Madeline Manzagol
ENVS40: Critical Thinking
TA: Karly Miller
November 30, 2021

Rooftop Gardening: an Urban Transformation

Imagine walking through a city's downtown and seeing green rooftops on every major building you pass by. Strange idea, right? Well it's time to consider why this phenomenon is so abstract to the average human being. The practice of gardening atop building roofs known as rooftop gardening is a concept that isn't widely practiced in many parts of the world, but transforming urban architecture to include rooftop gardening can provide urban centers with a plethora of public, private, and intrinsic benefits that positively impact the people and animals living in the community, as well as the environment in regards to climate change. Many individuals, companies, and communities have now recognized that we are in an era characterized by an anthropogenic climate crisis, and it has become clear that transformative change is needed. Rooftop gardening can help mitigate some of the environmental impacts imposed by human activity. In an effort to help repair the earth, choosing to incorporate rooftop gardening into city planning and renovation drastically increases a city's sustainability, fosters a healthier relationship between urban centers and nature, and boosts community well-being.

There are a variety of public benefits that rooftop gardens bring to urban life. One of the most visible benefits is transforming industrial settings into green environments, adding color to the typical gray and black city setting, and creating "community gardens, commercial space, recreational space" (Green Roofs for Healthy Cities). This transformation offers public benefits such as co-ops, display and restaurant terraces, and children's playgrounds. (Green Roofs for Healthy Cities). A second public benefit is waste diversion. For example, rooftop gardens often use recycled waste as substrates for plants, as well as using nontraditional water sources for irrigation such as A/C condensate (Sisco). By combining these factors, rooftop gardening contributes to slowing landfill accretion, which can help cities reduce their waste production (Sisco). Stormwater management is another public benefit that rooftop gardens offer because "green roofs help reduce stormwater runoff and slows the water flow to storm drains and can reduce road flooding" (Timberline Landscaping). Rooftop gardens retain rainwater within the substrate and roots, and then slowly release it, which "can mitigate the intensity of storm runoff" (Sisco). Rooftop gardens also mitigate the urban heat island effect, a phenomenon where cities experience higher internal temperatures than the rural or suburban areas surrounding them because they have higher concentrations of concrete or darker colored surfaces (e.g. roofs, roads, bridges) that absorb more sunlight and, in turn, keeps the cities warmer than their surrounding areas. Cities that lack greenery often suffer from "a decrease in evapotranspiration" and manage to compound the urban heat island effect because many of the construction materials used have "thermal properties" that retain larger amounts of heat (Sisco). Rooftop gardens combat this phenomenon directly as "more plant material in cities can help reduce temperatures and the urban heat island effect" due to the fact that "the sun heats concrete and asphalt faster than plants and trees" (Timberline Landscaping). A fourth public benefit offered by rooftop gardens is improved air quality when the gardens trap airborne pollutants, collect atmospheric deposition, and percolate noxious gases (Green Roofs for Healthy Cities). In addition to the plants' ability to filter and trap pollutants, their ability to manage city heat indirectly reduces demand on power plants, which in turn decreases the amount of CO_2 and other harmful pollutants released into the

atmosphere (Green Roofs for Healthy Cities). Rooftop gardens "act as filters to particles, alleviating the problems of poor air quality" (Wong). Rooftop gardens can also create local jobs as "the growth of green roof markets gives new job opportunities related to manufacturing, plant growth, design, installation, and maintenance" (Green Roofs for Healthy Cities). This creates a whole new market for a variety of local community members with different skills and interests. Considering the comprehensive list above, it is clear that rooftop gardens benefit the public in an array of different ways.

