

Addressing Food Deserts Through Re-localized Agriculture: Four Design Typologies with Community Engagement for Urban Food System Expansion on Available Municipal Land

COURTNEY CROSSON

University of Arizona

Keywords: urban food systems, water harvesting, food deserts

Tucson, Arizona has been a historic passageway and home to a rich overlay of settlement patterns for over 4,000 years. Currently, 13.6% of current Tucson residents live in food deserts, areas that are low-income and have restricted access to healthy and affordable foods. Despite its agricultural history, recent efforts to relocalize urban food production to meet these local nutritional needs face stern criticism that the city is already water-stressed and cannot afford the irrigation required for food growth. This project investigated the capacity for Tucson to expand its urban food system to meet food desert nutritional demands using only sustainable water supplies on vacant municipal land. Four typologies on identified land owned by community partners were tested through design inquiry and corresponding water and food production calculations. The paper concludes that if these design typologies were implemented across the 711 acres of available municipal land in current food desert areas, over 100% of the nutritional needs of these food desert areas would be met (Tong et al. 2020).

INTRODUCTION

In 2000, archaeologists discovered layers of irrigation trenches below the ground of the Tucson, Arizona, distinguishing it as the longest continuously farmed landscape in North America. Tucson, Arizona has been a historic passageway and home to a rich overlay of settlement patterns for over 4,000 years (Mabry 2008). Currently, 13.6% of current Tucson residents live in food deserts, areas that are low-income and have restricted access to healthy and affordable foods. Despite its agricultural history, recent efforts to relocalize urban food production to meet these local nutritional needs face stern criticism that the city is already water-stressed and cannot afford the irrigation required for food growth.

This research investigated the feasibility of expanding the urban food system of Tucson on available municipal land using only sustainable water supplies: passive rainwater harvesting, active rainwater harvesting, and reclaimed water. Working with community partner organizations on city or county

owned parcels, four typologies were developed to relocalize food production in food desert areas across the city: river adjacent, urban alley, community garden, and indoor controlled agriculture. The capacity to grow food across these typologies with sustainable water supplies was tested through designs for these parcels in an upper-level design studio course. Through the design process, community assets and needs were assessed for multi-benefit solutions through a series of engagement activities with food cultivators, distributors, and the neighbors surrounding the site.

This paper starts with a literature review of studies on previous attempts to address food deserts, the current success of community garden approaches, and integrated sustainable water practices such as passive and active rainwater harvesting and reclaimed water. Then the method for the research is outlined. Results are presented for four typological designs with their associated water harvesting and food production capacities the community engagement conducted to reach these design outcomes. Building on previously published research by the author with co-authors, the paper concludes that if these design typologies were implemented across the 711 acres of available municipal land in current food desert areas, over 100% of the nutritional needs of these food desert areas would be met (Tong et al. 2020). The work culminated in an outdoor exhibition in a large historic garden in Tucson open to the public to disseminate the research, stimulate conversation, and offer a platform to gather community support around the relocalization of urban food systems. The community garden typology designed as part of this research is currently being constructed by the county and the local community food bank.

LITERATURE REVIEW

Previous Interventions to Address Urban Food Deserts

Prior attempts to address the food desert issue of limited access to healthy and affordable foods have focused on introducing food retailers (e.g. super markets, large grocery stores) to low-income areas. Studies of these attempts have shown a failure of the introduction of these stores to result in nutritional changes. For example, food desert residents in Philadelphia (Cummins 2014), New York (Elbel et al. 2015), and Pittsburgh

(Dubowitz et al. 2015) reported no dietary change after the new supermarket introduction. Based on an analysis of 1,914 supermarkets opened from 2004 to 2015, Allcott et al. (2017) showed that supermarket entry had no or little effect on the healthy eating of food desert residents. All these findings suggest that healthy food access in food deserts goes beyond the availability of healthy food retailers; other barriers including poverty, education and nutritional knowledge play an important role (Allcott et al. 2017).

