ABSTRACT

Understanding the opportunities in urban settings to adopt urban agriculture within the
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Introduction

“Urban Agriculture is the growing, processing, and distribution of food and other products through intensive plant cultivation and animal husbandry in and around cities”.

There has been a recent increase in the effects of a changing climate. This includes increases in extreme weather events; increased and more intense wildfires; a general shift in weather patterns, including seasonal starts and durations; and longer and more intense droughts in many areas of the world. These effects are felt globally and have a direct impact on human health and ecological resiliency.

These climatic events and changes have impacted food security in both urban and rural settings. Many agricultural regions are unable to provide adequate and affordable food in the quantities required to sustain the global population.

One potential method to help alleviate pressure on agricultural producers and land is to adopt policy that mandates urban agriculture in areas where it is possible. Installing multi-use food gardens on rooftops, in parks, and other useable greenspace can help provide fresh food to local
communities; act as an educational tool for children; and provide employment for vulnerable populations in a variety of positions.

Creating opportunities to adapt to the changes that climate change will bring, as well as provide food security options that focus on social solutions, will help create a more just, equitable community.

The paper will offer an introduction of the concepts relevant to the topic. This will include background material and future projections of climate change effects; the occurrence of extreme drought and agricultural failure; prominence and successes of urban agriculture. There will be case studies that examine the success, or not, of adopting more urban gardening solutions in cities that have either always relied on urban agriculture or cities that have recently adopted policy to allow urban gardening.

The paper will then explore the possibility of adopting urban agriculture in the hyper urban city of Los Angeles, using their current policy and climatic characteristics of indicators of success. This exploration will include basic demographic information, which can inform the scope and need of this kind of project.

Finally, a specific site location will be chosen in Los Angeles, and a design will be created to redevelop a piece of land into a mix-use area, that adopts urban agriculture and employment with residential housing. This will include suggested policies to support the development; social benefits of the project; and potential P3 opportunities for funding and charity.
The paper will provide the background and real-world examples that illustrate how urban agriculture can work in aiding the issue of food security. The use of real-world examples, and then using Los Angeles as an example, will highlight how accessible and attainable fresh food security is, regardless of the size of the city. There are ample ways in which to encourage and promote green spaces and fresh food in a variety of land use types and densities.

Background

Conflict, drought, extreme weather events, and the ongoing effects of climate change are all affecting food security and world hunger. Many historical periods of turmoil have coincided with severe droughts, displacing thousands of people both historically and currently. This ranges from the collapse of many Mediterranean civilizations at the end of the Bronze age, to the displacement of thousands today in Syria. While some aspects of food security can be addressed through ending global conflict and decreasing human influence on climate systems, these goals are a little above and beyond what many individual citizens are capable of.

Many urban areas, particularly those that have high density, have a distinct lack of green areas and citizens often have little knowledge on where food comes from, or how it is grown. There are many benefits to adopting and implementing urban agricultural practices into cities and urban areas, even at a small-scale. One of the key features is its integration into the urban
economic, social, and ecological system which aids in city-wide and community resilience. The agricultural integration relies in the use of urban resources, such as land, labour, urban organic waste, while impacting the community in terms of food security, ecology, economy, social cohesion, health, poverty reduction and cultural meaning. Indeed, in addition to these benefits, there is the social dimension that integrates social aspects into urban agricultural practices. For example, citizen involvement, intercultural communication, participatory planning and governance are areas where the social dimension is key between multiple stakeholders.

Adopting urban agricultural practices within cities lessens the pressure on rural farms and can ease the environmental and health burdens associated with large-scale farming. Conventional agriculture can lead to: increased use of pesticides and fertilizers that pollute soil, water, and air, and harm human health; increased soil erosion, which leeches nutrients from the soil, which increases the amount of fertilizers required for growth yields; unsustainable water uptake rates; and the use of monocultures in large farms erodes biodiversity among both plants and animals. This is to say nothing of the space and energy inputs required to run and produce products on these large-scale farms.

