurring (95%) (Ruth: 2006,76), already affecting global crop yield, and will continue to affect agriculture, one of the most vulnerable sectors (**Section 1**). Meanwhile, increases in global and urban populations contribute to an increase in local temperatures, which affect human and ecological (**1.1.5**) health and wellbeing. While UHI's are localized smaller scale phenomena, they are linked to climate change and the mitigation strategies, (Duncan 2011), that include the addition of vegetative cover and tree planting are congruent. Whether or not a city is currently experiencing a significant impact from UHI's, the findings suggest that preparing for future uncertainties and anomalies such as heat waves (Quayle 2011; Duncan 2011), through the implementation of an urban management plan that incorporates green infrastructure, (GCAP, 2011) is a desired outcome of an integrated food and forest management plan which addresses multiple synergies.

With global populations expected to increase from 7 to 11 billion, and diminishing global agricultural production already occurring, food scarcity and shortages will likely impact

the MV and FV regions, consistent with the global trend. Furthermore, the global trend toward urbanization will compound energy outputs within most cites, interpolating the negative effects of climate change and the UHI in most regions. While the CoV does not experience an overall UHI effect, studies conducted, found examples that lower density sprawl areas, such as warehouse and industrial areas are more susceptible to surface heat build up, consistent with global studies, and there is a correlation between the Oke 2001 temperature study, and the recent *CoV Urban Greenspace Deficit Plans*, conducted independently, where CPUAF interventions would likely provide the greatest benefits. Research in the area of the Urban Heat Island Effect, found a direct correlation and relationship between lower medium density warehouse and industrial areas and higher local temperatures that would not been found, had the thesis research focused only on global climate effects as a rational to interlink food and forestation planning.

The following CPUAF Matrix (Figure 5.1) is devised as a planning tool and a checklist when considering the elements and steps in the process of developing a sustainable food and forestation system in a City/Region. Many of the tools, processes, guidelines, actions, policies and bylaws, indicated in the left vertical column, are demonstrated in the CoV, the MVR and the project examples presented in **Sections 3 and 4**. They are highlighted in black. All others are recommendations, which would contribute, if implemented, to the fulfillment of a CPUAF model. They are highlighted in green. The elements in the top horizontal bar are sustainability objectives, which can be met, directly or indirectly through application of the tools and processes in the vertical bar, as discussed throughout the thesis. There are three categories described in the impact key The three categories are described as one; having a high, direct or measurable impact; two, having a medium or indirect impact and three, having an impact that is not yet measured. While the impact levels are derived from the research found and assessed in **Sections 1 through 4**, further research is required to measure the direct and indirect impacts. As the process of CPUAF becomes a normative approach in the planning of sustainable and climate resilient food and forestation systems in cities and regions, more opportunity for data collection and evaluation will present itself. Currently, the matrix can be used as a checklist in the development of a continuously productive urban agriculture and forestation plan.

CPUAF MATRIX	GhG Emissions	Ecological Health	Human Health	Eco-Economy	Solid Waste	Storm-Water Mgmt.	Food Security	BLHI	CLHI	SLHI	SLHI
E.F Analysis	■	■	■	■	■	○	■	•	○	•	•
Climate Modeling	■	■	■	○	■	■	■	•	○	•	•
Regional Climate Change Report	■	■	■	○	■	■	○	•	○	○	•
Regional Sustainability Framework	■	■	■	○	■	■	■	•	○	○	•
Regional Food System Strategy	■	■	■	■	■	■	■	•	○	•	•
Regional Ecological Health Strategy	■	■	■	■	■	■	■	•	○	•	•
Regional Growth Strategy By-Law	■	■	■	■	■	■	■	•	○	•	•
Smart Density	■	■	■	■	■	■	■	○	○	○	•
Regional/Provincial ALC & ALR	■	■	■	■	■	■	■	•	○	○	•
Municipal Task Forces	○	○	○	○	○	○	○	•	•	•	•
Public Consultation	○	○	○	○	○	○	○	•	•	•	•
Interactive Website	○	○	○	○	○	○	○	•	•	•	•
Food Charter	○	○	○	○	○	○	○	•	•	•	•
Food Policy Council	○	○	○	○	○	○	○	•	•	•	•
Forest Management Plan	■	■	■	■	■	■	■	○	■	■	•
Private Tree By Law	■	■	■	■	■	■	■	○	■	○	•
Public Tree Inventory	■	■	■	■	■	■	■	○	■	■	•
Layered System Where possible	■	■	■	■	■	■	■	○	■	■	•
Greenways Initiative	■	■	■	■	■	■	■	○	■	■	•
Stewardship Programs	○	■	○	■	■	○	○	•	•	•	•
Green Streets	■	■	■	○	■	■	■	•	○	•	•
Orchards - Public Parks	○	■	■	■		■	■	•	○	○	•
Edible Landscape Guideline	○	■	■	■	■	■	■	•	○	•	•
Urban Apiculture Policy	○	■	■	■	•	•	■	•	•	•	•
Orchards/Farms Public Roofs.	■	■	■	■	■	■	■	○	■	○	•
Sustainable City Action Plan	■	■	■	■	■	■	■	•	○	○	•
Food Waste Management	■	■	■	■	■	■	■	•	○	•	•
Compost Demo Garden	■	■	○	■	■	○	■	•	•	•	•
Local Pilot	■	■	○	■	■	○	■	•	•	•	•

Projects (VV)											
Neighbourhood Matching Grants	■	○	■	■	■	■	■	•	○	•	•
Central Waste Mgmt. Facility (Public)	■	■	■	■	■	■	■	•	○	•	•
Assisted Housing with UA Provincial & City Partnership	■	■	■	○	■	■	■	•	○	○	•
Green Roof Bylaw	■	■	■	■	■	■	■	•	■	○	•
Vertical Wall Bylaw	■	■	■	■	■	■	■	•	■	○	•
Urban Farming Business License	■	■	■	■	■	○	■	•	■	•	•
Industrial/Warehouse Interventions	■	■	■	■	■	■	■	•	■	•	•
1:1 Parking to Tree By Law	■	■	■	■	○	○	○	•	■	○	•
Partnerships between SE-CSA or CSR's	○	○	○	■	○	○	■	•	•	•	•
Public Bldgs. with CPUAF Stewardship Program	○	○	○	○	■	■	■	•	○	•	•
Vertical Wall CPUAF UA By-Law	■	■	■	■	■	■	■	•	■	○	•
Sustainable Horticulture CPUAF Guidelines for Public and Private Realm	■	■	■	■	■	■	■	•	○	○	•
Intensive Green Roof CPUAF UA By-Law	■	■	■	■	■	■	■	○	■	■	•

Definition Key

GHG	Green House Gas Emissions - Carbon & Climate Leadership
E.F.	Ecological Footprint
E.H.	Ecological Health - Encompassing plant, water, air and species
Waste	Solid Food Waste
H.H.	Human Health – Air Water and Heat
UHI	The Urban Heat Island
Eco-Economy	The Ecological Model of Economic Growth – Includes SE, CSR, CSA.
ALR/ALC	Agricultural Land Commission makes decisions on Agricultural Land Reserves and Development

Impact Key

They are weighted, as having a high or measurable impact, a medium or indirect impact and low having a slight or unknown impact.