Alternative interventions to combating food deserts are growing. One strategy has been the expansion of the urban food system, particularly in low-income food desert areas. Benefits of urban agriculture have been broadly identified, ranging from healthy food access, aesthetics, community building to physical and mental health (Hynes and Howe 2004). Community gardeners are found less food insecure and tend to consume more fruits and vegetables (Carney et al. 2012; Barnidge et al. 2013). This is particularly true for food desert residents (Corrigan 2011).

Urban Food System Expansion and Sustainable Water Supplies

Research on the expansion of the urban food system have largely focused on issues surrounding the availability of land for urban agriculture. Limited research has addressed water scarcity issues in urban areas with high water stress. As urban water stress continues to be a growing issue globally, pursuing the relocation of food in urban areas will require a sustainable water strategy. This is especially critical for regions with restricted water access, such as the Southwest United States where a more arid climate and higher risk of water shortages are expected in the coming century (Seager et al. 2007). Potential sustainable water sources include passive rainwater harvesting, active rainwater harvesting, and reclaimed water.

Rainwater harvesting (RWH) includes the use of passive and active systems. Passive systems are designed to retain water until it can be naturally absorbed into the land (swales and pervious pavers are common passive strategies). Active systems, by comparison, collect, clean, and store rainwater for use (tanks and cisterns are prevalent elements of active harvesting). Active and passive RWH systems have been increasingly implemented in areas that face growing water constraints under climatic, environmental, and social changes (Amos et al. 2016). Lupia et al. (2017) conducted a RWH study in Rome and found that about 19% and 33% of the existing food production gardens could achieve water self-sufficiency for the low and high irrigation efficiency scenarios, respectively. Meanwhile, some areas such as the Southern U.S. and Mediterranean countries have started to use reclaimed/recycled urban wastewater to irrigate agricultural crops (Pedrero et al 2010). In the U.S., Florida and California are among the largest producer and users of reclaimed wastewater (Parsons 2018). It is highlighted that harvested rainwater and reclaimed water can provide a

sustainable, ecologically responsible, water supply for increasing food production and nutritional access.

Study Area: Tucson, Arizona

Tucson, Arizona has been a historic passageway and home to a rich overlay of settlement patterns for over 4,000 years. In 2000, archaeologists discovered layers of irrigation trenches in the region, distinguishing the area of the Southwest as the longest continuously farmed landscape in North America (Mabry 2008). However, persistent drought and increased urbanization challenge the food production history in this region.

Tucson faces two pressing and seemingly opposed challenges: (1) a projected shortage in local potable water supplies in the coming decades and (2) food access challenges for low-income areas, or food deserts. Tucson currently imports over a third of its water from the Colorado River 336 miles away, an uncertain and dwindling supply due to climate change and oversubscription.

Passive rainwater harvesting, active rainwater harvesting, and reclaimed water are available sustainable water sources for Tucson. Rainwater has drawn increasing attention as a possible solution to Tucson's water and food access deficits as, in sheer volume, annual precipitation would more than account for all of Tucson's annual water need. However, rainwater is a resource that must be gathered in decentralized interventions, rather than one large public works construction. Passive and active rainwater harvesting in Tucson occur at the architectural scale of sites, rooftops, and runoff surfaces.

Reclaimed water is another option for providing the water needed to expand Tucson's urban food system. Tucson began constructing its reclaimed water network in 1984. The current reclaimed water pipeline system connects the city's three largest irrigation land uses: golf courses, cemeteries, and parks (including university campuses). Annually, Tucson has approximately 1-3 billion gallons of unsubscribed reclaimed water available (Tucson Water 2015). As for food crop irrigation, the Arizona Department of Environmental Quality (ADEQ) regulates that reclaimed water irrigation must not come into direct contact with the food product (Arizona Administrative Code 2016). We obtained the reclaimed water network from Tucson Water (Tucson Water 2018) and for each candidate food production site evaluated the possibility of reclaimed water access based on a threshold of 200 feet, the maximum distance at which Tucson Water will connect parcels to the existing network (Tucson Water 2018).