Urban agriculture is, often by through space and limiting inputs, a form of sustainable agriculture. Urban gardens tend to use little to no fertilizers or pesticides-many of which are banned within cities-and due to space, often do not over-use water or lead to soil erosion. The health of the environment and
of humans is enhanced when more food is made in a local and sustainable way. More sustainable food systems help create closer connections between producer and consumers, leading to a more direct marketing of locally grown foods to the local consumers\textsuperscript{8}. An added benefit of buying local is, of course, the decreased distances of food from farm to table, leading to decreases in transport time, increased freshness, and a decrease in food waste.

The climate is changing dramatically. Increasing natural disasters, changing weather patterns, and prolonged global climate events are becoming the new norm. These changes affect urban and rural areas differently, yet no less dramatically. Rural areas will see an increase in droughts, reduced rainfall, increased aridity and erosion, and reduced biodiversity. Urban areas will experience a similar increase in drought as well as increased effects of the urban heat island and increased urban air pollution.
The bulk of food consumed in cities is produced in rural areas and the importance of rural areas on the state of the global food industry cannot be understated. Climate change will have dramatic impacts on the ability of agricultural land to be able to produce adequate amounts of food. Indeed, extreme events are more likely to occur more frequently and in greater intensity than previously seen.

For example, extremely strong La Nina events may hit nearly twice as often as they did previously due to global warming, occurring every 13 years,
as opposed to every 23 years as they currently do \(^1\). These events have major impacts on the global climate system, and can trigger floods, head waves, blizzards, and hurricanes worldwide; and new findings suggest some areas could get whiplash of weather of opposite extremes year to year, going from drought to flood\(^1\) seasonally. These events can have catastrophic consequences, for example, during the 1998-1999 La Nina, Southwestern US experienced one of the most severe droughts in history; in Venezuela, flooding and landslides killed 25,000-50,000 people, and in China, floods and storms killed thousands and displaced over 200 million. In Bangladesh, over 50% of the land was flooded, leading to food shortages and waterborne diseases that killed several thoughts and affected over 30 million\(^1\). These events impacted millions of people globally, during a time before the effects of climate change had begun to fully manifest.
These changes have a direct impact on the global food production system. Indeed, changes in droughts, floods, and extreme temperature events since the middle of twentieth century have greatly impacted land use quality. Over agricultural areas, disasters arising from extreme weather can cause market damage to crop and food system infrastructure, with the potential to destabilize food systems and threaten local and global food security. Many across the world already live with food insecurity, or undernutrition, and the climate induced events will only exacerbate these issues. These issues have already begun, as recent studies confirm that observed climate change has already affected crop suitability in many areas, resulting in changes in the production levels of the main agricultural crops. This is concerning due to the level of food required to ensure food security at an
affordable cost, but also for the employment and job security of farmers and other agricultural producers in many of the regions of the world.

The effects of climate change on large scale agriculture are not fully known, and likely will be more devastating than can be predicted. Some events, such as crop destruction from heat and drought, or flooding, can be predicted as these events have occurred in the past. Other issues, such as a seasonal mismatch between pollinators and flowers or increases in pest production and range, have not fully been considered. There is a variety of factors that affect food production and suitability for crops and while not often considered, crop production is also negatively affected by the increase in both direct and indirect climate extremes. Direct extremes include changes in rainfall extremes, increases in hot nights, extremely high daytime temperatures, drought, heat stress, flooding, and chilling damage, while indirect effects include the spread of pests and diseases, which can have negative effects on cropping systems⁹. These factors all contribute to changes in food security globally.

This is not an issue that will affect only developing nations, or the global south-although these areas will be disproportionately affected-but the entire human population will feel the effects of climate change on food security. Food security is and should be a high priority policy consideration for all nations, with innovation and sustainability at the fore of new programs and initiatives.
Staple foods, such as corn and wheat, have already been affected across the globe. Researchers have observed that temperature and precipitation trends have reduced crop production and yields, with the most negative impacts being on wheat and maize. For instance, research estimates that cereal harvests, including rice, wheat and maize, decreased by an average of 9-10% during droughts and heat waves between 1964 and 2007, with the worst effects seen in North America, Europe, and Australia. Production losses are a result of both a reduction in harvested area and in yields. This is a significant drop in production of global food staples, affecting millions of people. Additionally, this study shows the effects of climate change before the rate of the change has really begun. Since this study, there have been increased droughts, heat events, and other climatic events that have affected food production and distribution.