■	High, Direct and/or Measurable Effect
⊙	Medium and/or Indirect Effect
•	Low and or not currently measured effect

See Appendix 6. For a Blank CPUAF Matrix For Use as a City/Region Checklist

Figure 5.1. Durant © 2011 Matrix of a CPUAF Model

5.1. Recommendations

The recommendations synthesize material from the Vancouver findings, the GCAP and from global trends and best practices presented in the previous Sections. The recommendations are included as features in the CPUAF Matrix and although referencing The City of Vancouver specifically, they could be adapted to most city/regions as a systematic approach to sustainable urban food and forestations planning. The matrix is not a final list and could be expanded upon in the future based on future research and findings.

5.1.1. Industrial and Warehouse areas

As a result of the findings, a summary of recommendations to intensify urban agriculture and forestation in industrial and warehouse "hotspots" within the COV are highly recommended to contribute to the mitigation of the key challenges described in **Section 1** of the Literature Review.

Reducing parking requirements, as a by-law intervention in new development would be of benefit to the local climate, the ecosystem, and the local food system. The City of Portland is a good example where one tree is required for every parking stall and is recommended in the CoV. In both new development and existing zoning, policy to encourage conversions to stewarded fruit tree planting programs managed by community centers or CSA urban farming businesses is recommended. Due to the permanency of industrial areas, industrial sites are ideal locations for long term orchard planting, although not suitable for short-term land lease sites such as Sole Food, where a short-term lease to convert an underutilized parking lot to an urban farm may not extend beyond five years. Instead, the application of the innovative artificial vertical tree canopy is suitable for short-term occupancy as they are portable and are suitable for relocation to various sites, including rooftops. As well, the addition of vertical and rooftop urban agriculture interventions, initiated privately by building or business owners of industrial sites, as CSR or through leases and partnerships with SE's or CSA's businesses, is a focus areas where a city could target education and support, identifying the multiple sustainability benefits of Urban Farming and Partnership Programs. It is

within the industrial zones where one of the biggest wins can be achieved, identified in **Section 1** and **Section 4**. While it is difficult to intervene with existing zoning, as there is no "grandfathering" of bylaws to alter development permits previously issued, public education and awareness regarding the issues, can increase the acceptance of intensive UA, as a normative planning and developmental approach. The Case Studies presented in **Section 4** illustrate that CPUAF is possible and is in the process of implementation, not only in Industrial and warehouse areas but also in the high-end CBD area, where CPUAF could provide good results.

5.1.2. Central Business District

The project example of The Fairmont Hotel (FH) intensive rooftop installation provides an example of a private CSR intervention, which is ecologically, socially and economically feasible, proving that sustainability makes good business sense. Once considered "the messy aesthetic of agriculture", often a deterrent to the process, is gaining growing acceptance, even within one of the most livable and aesthetically beautiful cities in the world. Arguably, the increased implementation of CPUAF, not only contributes to the ecological health of the CoV; it contributes to the vibrancy and livability of the City and the Region. The addition of urban agriculture within a continuously productive land based and rooftop environment with vertical connected greenway operate as "linking spaces ", which encourages a new social norm where human and species interactions can occur, while providing climate protection and ecological health as an outcome. While the Convention Centre in Vancouver is an outstanding example of the possibility of a Green Roof in a CBD area, the next step toward sustainability would be a conversion of this and other public spaces (community centers, hospitals and schools, to food production as a CPUAF model.

5.1.3. Recommendations for Residential High Rise Districts

In the CoV High Residential West End, findings from several sources indicate that well designed density, with connected greenspace and with a mature tree canopy reduces GHG emissions, and appear to reduce the UHI effect. Further research is required to measure the benefit provided by the proximity to the ocean as well as the Stanley Park urban forest although it is safe to assume that the canopy is a significant mitigating

factor. Regardless, a city would benefit from additional food production, as demonstrated in the Freesia example, as well as reduced GHG emissions, due to reduced thermal emissions, although there is not likely to be a massive benefit to the heat island effect unless large-scale conversions of rooftops take place. This is an area, where private SE's and CSA, businesses could lease high-rise and medium-rise rooftops for sustainable economic profitability, following the FH CSR model of CPUAF. Finally, providing tax incentives to existing co-ops, strata's in existing buildings to retrofit for green roof installations may be costly, but worthy of further analysis.

5.1.4. Regional and Municipal Interactions

The following proposes to intervene in the Metro and Fraser Valley Regional Districts, in industrial areas resulting from the release of farmland, previously held in the ALR. Interventions in the planning process, particularly in the Metro and Fraser Valley Regions are highly recommended to implement intensive green roof and vertical farming bylaws in new industrial zoning. As well, a reduction in parking requirements and increase tree canopy, and the addition of permeable surfaces will intervene to address the climate implications caused by the removal of agricultural land. This is a recommendation, applicable for adaptation in any City/Region in which agricultural land is eroding due to industrial development. The release of AL in the FVRD for industrial use is a concern for the region as a whole, as research identified that industrial areas increase heat islands and contribute to higher GHG emissions more so than agricultural land or high-density high-rise area.

Furthermore, this thesis recommends a review of the tax incentives given to property owners within the ALR, which could result in better utilization of productive land through analysis of what it means to be productive. This could ensure maximum utilization of precious ALR farmland outside the urban edge, and increase the production on smaller lots, rewarded through tax incentives.