Tucson is currently experiencing widening areas of food deserts (Bao and Tong 2017). Feeding America, one of the nation's leading hunger relief charities, reported that in 2017 13.6% of

people in Pima County (Tucson Metropolitan Area) are estimated as food insecure compared to the national average of 12.5% (Feeding America 2016). The area may be at a historical low in food production while facing its greatest disparity in food access. Along with many cities in the region, Tucson is confronted with a challenge: how to devise a cost effective, equitable and sustainable water supply while addressing healthy food access for a growing population?

METHOD

To answer this question, this research investigated the feasibility of expanding the urban food system of Tucson on available municipal land using only sustainable water supplies. The design investigation was completed in an upper-level Bachelors of Architecture studio course with eight students and led by one professor (the author). Students used spatial mapping, quantitative analysis, design inquiry, and community engagement interviews and surveys to complete designs for the expansion of the urban food system. The studio course was sponsored by the GLHN Architects and Engineers, a regional firm dedicated to furthering sustainability in the built environment.

Community partnerships

Ahead of the semester, the professor worked with municipal officials and local food activists to identify four community partners operating on municipal land. A set of four typological conditions were identified and four corresponding sites with community partners were located: river adjacent (Mission Garden), urban alley (Las Artes), community garden (Community Food Bank of Southern Arizona and Pima County Flood Control), and indoor controlled agriculture (Merchant's

Garden). The capacity to grow food across these typologies with sustainable water supplies was tested through the physical attributes of the student designs. Each of these community organizations provided documentation of the site, an initial tour for students, a set of 2-3 interviews with various stakeholders during the semester, and participated in the midterm and final reviews of the projects.

Through the design process, community assets and needs were assessed for multi-benefit solutions through a series of engagement activities with food cultivators, distributors, and the neighbors surrounding the site. This paper presents the four typological designs, their associated water harvesting and food production capacities, and the community engagement conducted to reach these design outcomes.

Prior Research and Water Calculation Methods

Prior research by the author and a team of physical geography researchers underpinned the studio work. The prior research used remote sensing (LiDAR and orthophoto) and geographical information systems to map the potential for passive rainwater harvesting, active rainwater harvesting, and reclaimed water access for available municipal land in Tucson (see Tong et al., 2020). In the previous study, rooftops were assumed as the infrastructure for active rainwater collection. LiDAR data with a resolution of 1 foot were first collected from Pima Association of Governments to extract rooftops. Rainwater that could be harvested from a rooftop was estimated based on the size and type of the roof. Remote sensing data were also obtained from Pima Association of Governments to identify impervious surface and bare land in the study area. For a candidate food