The full effects of climate change have not yet been realized yet, and it is likely that the worst has yet to fully manifest. Given the current political climate in some areas of the world, and the mistaken belief that climate change is fake, the anthropogenic changes on the climate will continue, exacerbating changes we have already seen. Not to be doom and gloom, however, the likelihood is that the world has not considered the full effects of climate change, and how it will affect not only humans, but the world that we rely on for the continuation of life.
Humanity has done great things in order to be able to function in an urban society. The agricultural revolution, followed by the industrial revolution, have allowed cities in sizes and number that have never before been possible. This has led to increased reliance on the rural areas to provide the resources required to allow such numbers to live in urban areas. This has placed extreme pressure on rural and food production lands to provide adequate and affordable consumables for the billions who live within cities. This pressure has led to the use of GMO’s, pesticides and chemicals, and to the destruction of fertile land, resulting in less nutritious food and increases in arid areas and desertification. Indeed, western urbanization has not only established a structural dependency on unsustainable forms of exploitation of natural resources to be able to sustain its population but is progressively extending this model across the planet\(^4\).
This pressure can be alleviated through several measures. One of the key issues to address is that of climate change itself. The IPCC has stated that we have 10 years to address the warming of the planet and have released a special report on the effects of a 1.5C temperature increase from pre-industrial levels. There will be consequences on the climate, regardless of whether humanity is able to reduce and eliminate emissions that contribute to climate change. However, decreasing the amount and intensity of climate change should be a priority. An additional course of action would be to reduce global consumption and increase global recycling and reusing of goods and resources. This is a paradigm shift for the vast majority of the global north, but a worthwhile objective for securing a future for humanity and the world. Both measures involve a cooperative political climate and the support of the global north. These are large undertakings to commit to and may not directly benefit many of the vulnerable segments of the population.

At an individual scale, there are ways in which people can alleviate and address some of the direct effects of climate change. For example, adopting urban agriculture can help aid food security and address some of the issues of climate change. Urban agriculture creates opportunities for food production, education, and environmentalism and create human-nature connections that have been lessened with the shift from rural to urban areas by many people. Urban agriculture can create that sense of agency in food production, and pride of growing one’s own food, while lessening the pressure on large scale farms. There are other environmental benefits to
adopts urban agricultural practices in cities. Urban agriculture often consists of many small and dispersed units that together create a decentralized supply system that is in close proximity of the consumption system, reducing the need for costly transportation and processing.

There are many forms of urban agriculture that can be adjusted to fit different homes, cities, and cultures. Urban agriculture includes small-intensive urban farms, food production on housing estates, land sharing, rooftop gardens and beehives, schoolyard greenhouses, restaurant-supported salad gardens, public space food production, guerrilla gardening, allotments, balcony and windowsill vegetable growing, and other initiatives.

Figure 4. Artist rendition of what the Hanging Gardens may have looked like. City has garden terraces and an irrigation system to provide water for the plants and food produces.

Urban agriculture, in its many forms, is not a new concept. Indeed, the concepts go back to the most ancient forms of urban agriculture found in
Mesopotamia between 4000 and 600 BCE. The large temple complexes of the Sumerians, Babylonians, and Assyrians included roof gardens and the planting of trees and shrubs on aboveground terraces. The Roman city of Pompeii had elevated terraces where plants few, while the medieval Egyptian city of Fustat had a number of high-rise buildings with roof gardens on the top complete with water wheels for irrigation. These examples illustrate the importance historical cultures placed on access to food and food security. Of course, technological advances have changed the way and types of food that modern societies consume, however, fresh food should still be a priority.