In addition to public benefits, rooftop gardening offers a host of private benefits. Private benefits are benefits that positively affect the owners of the buildings on which rooftop gardens are placed. One of the biggest private benefits that rooftop gardening offers is increased energy efficiency. Rooftop gardens work to increase energy efficiency because "the greater insulation offered by green roofs can reduce the amount of energy needed to moderate the temperature of a building" (Green Roofs for Healthy Cities). Since the majority of heat is lost in the winter and accumulated in the summer through rooftops, installing rooftop gardens can directly combat this issue by using plants to absorb heat, increase evapotranspiration, and roof albedo, which act to store heat in the winter and mitigate heat in the summer (Sisco). According to research conducted by the National Research Council of Canada, "an extensive green roof reduced the daily energy demand for air conditioning in the summer by 75%" (Green Roofs for Healthy Cities). A second private benefit rooftop gardening presents is prolonged roof lifespan. Maintenance and repair costs are greatly reduced due to the longevity of rooftop gardens and the protection they provide to the structural integrity of the actual roof. Since the "additional layers of substrates and vegetation act as protection for the roof membrane," buildings with rooftop gardens can "outlive a conventional roof at a minimum of threefold" (Wong). Rooftop gardens also minimize the exposure of "waterproofing membranes to large temperature fluctuations . . . and ultraviolet radiation" that cause small damage to the integrity of the roof over time (Green Roofs for Healthy Cities). Although rooftop gardens often have a high initial cost, if one looks at their lifecycle analysis, they will find that they "are less expensive than tiled roofs in the long run because they last longer" (Wong). A third private benefit is marketing that ties to the public benefit of green spaces, as a lush green space is much more aesthetically pleasing and attractive to spend time in as opposed to the alternative generic gray, bland roofing commonly seen in cities. Rooftop gardens offer a unique look that often attracts buyers, renters, or other kinds of consumers the building intends to attract. Rooftop gardens can act as symbols for the green building movement, a movement that encourages practices that create more environmentally friendly and sustainable buildings. As a result, green roofs have facilitated "sales, lease-outs, increased property value due to increased efficiency, easier employee recruiting, [and] lower employee and tenant turnover" (Green Roofs for Healthy Cities). All in all, rooftop gardens offer many incentivising private benefits that largely support the building's integrity and outward appearance, both of which indirectly help make the building owners' investment in rooftop gardens worthwhile.

A third category of benefits that rooftop gardening has to offer are intrinsic benefits. Intrinsic benefits are benefits that are inherently part of the nature of rooftop gardens; therefore, these benefits will be provided simply from the existence of rooftop gardens in a particular area. One of the largest intrinsic benefits rooftop gardens have to offer is increased biodiversity. Biodiversity can be defined as the variety or diversity of life inhabiting a particular area. Rooftop

gardens provide the opportunity for cities to sustain a larger variety of plants and animals, which in turn introduces species that would have alternatively lived “fragmented” from each other (Orsini). The act of increasing biodiversity via rooftop gardening can produce multiple benefits in three main realms: ecosystem, economic, and social (Orsini). Increased biodiversity can produce “diverse ecosystems” that are more equipped to “maintain high levels of productivity during periods of environmental variation” compared to ecosystems with fewer species (Orsini). This is largely important for the structure of life and success of a working ecosystem, in the case of rooftop gardening: the city ecosystem. In terms of economics, increased biodiversity via rooftop gardens can help “ensure the delivery of ecological goods and services” as the rooftop gardens help secure stable ecosystems that are able to facilitate hydraulic and nutrient cycling as well as the production of cleaner air and water (Orsini). Ensuring the stability of ecosystems is greatly important to the functioning of cities as cities largely benefit economically from the ecological goods and services provided by increased biodiversity via rooftop gardening. Lastly, increased biodiversity aids in the social realm as “visual and environmental diversity can have positive impacts on community and psychological well-being” (Orsini). The implementation of rooftop gardens directly provides communities with these added benefits as having access allows communities to experience them. Similar to the social benefits from increased biodiversity, improved health and well-being is another benefit rooftop gardens intrinsically supply. Rooftop gardens themselves can become places where communities can congregate. In this sense, they can increase “social cohesion, sense of community, and public safety” (Green Roofs for Healthy Cities). These three aspects can work together to create a more supportive community, where mental health and well-being within the community is bolstered. The community space allows for socialization and the natural environment with vegetation helping “relieve anxiety and negative effects of stress” (Timberline Landscaping). As a result, rooftop gardens help create a happier and healthier community. The last intrinsic benefit that rooftop gardens offer, and perhaps the largest, is urban agriculture. Urban agriculture largely benefits the community as “residents can obtain cheap and environmentally friendly products that can boost the food security of urban areas" (Sanyé-Mengual). Urban agriculture via rooftop gardens is arguably one of the most important humanitarian and environmental benefits rooftop gardening has to offer as it combats food security within communities as well as slashes greenhouse gas emissions that are released due to outsourcing food production. As a result, rooftop gardens can “reduce a community’s [carbon] footprint . . . give increased feelings of self-reliance, and improve levels of nutrition” (Green Roofs for Healthy Cities). All in all, rooftop gardens have plenty of intrinsic benefits that largely support the communities who implement them in ways that cannot be matched by other forms of food production or rooftop architecture.