The removal of agricultural land occurs despite protection, even in the most protected of AL environments, the Province of B.C.; therefore, it is not hard to image how unprotected AL in other regions with less developed policies and bylaws is quickly disappearing. Therefore, strong consideration for increasing production through

intensified UA to make up the productive shortfall as well as to provide local climate protection is recommended. The business of UA, can be assisted through policy intervention, which will encourage the increase of rooftop and vertical agricultural production, and which makes way for creative utilization of under-utilized vacant space such in the SEFC area within the CoV and on vacant lands throughout the city and the MVR, on privately owned property, particularly in industrial zones.

Further research is required to determine the outcome of industrialization on the local UHI, in the MVR and FVR based on release of Agricultural land previously identified as facing climate degradation in the 2002 Environment Canada Study. Finally, future research, to survey ALR to create an inventory of farms and their output is recommended in the Metro and Fraser Valley Regions and within the CoV. The recommendations are applicable in any city/region where agricultural land is subsumed by urban sprawl for the purpose of industrial and warehouse development.

5.1.5. Green Roof and Vertical Walls

Toronto, Canada was the first municipality in North American to pass a bylaw requiring and governing the construction of Green Roofs. The Bylaw (section 108), adopted by Council in 2009, requires all new commercial institutional and residential construction over 2000m2 to have a green roof. Residential development under six stories is exempt. In addition, tower roofs on a building with a floor plate less than 750m^2 is also excluded from available roof space. In order to advance the concept of CPUAF, the implementation of a green roof bylaw is discussed in **Sections 1** and **Section 2.9.8** and **2.9.14**, Intensive green roof systems support vegetative growth, reduce site level stormwater runoff, reduce building energy demands and extend the service life of roof membranes. Expansion of the Toronto bylaw to require a percentage of tree and shrub coverage in alight with the CPUAF model, as implemented at the FH, encompassing the principals of agro-ecology and forest gardening is recommended. Public awareness and training as to the benefits of this model could expand implementation in the private realm, not only on rooftops but also on residential lots. Finally, further research is required to investigate the benefits of the installation of rooftop agriculture on public buildings, to include schools and community centers in which stewardship would provide a consistent source of support.

5.1.6. Vertical Farming

Vertical Farming is an innovative process, which provides a hybrid form of ecological intensification. Applied to building surfaces it can increase the site area of a built form as much as five fold (**2.9.11**), and could significantly reduce the ecological footprint of a city, reduce climate impacts by reducing the thermal load of buildings and mitigate the effects of the CLUHI without major technological interventions. Vertical farming, discussed in **Section 2.9.9** through **Section 9.14**, is the key link to implementing a CPUAF model, as the connecting fiber between lands based agriculture and rooftops. Vertical agriculture crosses the boundaries between the CLUHI and the BLUHI and may have significant implications to support global food security as a result of climate uncertainly. Vertical farming, could contribute significantly to address the issues identified in **Section 1**. Further research is necessary in order to address technical design and implementation challenges, including the optimization of growth performance of various horticultural products, which are regionally specific. This is a process, in which municipal planners could support through bylaws requiring and governing the construction of vertical agriculture installations in conjunction with green roof bylaws.

5.1.7. Food Waste Management

Local organic and food waste will increase with population growth, the increase of urban farming and with the goal of the COV's urban forest management plan to plant 150,000 trees by 2020. It is essential to develop a comprehensive composting education program to incorporate waste management strategies at the local level, utilizing the expertise of NGOs such as the VCDG and Transitions Vancouver to assist in the transition to a zero waste culture. Midscale private and shared food and organic waste management services is already considered by SE organizations such as SOLE and in the private sector, as the FH example demonstrates. Further opportunities through neighbourhood matching funds should be made available to the public. Adapting policies and bylaws from San Francisco and Victoria where food waste is banned is recommended to speed the process toward zero waste. However, the process must be accelerated at a municipal and regional scale to contend with increased waste, an outcome already considered by the CoV. Locating a waste treatment plant within the

heart of the city will reduce GHG emissions and create awareness about all waste, The Spittelau waste treatment plant in Vienna Austria is a global example of innovation, worthy of further research by the CoV and other cities and regions as a solution to sustainable food waste management. An added benefit of a centralized waste management plant as demonstrated by Spittelau, is the benefit of attacting tourists to view a green economic waste management plant. This will urther increasing awareness concering sustainability issues (See Appendix 3) as well as increase tourism revenue while addressing the goals of theGCAP: 2020.

5.1.8. Stewardship

Stewardship of community orchards and communal gardens in recreational facilitates can increase urban greenspace and urban agricultural production. Community Centers, currently responsible for leading recreational programs could extend their leadership to steward community orchards, programs already underway on existing parkland and within the CoV and in shared projects in industrial areas, previously discussed. Leasing of city owned land, such as the SOLE proposal for the SEFC land, is a means to privatize stewardship, on underutilized public land, in the same way that the SOLE DTE urban farm utilizes private land through a tax incentive, The Fairmont Hotel rooftop garden and the Freesia Apartment Rooftop garden, built under the new relaxed building code, are examples where corporations and private business steward agricultural production. A goal of the COV is to acquire and build new parks, and convert street right-of –ways, incorporating food production and will support the role of stewardship in the public realm. However intensifying production, treating and supporting urban farming as a business is required and will contribute to, and support stewardship of agricultural land in the private realm.

5.1.9. Health and Local Applications - Heat Islands

It is the elderly and the most vulnerable members of the population that experience heat related illness and mortality as the European Heat wave in 2003which killed 30,000 (Habitat Debate: 2007,7) (Oke 2011) bears witness (Section **1.3.7, Section 3**).

While the CoV has prepared an action plan for extreme heat waves, it could be taken a

step further by including the plan in the GCAP. By targeting and producing goals, the effects could be measured over a period of time. It is recognized, according to the experts interviewed that for the response to be effective, mitigation strategies must take place over a regional scale.

This thesis agrees with the experts that the urban heat island effects are expected to be less extreme in the CoV and MVR by comparison to the occurrences in Europe and in other regions; however, the literature and the data provided by the experts suggests concerning climate uncertainty and temperature anomalies suggest they will occur. Integrating food and forestation planning, an ecological approach taken by the CoV, is suggested to reduce global climate impacts as well as local UHI effects and is a useful model, applicable in any global city or region.