**Urban Agriculture Around the World**

There have been recent initiatives to bring more gardens into cities and create awareness of food security. There exists many projects and initiatives to help encourage food security and outreach that aims to get more people and communities to adopt small scale agriculture within city limits. Some established projects combine measures such as the establishment of land trusts, the organization of training programmes, and links with existing food outlets, that have become reference points for the food justice movement. These initiatives have not only been granting access to urban land for the recreational and food production needs of immigrants and other food-insecure populations, but have been systematically challenging the concentration of land, and other inequalities embedded in
the dominant agriculture and food systems, such as environmental impact, health hazards, and the exploitation of workers\textsuperscript{4}.

Indeed, international organizations have been developing policy and initiatives to help address food insecurity at a global level. Various UN programs and organizations play important roles in the development of urban agriculture policy guidelines. The policy framework thus developed reflects the three dimensions of sustainability and has three broad dimensions: social, economic, and ecological. (see below)\textsuperscript{5}.

\begin{itemize}
\item **SOCIAL AND CULTURAL POLICY DIMENSION**
  - Capacity building
  - Participatory planning and governance
  - Equity in gender and for disadvantaged groups
  - Food sovereignty
\item **ECONOMIC AND FINANCIAL POLICY DIMENSION**
  - Microcredit
  - Marketing and safeguarding the sector
\item **INFRASTRUCTURAL AND ECOCLOGICAL POLICY DIMENSION**
  - Management and planning of urban spaces for agriculture
  - Recycling organic wastes
  - Treatment and use of wastewater
\end{itemize}

\textbf{Figure 5. Policy framework for urban agriculture, developed for UN. Source: 5}

This framework helps to guide the development of urban agriculture in cities. These suggestions showcase the various areas that need to be considered when adopting agricultural policy, in order to adequately assess the success of implemented programs, both in terms of the effects on sustainability and the community. While ensuring that good food is available for all, it is also important to consider the societal impacts, including
inclusivity, accessibility, and how equitable the programs or initiatives may be.

It is important to increase food security, sustaining urban and rural populations alike. Indeed, urban subsistence production can lead to immediate reduction in urban hunger and improve nutrition, particularly in vulnerable populations. Urban agriculture can also be a form of empowerment for vulnerable populations, in that it affords low-income people the opportunity to increase control over their own nutritional intake and potentially increase their incomes. This income can come from employment in food production, including tending the garden, planting or weeding, or from selling produce that one has grown, or for someone else in farmers markets. Creating opportunities for part time employment in food production can be beneficial for vulnerable populations or individuals who require temporary employment. An additional benefit of urban agriculture is that generally, fresh food prices decrease as food supplies increase, which helps keep food security affordable by more members of the community.

Urban agriculture can also increase food security at the national scale as well. By producing fresh food in the markets they serve, there are multiplier effects, generating additional activity in terms of food cultivation, storage, preparation, and processing. This can generate additional local income, lessening a nations reliance in imports and the global economy. In that vein, providing local populations with local food frees up the pressure on
agricultural lands, allowing rural farmers to have the option on concentrating on export production\textsuperscript{13}.

Several cities have well developed urban agriculture already in place. In fact, some areas of the world have coupled urban growth with agriculture, ensuring that the growing populations have access to green space and fresh food, relying on urban produce for the bulk of their fresh food intake. Indeed, the international importance of urban agriculture is illustrated by studies showing that 15\% of all agricultural production occurs within metropolitan areas. In some cities, urban agriculture may already occupy 35\% of the land area, employ 36\% of the population and supply up to 50\% of urban fresh vegetables\textsuperscript{13}. These numbers are not the norm, however, but show that some areas have already established successful urban agriculture initiatives and programs.

Hanoi, Vietnam, for example, has an extensive urban farming program, producing much of the fresh produce within the city limits. Other cities, such as Singapore, have recently adopted urban agricultural initiatives in innovative and sustainable ways, in order to reduce reliance on imported goods. Other cities, such as Havana, Cuba, have adopted urban agriculture to meet debilitating food crisis due to political upheaval. These examples show how cities in different countries with different cultures have adopted urban agriculture, all with different goals in mind.