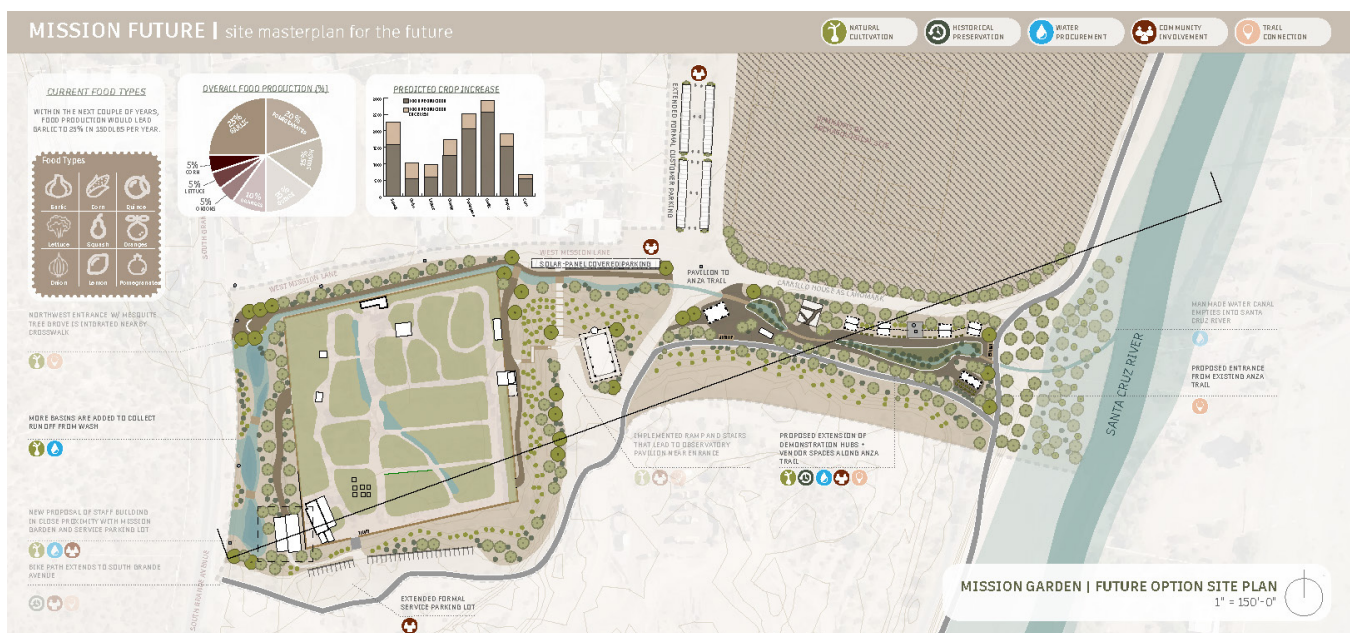


FIGURE 1: Master plan for Mission Garden (author: ARCH 410f Spring 2021 students Rico Lizama and Bo Su and author)



FIGURE 2: Water harvesting calculations for Mission Garden (author: ARCH 410f Spring 2021 students Rico Lizama and Bo Su and author)

production site, rainwater availability was estimated based on both active and passive rainwater collection: active rainwater was estimated using non-residential rooftops within 200 meters from the site, and passive rainwater was computed based on the ground level impervious surface within a catchment of 100 meters from the site. Daily rainfall information from 2007 to 2016 was obtained from National Oceanic and Atmospheric Administration (NOAA) to analyze the precipitation patterns in the region. This data is representative of the projected increase in multi-year drought for the region in the coming century. Tucson experiences two seasons of rain: short winter rains and long summer deluges during the North American Monsoon season.

Similarly, in this design studio, the same precipitation data was used. Active rainwater harvesting was assumed to occur on all rooftops within the site (unless they were historic). Passive rainwater harvesting was assumed to occur on major run-off/run-on areas. Since these passive and active rainwater harvesting collection areas were being modified through the design, student designers used their models to design and calculate surfaces for water collection with corresponding sized storage to span long period of dryness.

Design studio and exhibit

This work aimed to also serve as an engagement opportunity on local food system issues for the Tucson community. The work concluded in an end-of-the-semester exhibition in Mission Garden, an open-air historic garden in Tucson. The whole project aimed to engage three community groups: (1)

community members from four real food system expansion sites, (2) over 100 citizens from across Tucson through the exhibit, and (3) eight architecture students that will be the future professionals creating the integrated design solutions. At the exhibit, the four designs and corresponding typological ideas were communicated through a series of twenty boards strung up in the garden. Additionally, the exhibit included a community engagement station where exhibit visitors could 'plant' their hopes for the future of Tucson's food system through commenting on the main categories: community, water, land, nutrition, growth. The exhibit was open for a full morning and afternoon in December 2021.

RESULTS

River Adjacent: Mission Garden (Pima County owned land)

Mission Garden is sited at Tucson's birthplace located at the foot of Sentinel Peak, at the site of the Native American village of S-cuk Son, a place sacred to the Tohono O'odham. The Garden sits on land that is owned by Pima County. Mission Garden is a living agricultural museum of Sonoran Desert-adapted heritage fruit trees, traditional local heirloom crops, and edible native plants. The garden currently has a well-developed series of historic gardens, documenting each major period of Tucson's agricultural history. There is a large adobe wall that surrounds the garden and a visitor's center, education center, and outdoor kitchen currently exist.