After learning about all the benefits rooftop gardening has to offer, it can be quite perplexing to ask why rooftop gardens aren’t implemented on a wider scale. After researching further, I found that there are a few primary barriers that have limited the construction of rooftop gardens. The first barrier that stands in the way is lack of education; people simply do not know enough about the holistic picture of rooftop gardening to be able to successfully support the transition to green city roofs. Not enough people fully understand the lifecycle analysis of rooftop gardening to be able to accurately interpret the benefits or, worse, don’t have accurate information about the topic as a whole. As a result, many people have misconceptions about rooftop gardens and are turned away from the idea. Another huge barrier that turns people away

from rooftop gardening is the high initial cost. Unfortunately, the upfront cost of rooftop gardens can be significantly higher than the upfront cost of tiled roofing. In most cases "the structural cost of roof deck with roof garden is approximately 50% more than that of a roof deck without a roof garden" and, as a response, most "developers are unwilling to include plantings on rooftops" (Wong). However, if developers were to actually analyze the full lifecycle costs of rooftop gardening compared to normal roofing, they would find in most cases that although rooftop gardening is initially "three to six times the cost of a typical roofing system, in the long term, green roofs may be less expensive and outperform conventional roofing" (Wong). In response to this statistic, many developers may be turned away from conventional rooftops and be more inclined to invest in rooftop gardening. The final barrier that limits the implementation of rooftop gardening is building security. A lot of the time, city planners and developers who are interested in incorporating rooftop gardens into their cities or buildings often find that the buildings they wish to have rooftop gardening cannot support the weight of the gardens themselves. Specifically looking at Denver, Colorado, three separate engineering evaluations "revealed that 85 to 90 percent of large buildings would have to be exempt" from rooftop gardens as "their structures weren't capable of handling the additional weight" (Kiger). This is also the case in many other cities where many buildings were designed without considering the possibility of incorporating rooftop gardens into their design. Sadly, a lack of education, high initial costs, and insecure building plans are the primary reasons why rooftop gardens aren't yet a popular form of architecture.

To combat these limitations, there are a few different pathways that can be taken to help promote rooftop gardening and its benefits, as well as addressing the misconceptions. The first solution that would help garner support and debunk fallacies would be to encourage positive discourse regarding rooftop gardens. By changing the public opinion on the topic through developing more educated and positive conversations about rooftop gardens, there is likely to be a boost in support of rooftop gardens as local people will want to experience the added benefits. With enough positive discourse, there will hopefully be a call to action and, in response, cities would be supported by their citizens in the construction of rooftop gardens. A second way to combat the suppression of rooftop gardens would be to offer more easily accessible education on the topic. Rooftop gardens are very much a hidden solution to humanitarian and environmental crises in the sense that they are often not included in primary or higher education and are not well covered in the news. This is likely because its support is largely "underground." If more information about rooftop gardens is made publicly available, or even promoted in public spaces, it's likely the rooftop gardening movement would become increasingly supported by people of many different socioeconomic backgrounds as rooftop gardens benefit communities as a whole. The third most important way to promote rooftop gardens is by pushing more institutions to include rooftop gardening as part of their solution to becoming more environmentally friendly and sustainable. By creating pressure to act upon sustainability, many institutions would likely be more open to the idea of rooftop gardens. This kind of pressure would be fostered through peaceful protests, letters addressed to developers and municipal administrators regarding sustainability and the benefits of rooftop gardening, organizing supportive groups, and many other alternatives. Moreover, if larger institutions are aware of the public support for a movement or transition, like rooftop gardening, it is more likely that representatives will be willing to make this transition happen as the people they represent are requesting it. By combining the impacts of positive discourse, more accessible education, and pressure for change, the conversation about

rooftop gardens is able to change into one that corrects misconceptions and gathers support for the transition. This in turn, will help create the solutions to the existing problems with rooftop gardening as well as assist in the implementation process.