\textbf{Hanoi, Vietnam}
Hanoi is the capital city of Vietnam, located in the heart of Southeast Asia. As of 2015, the population of Hanoi was 7.588 million, spread across 3,328.9km$^2$ at a population density of 2,300 per km$^2$. In Hanoi, approximately 80% of fresh vegetables and 40% of eggs consumed in Hanoi are produced by urban and peri-urban agriculture within the Hanoi province.

Hanoi has been recently shaped by war, living under the rule of the French until 1954, and then under communist rule until 1986. This has affected the way that agriculture and cities have formed and expanded, shaping the capital city. The revolution of 1986 had significant impacts, notably, the agricultural sector could now work on their own land, growing crops of their choice, and selling them where farmers chose, a far cry from the government run farms. This change has increased demand for diversified foodstuffs, and there has been a shift in agriculture on the outskirts of Hanoi, which has increased animal breeding, fish farming, market gardening and horticulture. This has been especially true on the peri-urban lands, where there is available space for these types of agriculture.

The Vietnamese government places importance on their agricultural land, even while focusing on development. The area of Hanoi is the location of the bridgehead of the Red River Delta and has some of the most fertile land in the country, making it important for agricultural production. The government passes a resolution that aims to protect at least 3.8 million hectares of rice fields in order to preserve domestic supply. This resolution
was further cemented into legislation in 2012 with the approval of the Master Plan of Hanoi. This plan seeks to make 60% of the province into a green corridor, where 2/3s of the land will remain free from any development\textsuperscript{17}. This is an ambitious plan that really highlights the importance of preserving fertile agricultural land that ensures Hanoi, and Vietnam's, food security.

![Image of Tran Nguyen Bo taking care of his farm in Hanoi. The farm provides his source of income and food security on the 800m\textsuperscript{2} farm. Image from cityfarmer.info, 2012.](image)

**Figure 6.** Tran Nguyen Bo taking care of his farm in Hanoi. The farm provides his source of income and food security on the 800m\textsuperscript{2} farm. Image from cityfarmer.info, 2012.
Havana is the capital of Cuba, located in the Caribbean, and is the largest Caribbean country by land area. Havana has an estimated population of 2 million, with an area of 311km² and with a population density of 6,500/km². Cuba faced an economic crisis that led to food rationing and increased rates of malnutrition in 1991 with the collapse of the Soviet Union, and the loss of the country’s main trading partner. This loss affected both the main source of income and food for Cuba, but also affected shortages of petroleum derivatives that aid in agriculture, namely mineral fertilizer and pesticides. Even before the fall of Soviet Union, Cuba began to promote intensive horticulture, and developing ways to use less inputs to create more sustainable agriculture.

Cuba has developed their own technology to promote intensive horticulture, called organoponics, that grows plants using an organic substrate, obtained from crop residues, household wastes and animal manure. This innovative technology relies on organic inputs that increases the nutrients in the soil as well as the natural moisture, while adding to the height of the plant bed, which improves the typically poor soils in urban areas. The garden is created by making furrows in soil, then lining with protective barriers such as wood, stone, brick or concrete. This ensures that the soil stays in place and prevents erosion.
Organoponics refers to both the technology and the garden that is created. These gardens can be applied on building sites, vacant lots, on roadsides, and arranged in terraces on sloping land, which would otherwise be unsuitable for agricultural pursuits\textsuperscript{19}. This way of farming is versatile and adaptable, suitable for a variety of high yield produce and for a variety of garden sites. The crops that flourish in this kind of garden include lettuce, radish, beets, beans, cucumbers, tomatoes, spinach and peppers\textsuperscript{19} all of which are high yield with high nutrient content and, if exported, can generate higher income. This type of agriculture has been implemented in many areas in Havana, and across Cuba, generating hundreds of tonnes of organic vegetables a year. Indeed, the best-known garden, Vivero Alamar, a formerly
abandoned wasteland, generates 300 tonnes of vegetables a year, and is run by a local coop\textsuperscript{19}.

Havana encourages both urban and peri-urban agriculture, and the city province has some 700 crop farms, 170 cattle farms, 20 cooperatives and 27 tree production units\textsuperscript{19}. There is an estimated 36000ha of area used for agricultural production, which produces 20,000 tonnes of fruit, 10,000 tonnes of roots and tubers, and 10.5 million liters of animal milks\textsuperscript{19}. Additionally, there are nearly 90,000 backyard plots (less than 800m\textsuperscript{2}) used by families to grow produce or raise small animals for consumption, engaging 90,000 residents\textsuperscript{19}.