A requirement for the implementation of Intensive Green Roof CPUAF in Assisted housing, funded by the Province and managed by the CoV is recommended as discussed in Section 3.11.8. The implementation would provide climate, storm water management and UHI benefits, as well as a healthy, affordable and safe source of local food. The added benefits of social interaction and education through stewardship to some of the most vulnerable members of society would provide additional positive outcomes.

5.1.9.a. Summary – The UHIEs

It is necessary to reduce the negative climate impacts of carbon sequestion as well as reduce the effects on human health and wellbeing of increased global and local temperatures. As the experts interviewed suggest, mitigating the impacts of climate change as well as providing a reliable food source by improving urban green space by increasing vegetated surfaces must go beyond providing rooftop greenery and ornamental tree planting to provide sustainable local food security for increasing urban population. There is substantial evidence; presented in the literature review that indicate that urban forestation will reduce urban temperatures. Furthermore, according to Oke (2011), urban agriculture could on principal, assist in cooling urban soil temperatures (HI_{soil}), although further research is needed in order to study before and after installations to measure soil temperatures in specific applications. The experts data, presented in

Section 1.3.4, support the hypothesis that it is within the canopy layer (CLHI), at humanscale, where planning policy and by-laws that incorporate aspects of CPUAF can effect the most change. The success of the mitigation strategy is dependent upon the scale of implementation. While one rooftop farm or a single fruit tree will have little effect, it is essential to begin locally while implementing strategies that become normative on a larger scale. The accumulative effects of thermal loading contribute regionally as well as globally (Section 1.3.4.). It is in this layer where the broad implementation of CPUAF on rooftops, as presented in the local example of the Fairmont Hotel, can be expanded as a mitigation strategy.

5.1.10. SOLE Food South East False Creek

The SOLE Food Social Enterprise (SE), provides insight into the potential baseline for a sustainable plot size or operation in an urban environment, while Community Supported Agriculture operations (CSA), produce food more sustainably, moving away from grass and the mono crop model of urban agriculture. Further analysis is required, to fully assess what a truly sustainable approach to urban agriculture looks like, in which inputs and outputs of the system, remain in ecological, social and economic balance.

This is a tremendous opportunity for future study of the SOLE Food proposal on the SEFC land to analyze the long-term application of a (CPUAF) model, within the core of a city on a Brownfield industrial site. Further research, including a complete life cycle analysis would provide valuable insight to determine what a sustainable plot looks like, and what type of horticulture is most suitable to address multiple sustainability issues.

5.1.11.General Future Research

Further research is required to determine, the optimal methods of urban agriculture and forestation for food production on intensive green roofs, vertical walls and vacant urban plots as well as private land. More research is necessary to monitor the impacts and potential of the form of edible forest design and spatial patterning within the diverse urban form to define a sustainable land use mix.

Further research to measure the most sustainable edible processes and applications, as well as interrelationships between cover and canopy and the built and urban environment is necessary in order to produce a baseline and implementation strategy that efficiently optimizes a reliable food source and reduces local and global climate effects. As further vacant lots become recognized as a source of food production, it is an opportunity to undertake before and after field studies of the benefits of specific urban agriculture and forestation processes. As well, studies of city lot conversions are an ideal source for small test studies of urban temperature improvements in microclimate situations.

Focusing on the horticulture aspect and selecting the best combination of plants, trees and shrubs, is regionally contextual, and is a recommended "next step" to optimizing a fully integrated intensive green roof system of planting, allowing for diversity and regional variables, to provide local food security and climate benefits. Applying the layered approach, in the public realm is recommended wherever possible. Including recommendations, that embraces the concept of CPUAF, in the edible landscaping guidelines would educate and empower the public to grow local food more sustainably, and more productively.

A well designed urban management system, with a combination of trees and shrub layers that are drought and shade tolerant can for example, mitigate municipal water use as well as optimize evapo-transpiration and contribute to the reduction of the Heat Island within the (UCL). GHG emissions can be reduced through the production of urban food by reducing food miles traveled and by reducing thermal loads created by heating and cooling and reduce environmental impacts on the regional watershed. While, these features generally are not mandated through bylaw controls, they can be provided as a list of recommendations, following the same approach utilized in the Edible Landscape Guidelines.

It is necessary to close the gap in definition of what a sustainable urban agriculture and urban forest model looks like, what a sustainable plot of land within a city looks like and what areas are best targeted to achieve optimal results. Determining the number of intensive rooftop gardens and urban farms that exist within a city is a necessary step in

the process in order to access and plan for future uncertainties. As well, further research, to develop policy and by-laws that encourage poly-culture agriculture rather than decorative landscaping initiatives in the municipal and regional planning context, as well as private application is recommended. Finally, adopting policy that permits urban agriculture, as a legal business is a priority for any city in order to take the process forward.

By restoring and regenerating the biophysical form of the city by implementing multi-functional forestation and food production as a continuous productive integrated ecological system requires further investigation as to the role that the two can play within local urban management systems, as well as further investigating their feedback to the global climate system. Reversing feedback loops that contribute to global climate issues requires an applied intervention that crosscuts through forestation and agriculture practices, in the urban environment as well as requires integration, through policy and bylaws that support intensive UA with implications in the social and economic structures of planning. In order to address the mounting global crises, what is needed is a clear definition of what a local food and forest action plan looks like and how it could be implemented. **Continuously productive urban agricultural forestation (CPUAF)**", is defined as an integrated system and a tool for implementation in **Section 2.11**, with features grounded in the principals of sustainability defined in **Section 1.6.**

Section 14.2 of this thesis closes the gap, with the terminology **Continuously Productive Urban Agriculture and Forestation (CPUAF)** defined as actively linking all surfaces, vertical and horizontal including rooftops and vacant lots to provide for human, species and ecological continuum and to provide urban food security and climate resilience, reduce the UHI effect. Further, **Section 2** introduces the processes and tools necessary to achieve a successful CPUAF model. Allowing for new social and economic norms to develop organically, and by planning active and continually connected greenways, by supporting communal over community gardening and by supporting the business of urban farming in the neighbourhoods in which they serve, a sustainable food and forestation system is achievable.