Considering that rooftop gardening is a local solution that benefits those living within the community that sponsor rooftop gardens, I decided to look specifically into what it would take to create rooftop gardens on the UCSB campus—our local community. To begin my research, I needed to determine if rooftop gardens were something that UCSB would even entertain. The first step was determining if UCSB had flat roofing and how much of it was available. To do this, I went to Google maps and looked at an aerial view of the campus to determine which roofs, if possible to see, were flat. It was somewhat difficult to determine which roofs were flat and which were slanted, so I went back online to research floor plans for the buildings and lecture halls on campus. Unfortunately, I did not have much luck with this path as many of the floor plans that I found did not include or mention rooftop design. As an alternative to floor plans, I decided to walk around campus and fact check what I found on Google maps. What I found was that there are definitely spaces on campus that could potentially support rooftop gardening. After identifying viable roof spaces for rooftop gardening, the next steps of the implementation process were out of my own personal control; however, I brainstormed what steps would be necessary to see rooftop gardening being implemented on campus. After considering the spaces available for rooftop gardening, I would contact the office of Design, Facilities, and Safety Services. Getting a hold of the right personnel would likely increase the chances of UCSB actually looking into what could be a school-wide project. After addressing the benefits of rooftop gardening to the proper university staff, a building assessment would be necessary. Assessing the integrity of the buildings that have flat roofs is a vital step in the installation process of rooftop gardens. Confirming that the target buildings have the capacity and correct structure to withstand the weight of rooftop gardening is absolutely necessary for the safety of the community and success of the gardens. The next steps of this process would be the construction and installation of the actual rooftop gardens, and the further organization for those who would be in charge of growing and distributing the produce. I would be curious to see where the produce goes and who consumes it. I think that it would be really exciting to see the dining commons use the food grown from the potential rooftop gardens so that the UCSB students can benefit from the organic and locally grown produce.

Circling back to the main picture, rooftop gardening has a lot to offer and can be part of the solution to many humanitarian and environmental problems cities today are experiencing. As cities become increasingly populated and urban settings strain the demand for resources, it makes sense for food production to be sourced from local areas and offer communities healthier and fresher produce while limiting the emissions from processing and transportation. Rooftop gardening can help combat food insecurity while providing urban communities with additional benefits that increase their livelihood. In an effort to take a more environmentally friendly path, developers who incorporate rooftop gardening into city planning and renovation can significantly increase a city's sustainability, develop a friendlier relationship between urban centers and nature, and advance community well-being. Looking specifically at UCSB, it would be an intriguing experiment to see how rooftop gardening would impact the students and staff and could potentially change the diet culture at the university, as well as how the additional benefits associated with rooftop gardening would impact the community.

Bibliography

"About Green Roofs." *Green Roofs for Healthy Cities*, Green Roofs for Healthy Cities - North America Inc., 1999, https://greenroofs.org/about-green-roofs. Accessed 30 Nov. 2021.

Kiger, Patrick J. "Why Don't More Cities Require Green Roofs?" *HowStuffWorks Science*, HowStuffWorks, 3 Apr. 2021, https://science.howstuffworks.com/environmental/green-tech/sustainable/why-dont-more-cities-require-green-roofs.htm. Accessed 30 Nov. 2021.

Orsini, Francesco, et al. "Exploring the Production Capacity of Rooftop Gardens (RTGs) in Urban Agriculture: The Potential Impact on Food and Nutrition Security, Biodiversity and Other Ecosystem Services in the City of Bologna." *Food Security*, vol. 6, no. 6, Springer Netherlands, 2014, pp. 781–92, https://doi.org/10.1007/s12571-014-0389-6. Accessed 30 Nov. 2021.

Sanyé-Mengual, Esther, et al. "Techniques and Crops for Efficient Rooftop Gardens in Bologna, Italy." *Agronomy for Sustainable Development*, vol. 35, no. 4, Springer Paris, 2015, pp. 1477–88, https://doi.org/10.1007/s13593-015-0331-0. Accessed 30 Nov. 2021.

Sisco, Laura, et al. "Roof Top Gardens as a Means to Use Recycled Waste and A/C Condensate and Reduce Temperature Variation in Buildings." *Building and Environment*, vol. 117, Elsevier Ltd, 2017, pp. 127–34, https://doi.org/10.1016/j.buildenv.2017.02.025. Accessed 30 Nov. 2021.

"The Benefits of Green Roofs and Rooftop Gardens." *Timberline Landscaping*, Timberline Landscaping , 24 Aug. 2021, https://www.timberlinelandscaping.com/the-benefits-of-green-roofs-and-rooftop-gardens/. Accessed 30 Nov. 2021.

Wong, Nyuk Hien, et al. "Life Cycle Cost Analysis of Rooftop Gardens in Singapore." *Building and Environment*, vol. 38, no. 3, Elsevier Ltd, 2003, pp. 499–509, https://doi.org/10.1016/S0360-1323(02)00131-2. Accessed 30 Nov. 2021.