The Cuban government has implemented several policies that support and encourage urban agricultural practices to flourish within the country. The government strongly encourages measures to grant vacant land free of charge for agriculture, encouraging the participation of women and youth in the programs\textsuperscript{19} and crop recognise crop and animal production as legitimate land use in the city’s strategic plan, allowing agriculture in areas where construction is not foreseen\textsuperscript{19}. 
Singapore

Singapore is the world’s only island city-state, located off the coast of Malaysia. The population is 5.7 million, living within 720km$^2$. The population density of Singapore is 8,000/km$^2$. At present, the bulk of food consumed in Singapore is imported in, as the large population requires vast amounts of food. Currently, only about 7% of Singapore’s food is grown locally, and the rest is imported from neighbouring countries, such as Malaysia, Thailand, and the Philippines.

The amount of food produced locally in Singapore is drastically smaller than the previous examples, making it a curious example as a beacon for urban agriculture. While it is true that compared to many other cities, Singapore produces a relatively small amount of agricultural products locally,
however, they have developed innovative solutions for adopting urban agriculture within the concrete city. Indeed, Singapore has developed and implemented vertical farms in order to feed its residents.

Singapore has implemented several forms of small-scale gardening in order to increase food security, coupling technology to produce more with less land. The city state has developed various forms of rooftop gardens, vertical gardens, and even sky gardens to address food security. The sky garden is the product of a public-private partnership that has produced a low-carbon, water driven rotating vertical farm\(^\text{18}\). This system consists of a series of aluminium towers containing 38 tiers equipped with troughs for vegetables that rotates on a slow cycle, taking around 8 hours to complete each cycle. This allows the plants to receive ample sunlight, and the system uses the hydraulic power that moves to garden to water the plants as well, creating a closed system\(^\text{18}\). These towers which will be added to many multi-storey residential units can be harvested every 28 days, providing a safe and secure source of food for the city\(^\text{18}\).
The city has also explored other ways of locating farms in different parts of the city in order to cultivate a food resilient city. Some of these ideas include commercial rooftop farming in under-utilised spaces, such as under viaducts; floating ponds that allow the creation of fish farms in urban environments; and the floating farms that integrate farming with mix-use buildings. Another innovation includes an Aquaculture three-tier vertical recirculating aquaculture system that allows the project to grow pearl grouper, coral trout, and white shrimp indoors in multiple levels. These are unique innovations that consider space and resource inputs as limiting constraints, while optimizing nutritional outputs. These initiatives still need to be fully tested and developed to determine their viability at larger scales,
however, they are promising initiatives to ensure food security in a city-state with limited land availability and resources.

Figure 10. Concept image of Floating ponds in Singapore, as part of the vertical farming movement within the city. These farms can produce several types of consumable fish and seafood, while providing additional greenspace for other farming initiatives.²⁰

Los Angeles
Demographics

Los Angeles is a vibrant and dynamic city, with diverse and varied areas, communities, and neighbourhoods. The population of the Greater Los Angeles area is 18,700,000 with a density of 7,068 in a 1,668 m² area, which makes it the most densely populated area in the United States and one of the largest metropolitan agglomerations in the world. The area is also very ethnically diverse, with over 37% of the population being born from elsewhere. Indeed, within Los Angeles, over 140 countries are represented with over 224 languages spoken within the city. There are several large
ethnic areas, such as Koreatown, Thai Town, Little Ethiopia, and Little Tokyo, which represent some of the cultural aspects of Los Angeles. According to census data, there are only 28.7% of the population that are non-Hispanic white, which is a relatively low percentage.