5.2. Conclusion - Urban Agriculture and Forestation

Cities and regions must move from food consumption to food production to reduce their ecological footprint and reduce global GHG emissions. Countries, regions and cities are beginning to consider the restructuring of food policy and agricultural production and shift toward creative optimization of urban and peri-urban land, to conserve finite natural resources and protect ecosystem services which include water, soil and forests. CPUAF is developed as a model of a restorative; regenerative living systems approach to mitigate climate change, by reducing Co2 emissions, by reduced transportation and production costs and by contributing to the reduction of UHIEs, which is linked to climate change. Locally based food production is an increasingly necessary integral and integrated component of urban food and forest management, in cities and regions and is of particular benefit in medium density industrial areas. The optimization of vertical and horizontal space in the built and urban environment as potential agricultural land, including rooftops, building facades, boulevards and connected greenways is essential in the 21^{st,} century. Cities must learn to feed themselves and engage in cyclical reciprocal interconnectivity with their own food source as global trends in urbanization and unsustainable rural agriculture practices and increasing global population stresses the carrying capacity of the planet to sustain human and species populations. Further, the approach to urban agricultural forestation must be continuously productive, diverse, self-renewing and multifunctional; circulating matter and energy through localized geographical region or biospheres.

Urban agriculture, integrated within an urban forest management plan as CPUAF, has the potential on a city and regional scale to address issues of food security, climate change, and local climate variables. While, acknowledging that local food cannot provide the entire food source, it can contribute to a healthy supply of edible horticultural products as well as balance food supply during times of geo-political and climate uncertainty. Integrating urban food and forestation targets in city and regional planning strategies and introducing policy and bylaws that support the implementation of both targets has the potential to address climate change and local temperature variables as well as provide a secure local food source.

Social equity, economic viability and the balance of ecological systems do not need to be in contradiction of each other. A shift from an economic lead value system to an ecological model that nurtures life's ecological sources is the starting point for sustainable planning. This system of planning, already well under way in the CoV and the region recognizes that all of humanity are participants in the larger global challenge and that actions that are taken locally are felt globally, therefore, conversely, restorative and regenerative reversals can be taken locally as recommended by the IPCC and demonstrated in the CoV, to effect larger systems. The objective of CPUAF is to transition and transform cities and regions to create resilience and to address the global challenge of urban population growth, climate change and degraded agricultural land, forest and water. The process recognizes the interrelatedness and interconnectedness of multiple systems and conversely, that addressing multiple synergies solves the pattern across multiple systems.

The tools needed to address the global challenges facing planners today draw from a toolbox of various processes, theories, and strategies included in **Section 2**. Meanwhile, the case study and project examples of the City of Vancouver, articulated in **Section 3 and Section 4** answer the thesis question **"How Can a City link Urban Agriculture (UA) and Urban Forestation as an integrated sustainable urban management solution to address global climate change and local heat island effects and provide local food security?**

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7.0. Appendix I

Unstructured Interviews

Unstructured interviews were conducted during the months of July and August 2011, in the City of Vancouver. The interviewees are listed below, with a brief description of their expertise and their relationship to Urban Food and Forestation in the field of professional planning and climate research. Follow up e-mail conversations took place with Dr. Tim Oke and Seann Dory of SOLE food. The list of interviewees is presented in chronological order at which they occurred. The exception includes the interviews, 14. 15. And 16, which took place as a precursor to the formalization of the thesis methodology. The purpose of the three interviews, which took place in Cape Town, was to experiment and test methods, as discussed in the Methodology Section, prior to the commencement of the thesis interview process.

1. Dr. William Rees

Expertise: The Ecological Footprint

Department: SCARP, The University of British Columbia

PhD Population Ecology (University of Toronto)

Email: wrees@interchange.ubc.ca

William@oneearthweb.org.

http://oneearthweb.org/

Director of the One Earth Initiative, Recently retired Professor in the School of Community and Regional Planning (SCARP) at the University of British Columbia (UBC), and Director of UBC's Centre for Human Settlements. He is a leading thinker on sustainable consumption and production and is best known internationally for his invention of Ecological Footprint Analysis (EPA), a quantitative tool that estimates humanity's ecological impact on the ecosphere in terms of appropriated ecosystem (land and water) area. The book *Our Ecological Footprint*, co-authored with Mathias Wackernagel was published in 1999.

Unstructured Interview: June 28, 2011.

Unpublished Documents Provided:

Globalization and Sustainability: Conflict or Convergence?

The Big Picture: What will Better futures look like? What will it Take to Get Us There?

Prior to the lead up to Rio + 20 Earth Summit, The International Society for Ecological Economics (ISEE), awarded Dr. Rees and Dr. Wackernagel the field's top honour in ecological economics. The biennial award is given to "outstanding individuals who have contributed original and seminal approaches that have furthered our understanding of the interfaces between the social, ecological, ethical, economic and political dimensions of our world," said the ISEE in announcing the award.
http://www.footprintnetwork.org/en/index.php/GFN/blog/gcat/ecological_limits/
(Accessed, July 12, 2012) In 2012.

2. Dr. T.R. Oke

Expertise: Urban Heat Island Research

Professor Emeritus, Department of Geography
Member, Atmospheric Science Programme
Geography Department, The University of British Columbia
Phone 604 822-2900 Fax (604) 822-2900
Email: toke@geog.ubc.ca

Tim Oke, a geographer and climate researcher is the worlds leading authority on urban microclimates. During his 40-year career, Oke has also elevated the field of urban climatology — the study of how cities affect weather patterns — from an academic science to a predictive one, with countless practical applications ranging from air quality to water and energy conservation. In 2005, he received the Massey medal for outstanding achievement in the field of Canadian geography.

Unstructured Interview: July, 5 2011.

Un-published Documents Provided Include:

http://ams.confex.com/ams/89annual/techprogram/paper_150552.htm

UC Fig-7-3-2.pdf;

Eco-Density Talk PowerPoint;

Vancouver UHI, July, 4 1972. 2100h. ppt. (October 13, 2011).

Published Document Provided: *"Urban heat islands". Chapter 11 in Handbook of Urban Ecology.*

3. Dr. Moura Quayle

Former Dean, Faculty of Land and Food Systems

Expertise: The Urban-Agriculture Interface

248 -2357 Main Mall

Vancouver, B.C. V6T 1Z4

1.604.822-1219

moura.quayle@sauder.ubc.ca

As former Dean of Land and Food Systems at UBC, she focused on urban landscape, including: the public realm; urban ecology; greenways; and public ways. Sustainable agriculture, especially in relation to planning and design concerns where urban and rural areas come together was her interest. Her main research revolved around the implementation and impact of urban greenways in the City of Vancouver and how to promote planning at the agricultural-urban interface. Dean Quayle chaired the City of Vancouver's Urban Landscape Task Force in 1998 and prepared a report, for the provincial government on the "provincial interest" in the Agricultural Land Commission Act.

Unstructured Interview: July 9, 2011. Published Articles Provided:

Quayle, M. 1995. *Urban Greenways and Public Ways: Realizing public ideas in a fragmented world.* Landscape and Urban Planning 33 (1995) 461-475. Elsevier Science. B.V.

Quayle, M., van der Lieck, T. 1997. *Growing Community: A case for hybrid landscapes.* Landscape and Urban Planning. 39 (99-107). Elsevier Science. B.V. Article provided by M. Quayle during interview.

4. Alan Slater Duncan

Environmental Planner

604 257.8515

Vancouver Board of Parks and Recreation

alan.duncan@vancouver.ca

2099 Beach Avenue, Vancouver, B.C.

Friday June 9,2011

Unpublished Document Provided: Duncan, A. 2011. Vancouver Board of Parks and Recreation: Urban Agriculture Update. February 2011 Document and Power point.

5. Dr. Art Bomke, Associate Professor

Professor, Agro Ecology

art.bomke@ubc.ca

1.604.822.6534

Dr. Bomke has taught Agro Ecology at the University of British Columbia for many years. His research builds from a basic concern for sustainable soil management and extends to broader applications of agro ecological principles to agricultural systems, including people. His research is based on a **participatory model** in which the farm community is an equal partner. Dr. Bomke connected me to the urban farming community and the food policy council.

Unstructured Interview, July 12, 2012. He provided 25 books on climate change and agro-ecology from his library, as he was retiring. List available upon request. Introduced to Brent Mansfield, and sent in the direction of the Food Policy Council Meeting, A Riley Park Public Consultation and an Urban Farmers Monthly Meet-up, and a Farm tour led by Ilana, Lablow co-founder of Fresh Roots Urban Farm: info@freshroots.ca (778) 862-FARM.

6. Food Policy Council Meeting

July 13, 2012

Informal Discussions with:

6.1. Ann Rowan, Policy Analyst, MVR;

6.2. Ross Moster Transitions Vancouver. I subsequently met with Ross Moster at his home and we toured the urban plot at the local Billy Bishop Community Centre Urban Garden on July 21, 2012.

7. James O'Neill

Social Planner, Food Policy, The City of Vancouver

(604) 873-7764

james.oneill@**vancouver**.ca

Unstructured Interview July 15, 2011.

8. Seann Dory

Project Manager

SOLE Food Urban Farm

July 17, 2011

Unstructured Interview and field research at the SOLE Food Urban farm.

9. Vancouver Compost Demonstration Garden

City Farmer, Sharon Slade

2150 Maple Street, Vancouver

Phone: (604) 736-2250

cityfarmer@gmail.com

July 19, 2011

Unstructured Interview and Field Research at the VCDC Site.

10. Brent Mansfield

Vancouver Food Policy Council, Member at Large

July 27, 2011

Unstructured Interview

Document Provided: Draft MVR Ecological Health Action Plan

11. Jinny Wu Communications Manager

604-647-7353

jwu@vancouverconventioncentre.com

July 26, 2011

Media release provided

12. Graeme Evens

Sustainability Manager, The Vancouver Fairmont

604 684-3131

July 27, 2011. Field Research at the Hotel

Unstructured Telephone Interview August 10, 2011.

13. Kira Gerwing

Planner, DTEs, Neighbourhoods Group Central Area Planning,

City of Vancouver

604-871-6168

kira.gerwing@vancouver.ca

August 19, 2011
Unstructured Interview.

Earlier Interviews

14. Joe Van Bellegan, developer, Australia
September, 20 2010
Dockside Green, Victoria, Canada
Green Building Council Convention, Cape Town South Africa
Unstructured Interview .

15. Bill Reed, Planner, US
September 20, 2010.
Green Building Council of South Africa. Conference Presentation
The Integrative Design Process: The Philosophy and Practice of Integrative Design.
Cape Town CTICC and unstructured Interview.

16. Stanley Visser, South Africa
Date of Unstructured Interview : April 12, 2011
Respondent: Stanley Visser, Head, Economic and Human Development, CoCT
021 5501201 or 084 5545 785
Stanley.visser@capetown.gov.za
Interview: Number: 1
Method: Informal Interview, Documentation and Archival Documentation, Snowballing – additional contacts provided.
Date of Summarization: April 18, 2011.

Unpublished Documents Provided:
1. Map. Cape Flats District Plan. Sub District 4: Philippi Horticultural Area. CoCT (MapCFD).

2. Position Paper on Food Security in Cape Town: Feeding the City The Challenge of Urban food Planning. December 14, 2010. (PPFS).

3. Report To Portfolio Committee for Economic Development and Tourism: PC Report on Urban Agriculture: February 2011. City of Cape Town. (RPCUA).

4. Urban Agriculture Policy for The City of Cape Town. 2007. City of Cape Town. Government. (UAPCoCT).

Contacts Provided:

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Note: Partnership with Queens University in Kingston Ontario
http://www.egs.uct.ac.za/downloads/PUFS.pdf

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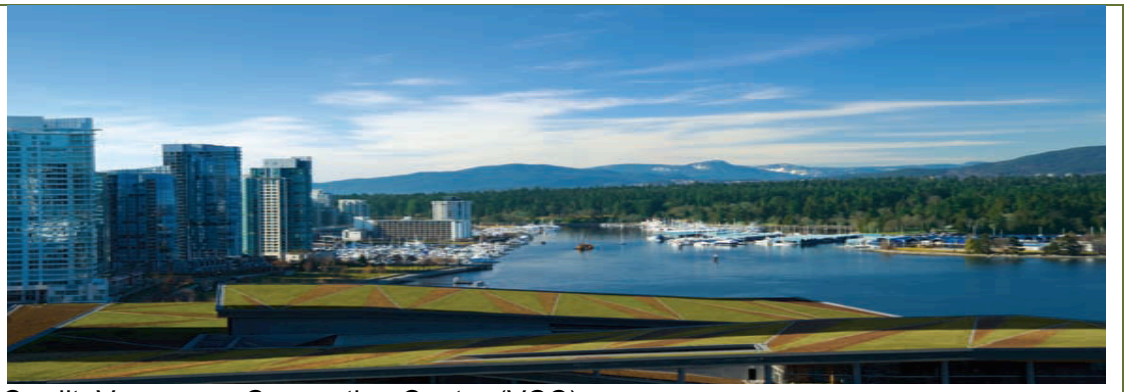
8.0. Appendix 2 - Rating Tools and Green Roofs