California is a large state that encompasses several climatic zones, depending on specific location. In general, California has a Mediterranean climate in parts and large climatic variations, across the state. There is a large variation among the coastal areas, inland zones, deserts, higher elevations, and mountains which makes the state challenging when determining a state-wide climate policy, rendering municipal or local knowledge a key aspect of climate and social policy. In terms of heat, from a health perspective, some of the concerns relate to the fact that California is among a few states with higher rates of long-term temperature increases in the summer, with a great deal of variation among coastal to inland areas. For example, according to Taha, the 2011-2014 average maximum temperature departure from the 20th century average was 1.1-2.2°C. There is also the concern that extreme heat events may become more common, and last for longer amounts of time. Indeed, during the California July 2006 heat wave, there were 16,166 emergency department visits and in increase of 9% mortality for every 5.5°C increase in apparent temperature. These emergency visits and mortality events disproportionately occur to more vulnerable members of the population, including children, seniors, and those who are residentially challenged. These are also the members of the
community who are least likely able to pay for medical bills related to heat stress or exhaustion, exacerbating an already precarious situation. These challenges affect the entire population, given that food affordability and access are directly related to a person’s health.

Green Space within Los Angeles

Los Angeles is arguably one of the most built up, automobile reliant cities in America, and there is a distinct lack of green space within the city (see Figure 11). There is little in the way of large community parks in the city, and access to green space is a luxury afforded to those who live in higher income areas. There is an equity issue within Los Angeles, in terms of income, access to food, and access to green space. Indeed, the luxury effect shows that urban plan biodiversity generally increased with residential income\(^2\). These disparities are a complex issue, with few catch all solutions, regardless of the governmental and organizational support. However, creating space for urban farms and agricultural land within the city limits, particularly in low-income areas, can help create a more engaged and involved community that has access to food and green space. This will not fix all the problems that are inherent in a large, well-developed city like Los Angeles, but it can lessen some of the accessibility and food security issues.
Given the space requirements within much of Los Angeles, community gardens are one strong option to implement urban agriculture within the city. Community gardens are important sources of preserving urban biodiversity, food provisioning in the form of edible crops, aesthetics, and other ecosystem services, such as aiding pollinators, pollution reduction, and mitigation of the urban heat island effect. While frequently considered as a temporary land use, community gardens have often been relocated or demolished entirely. In Los Angeles, a 14-acre farm was demolished to make way for a private development, showing that higher-value development often trumps what is considered to be temporary uses. However, this view is changing as there has been a global interest in urban food production and recent efforts to make community gardens a permanent part of the city. This comes with the realization that food security and climate change are the
responsibility of lower levels of government and individuals alike. Communities can function together better to meet common goals and outcomes than federal commands and decrees. Given the political independence and agency of large cities, Los Angeles included, these cities need to serve as examples of good policy adoption and climate change adaption measures.

Downtown Los Angeles

Los Angeles often has the reputation of being a concrete jungle, with development on development. This is not entirely inaccurate. A site visit showed that green space, particularly in the downtown core, is hard to come by and often coupled with municipal and official building complexes. The downtown area is 5.84 m$^2$ (15.12km$^2$) in area and is bordered by several freeways. The downtown area has a high percentage of residents who are foreign born (41.9%) with Mexico and Korea as the main foreign nations of ancestry.

The downtown area, (figure 12) is the poorest in Los Angeles, with a median income of $15,003 per year, with an area population of 34,811. This area has a daytime population of 207,440 due to the economic generators within the area as the downtown core is the central business district. Big employers include the Los Angeles City Hall, the Los Angeles Convention Center, and multiple museums and entertainment facilities.
Figure 12. The downtown district of Los Angeles and surrounding area. Shows the location of the central business district in relation to the city. Image source.

There is a distinct lack of green space within the downtown Los Angeles area. The satellite image, below, shows the central business area, and several of the districts within the downtown area. This includes Skid Row, largely considered the most notorious Los Angeles slum.
Policy Suggestions/Implementation

There are multiple measures that can be implemented to address food security and access to green space within downtown Los Angeles. As the population of all cities grow due to population increases and immigration, it is important to address these issues in policy initiatives as soon as possible in order to begin these programs.