Credit: Vancouver Convention Center (VCC)

Accolades for Rating Tools – Points for criteria and not food production

Vancouver Convention Centre and LEED ®

Located directly adjacent to the Fairmont Hotel's intensive UA roof top garden is the six-acre (2.4-hectare) living roof of the Vancouver Convention Centre (VCC), constructed in 2010 for the Winter Olympics (Fig.3.3). The rooftop garden was designed to imitate a Pacific North Coast grassland, with 400,000 plants and grasses imported from Vancouver Island. The roof is the largest self-maintaining, non-industrial "regenerating" living roof in North America (Wu 2011) and the Centre is the first Convention Centre in North America to receive LEED® (Leadership in Energy and Environmental Design) Platinum certification. According to the VCC fact sheet provided by Wu (2011), "A locally established population of honey bees, pollinate the flowering plants, " While, most likely the bees responsible are the resident bees from the Fairmont Hotel. The Convention Centre has added four beehives to their rooftop since it's construction.

Sean Dory of Sole Food (2011) said, "The VCC site is of interest to almost everyone involved in urban agriculture in the City", since its inception and construction. The potential exists for the development of a highly productive urban farm. While Sole's application was turned down, due to lack of accessibility and other factors, it is hoped that in the future, the VCC will reconsider as public interest in Urban Agriculture increases.

To read more about the construction and technical background on the construction of the Vancouver Convention Centre Living Roof, link to the following case study: http://www.sabmagazine.com/blog/2010/03/11/21-living-roof-case-study/ July 2011.

Back Ground and Motivator to the CoV Green Roof Policy

There are many benefits to planting an intensive green roof; however, urban agriculture would increase the synergies and multiply the sustainability benefits. The growing medium and plant material insulate the building against heat gain and loss. For example, it is projected that VCCEP's green roof will reduce summer heat gain by as much as 26% (Wu, 2011). In addition to these building-related benefits, a living roof can provide significant improvements to storm water management by detaining runoff and reducing peak flows. In a building of this scale, storm water retention can translate into significant cost savings by reducing the size of the municipal storm water infrastructure. This became a strong argument in support of the green roof for the VCCEP project. Urban air quality is also improved as the living roof traps airborne particles and the plants absorb carbon dioxide and release oxygen, with the added benefit of providing a habitat for birds and mammals are all significant ecosystem benefits. In the process of developing policy to support green roof development, (CMHC: 2006,40) the CoV's first step was to require all new development on the South East False Creek land (SEFC), a former Brownfield site, to obtain LEED © Certification (CMHC, 2006) and a number of Green Roofs were installed as seen in Figure 1.4 and 3.5.

What is a rating tool and what are the limitations?

LEED © (the U.S. Green Building Council Leadership in Energy and Environmental Design Green Building Rating System) is a third party rating tool, recognized in the US and Canada as a benchmark for the design, construction and operation of buildings (VCC 2011; Reed 2009; USBC 2011). In regions, that include Australia and South Africa, Green Star © is the rating tool utilized, as it is adaptive to the construction technologies in the South. Rating tools promote a "whole building" approach to sustainability by recognizing key areas of human and environmental health with a score card in key areas that include: site development, water and energy efficiency, material selection, indoor air quality and waste management. However, once all of the technology points are tallied, the building is constructed and then we have a "green building causing "less harm" to the environment, (Reed, 2009) while not really solving the problem of sustainability. There are limitations to rating tools, and there is too much emphasis on points, stated by Reed and Van Bellegan (2010) at a Green Building Council conference in Cape Town. Rees further emphasized at a recent sustainability conference in Toronto, "that green certification should be based on post occupancy performance and not intent (Rees: 2010, 30). Furthermore, Reed said (2009, 2), this is an "Unholistic, unintegrated approach, which lacks clear leverage or methodology to change the way we build". A building according to Reed (2009) "is a complex organism" and "part of the larger metabolic system we call the city (Rees 2011)". Buildings should not be considered as stand alone entities, and it is important to determine the true impact of a building, on the ecosystem services of the city, the GHG emissions, the UHI effect and the ecological footprint as a component of a larger system.

While a Gold or Platinum status is a useful marketing tool and does contribute to improving sustainability, there is room for greater innovation and transformation in the process of incorporating a sustainable food and forestation system as CPUAF as Green Roof Points in the rating system. Currently, up to (21) twenty-one of a possible (100) one hundred points can be earned for a green roof, although, to date there is no reward for agricultural production (USBC 2011). Incorporating food system planning into all aspects of development including the roof tops and the vertical surfaces to create a more sustainable integrated city requires rethinking the point system and going beyond LEED ® as the Fairmont Hotel demonstrates within the case study. LEED ND® takes the rating system a step further and considered a larger ecosystem. The Dockside Green Development in Victoria, B.C. successfully implemented LEED ND®, receiving the first LEED ® Platinum for neighbourhoods in North America. The development takes a systems approach, to look beyond a single building, to contribute to a larger sustainable community.

Future Planning

In discussion with the experts consulted, including Rees, Quayle, Oke, and Bomke (2011), it was recognized that the LEED ® Platinum rooftop conserves stormwater run off and provides thermal properties meeting the sustainability goals of the VCC and The Olympics; however, the consensus was that if the rooftop were planted today, it would have most likely incorporated a food system into its structure. Sole Food has approached the CC to farm the 6-acre site; however, due to a number of constraints, including lack of accessibility, development proposals were refused (Dory 2011).

Vancouver has moved very quickly and with tremendous innovation to address sustainability issues; however, this is example where policy is playing catch up with innovative thinking and where thinking “Beyond LEED®” is necessary in future planning to address global and local climate and food security issues.

9.0. Appendix 3 - Global Best Practice: Spittelau Waste Incineration , Vienna Austria

Spittelau Thermal Waste Incineration Plant – Global Best Practice

Figure 4.5. Photo V. Durant, 2010 Site Visit and Tour August 2010.

Spittelau Thermal Waste Incineration and Thermal Heat Generation Plant is located in Vienna Austria, a city which rivals Vancouver as one of the most liveable in the world (Figure 4.8). Spiteleu is a tourist attaction, designed by architect, F. Hundertwasser who was a champion of the living-building approach as early as the 1930's. The plant attracts 10,000 visitors on tour every year with many more visiting the external environment (October 25, 2011). Most importantly, the plant employs sustainable,environmentally sound practises to reduce Co2 and other emmisions, significantly lower than required by the Austrian Clean Air Act of 1988 and the city is considered the world city closet to sustainable waste management (Spitteleu Energy Report, 2010). This is an innovate waste treatmeant plant worthy of further research by the CoV and other Global Cities as a solution to sustainable food waste management with an added benefit of attacting tourists to view green economic waste management practises. While Spitteleu is unique in form to its location, Vancouver could consider innovative ideas, unique to the cultural environ of the region, while considering a location within the city limits for the wast treatment site.

10.0. Appendix 4 – Neighbourhood UA

How the COV provides grants for neighbourhood UA initiatives:

CoVAR2010 (2). CoV Administrative Report, Administrative Report. June 8, 2010. Zak, M. Mendes, W.

Grant of $50,000.00 to SOLE Food Urban Agriculture Project approved as second installment to approval of April 6, 2010.

The Proposal presented to Council, by Social Planning outlined the criteria to expand the Greenest City Neighborhood Grants and Initiatives. Full Details about the Neighbourhood Grants program available at:

http://vancouver.ca/ctyclerk/cclerk/20100622/documents/a8.pdf (Accessed, August 9, 2011). Council approved funding allocation and expanded the program to support local food systems that achieve multiple goals and objectives identified in the GC2002 action plan. The criteria for funding supports environmental implications that catalyze community action around environmental and food systems goals. They include the support of urban greening, ecological health, the reduction of food waste, and the creation of sustainable local food production and distribution (CoVAR: 2010,4). The social implications address capacity building to develop long-term resilience and to address current food security issues by improving neighbourhood food assets and food access through local green economic development. The expanded granting process required community initiatives such as SOLE to demonstrate how their projects would enhance and build upon and support prior city policies such as the Vancouver Food Charter. Through comprehensive development of food security policy in the CoV (CoVAR2010 (2).

11.0. Appendix 5 –CoV Funding – Waste Projects

How the COV funds UA and Waste Projects

The following refers to the Waste Management Proposal by SOLE food, to develop mid scale waste management in the Basement of the Save-on Foods Building. Details of the CoV Administration is described below:

CoVAR2010 (1). CoV Administrative Report April 6, 2010. Gerwing, K.

DTES Capital Budget Funding Allocation: Green Community Projects

A Grant of $100,000.00 to SOLE Food Urban Agriculture Project approved by Council. As part of the Quick starts program, projects were identified as implementable actions to chart the CoV on a trajectory to becoming the greenest city by 2020. In order to support the GCAP, the neighbourhood grants fund was established to **support urban food projects**, which could provide opportunities for economic development in the green economic sector, particularly supporting vulnerable and low-income populations (CoVAR2010 (1)). Full details available at: http://vancouver.ca/ctyclerk/cclerk/20100420/documents/a1.pdf (Accessed, August 9, 2011).

In addition, CoV grants supported a material **waste exchange** program to the Strathcona Business Improvement Association (SBIA) to divert goods from the landfill. Thirdly, the installation of creatively branded bike racks for the DTES, received funding which supports **sustainable transportation**, leveraging funding from VanCity EnviroFund.

12.0 Appendix 6. Blank CPUAF Matrix as Checklist

CPUAF MATRIX	GhG Emissions	Ecological Health	Human Health	Eco-Economy	Solid Waste	Storm-Water Mgmt.	Food Security	BLHI	CLHI	SLHI	SLHI
E.F Analysis											
Climate Modeling											
Regional Climate Change Report											
Regional Sustainability Framework											
Regional Food System Strategy											
Regional Ecological Health Strategy											
Regional Growth Strategy By-Law											
Smart Density											
Regional/Provincial ALC & ALR											
Municipal Task Forces											
Public Consultation											
Interactive Website											
Food Charter											
Food Policy Council											
Forest Management Plan											
Private Tree By Law											
Public Tree Inventory											
Layered System Where possible											
Tree Inventory For the Private Realm											
Greenways Initiative											
Stewardship Programs											
Green Streets											
Orchards - Public Parks											
Edible Landscape Guideline											
Urban Apiculture Policy											
Orchards/Farms Public Roofs.											
Sustainable City Action Plan											
Food Waste Management											

Compost Demo Garden											
Local Pilot Projects (VV)											
Neighbourhood Matching Grants											
Central Waste Mgmt. Facility (Public)											
Assisted Housing with UA Provincial & City Partnership											
Green Roof Bylaw											
Vertical Wall Bylaw											
Urban Farming Business License											
Industrial/Warehouse Interventions											
1:1 Parking to Tree By Law											
Partnerships with SE-CSA or CSR Urban Farming Operations											
Orchard Interventions: Policy & Bylaws											
Green Roof By-law or CSR % Policy											
Vertical Wall By-Law and Policy											
Residential High/Medium Rise Districts											
Partnerships between SE-CSA or CSR Urban Farming Operations											
Public Bldgs. with Stewardship Program											
Vertical Wall CPUAF UA By-Law											
Public Bldgs. as Stewardship Program											
Sustainable Horticulture CPUAF Guidelines for Public and Private Realm											
Intensive Green Roof CPUAF UA By-Law											

Definition Key

GHG	Green House Gas Emissions - Carbon & Climate Leadership
E.F.	Ecological Footprint
E.H.	Ecological Health - Encompassing plant, water, air and species.
Waste	Solid Food Waste
H.H.	Human Health - Air, Water and Heat
UHI	The Urban Heat Island
Eco-Economy	The Ecological Model of Economic Growth – Includes SE, CSR, CSA.

ALR/ALC Agricultural Land Commission makes decisions on Agricultural Land Reserves and Development

IMPACT Key
They are weighted, as having a high or measurable impact, a medium or indirect impact and low having a slight or unknown impact.

- ■ High, Direct and/or Measurable Effect
- ⊙ Medium and/or Indirect Effect
- • Low and or not currently measured effect

Figure 5.1. Durant © 2011 Matrix of a CPUAF Model