Objectives

- Create affordable spaces for residents to participate in small-scale food production.
- Ensure that development considers both future residents and the community.
- Increase agency in food production processes, particularly for vulnerable populations.
• Generate financial contributions for the creation and maintenance of community gardens, increased green spaces, and other climate change mitigation measures.
• Reduce food insecurity at a city-wide scale, using under used space and unique technologies.
• Generate increased local incomes and economies by hiring local community members to operate agricultural lands and sales.

**Policy Suggestions**
• Adopt a development cost charge on new development in order to pay for adding green spaces within the city. These spaces can be added to existing parks, along the river, rooftops, or in the new development proposals. This measure creates the funds necessary in order to create gardens and finance the tools and equipment as necessary.
• Require all new residential development and certain types of commercial development to have rooftop or vertical garden infrastructure. This ensures that new housing addresses the issues of food security, and utilizes otherwise underused spaces.
• Partner with local organizations in order to facilitate knowledge and learning regarding gardening practices and food production. One challenge in adopting urban agriculture is that of the actual knowledge of food production, which is often so far removed from urban life that many citizens have no knowledge of soils, seeds, or production. Addressing this issue with partner organizations can help bridge the gap between consumer and producer.
• Partner with international organizations to mimic and adopt new technologies used in other regions. For instance, adding orgonoponics on rooftops of buildings in downtown Los Angeles can create functional, food producing space on otherwise unused areas.
• Create employment opportunities for the vulnerable members of the population by teaching basic gardening skills. Employment opportunities can come from tending the agricultural areas, from
processing fruits and vegetables into preserves, or in sales at farmers markets. This allows un or underemployed residents the opportunity to earn an income and increase their food security, while also learning a new skill.

- Create green spaces along the sidewalks and along alleyways. This can be done through the sky gardens, like in Singapore, or with edible landscaping. These measures can help ensure equitable access to small amounts of food, while increasing shade production and climate change mitigation efforts.
- Encourage schools have community gardens and basic agricultural classes and practice. This will teach children about the importance of food security, while also ensuring the next generation has the basic skills and knowledge in order to create and maintain their own gardens, or aid in community gardens.

**Site Specific Redesigns**
This redesign uses space that is being under utilized and creates areas for pocket agriculture. The trees can be edible landscaping, such as fruit.
trees that produce apples or berries. The planters can hold root vegetables, or leafy greens. These can be tended to and maintained by vulnerable members of the community and produce collected can be used for local soup kitchens, for profit in farmers markets, or for local restaurants. The site is located a few blocks from the LA City Hall at 2nd Ave and San Pedro Road, in downtown Los Angeles (34°2’58”N 118°14’31”W). Both images by author, 2018.
This redesign adds functional gardens to an unused residential space. This redesign adds an area for residents to have their own plots, while adding a
great deal of potential agricultural producing area. The area can hold various
types of produce, and the trees can be converted to edible landscaping
adding to the productivity of the area, while also creating detritus that can
add to the nutrients in the soil, ensuring continued crops. Adding greenery
along the road creates a barrier between the road and pedestrians, which
increases safety, but also creates a buffer between automobile exhaust and
the consumable products. Site is located at 3rd Ave and San Pedro in
downtown Los Angeles. (34°2’51”N 118°14’34”W) Both images by author,
2018.

Conclusions

Developing and implementing policy that aims to increase local food
production, while also increasing a community’s resilience and access to
green space should be encouraged in cities of all sizes, but especially large,
metropolitan areas. Numerous studies have shown that urban agriculture can
play a key role in providing valuable food security and income generation
among urban households\textsuperscript{13}. The benefits are numerous with minimal
negative impacts, many of which can be reduced and minimized. Creating a
political environment that encourages resiliency and taking action against
food insecurity should be a priority for all municipalities and countries.
Indeed, the IPCC states that implementing specific strategies can partly or
greatly alleviate the climate change impacts on food security and food
production systems\textsuperscript{10}. Establishing urban food production policy will increase
access to local food; increase community resiliency and foster engagement;
and create a more equitable space. In addition, green space will be created
which, even in small amounts, can help combat the effects of urban heat islands and absorb carbon; provide shade and recreation spaces; and help create opportunities for education, learning, and employment.

References
2. Nature