The design of this project focused on the past, present, and future of the historic garden (FIGURE 1). Project goals included local vegetation, historic preservation, water procurement,

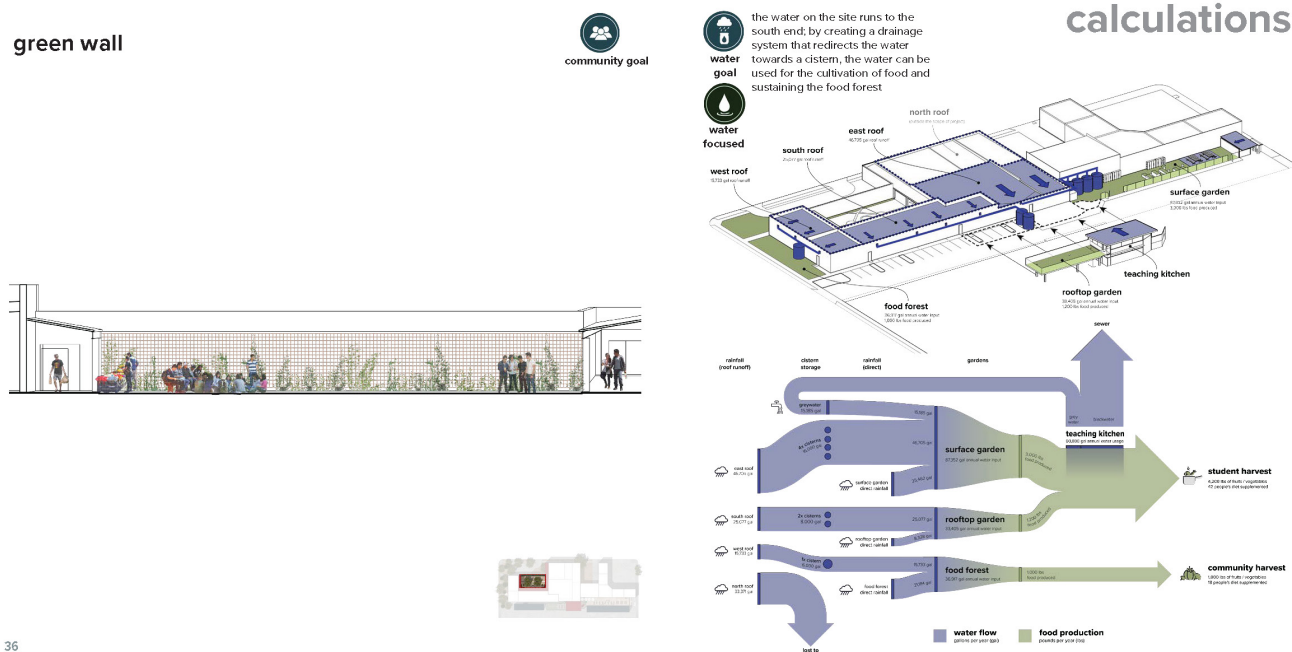


FIGURE 3: Design overlayed with calculations for water catchment and food production for Las Artes (author: ARCH 410f Spring 2021 students Anisa Hermosillo and Sam Owen and author)

community involvement, and connection to the river bike path adjacent to the garden. Students met with Mission Garden's outreach coordinator, Garden Supervisor, Curator, Board members, and Executive Director to receive input on what the garden and its visitors and volunteers needed. Students conducted a survey on one Saturday mid semester, to gather visitor feedback on the desired future for the garden. In response, the students designed a staff building that sat outside the historic walls and a master plan that tied together the garden with the surrounding neighborhood and river bike path. A series of growing sites for the community were developed as well as vendor sites to sell the produce. Passive and active rainwater harvesting were introduced throughout the garden, something which the garden currently does not use (FIGURE 2). All new garden spaces were irrigated solely through a mix of passive and active rainwater harvesting. Existing agriculture received a significant benefit from the new water collection designs. Ultimately, the garden hopes to use connection to a nearby reclaimed water line on appropriate produce.

Urban Alley: Las Artes (Pima County owned land)

Las Artes is a branch of Pima County under their employment, job training, and education programs offering a unique learning environment for 17-22 year olds. It provides structure classroom instruction combined with community art projects that allow students to prepare to General Education Development (GED) test and learn valuable job-readiness skills. Las Artes is

located in South Tucson, a low-income and under resourced area of the Tucson Area. It is on Pima County owned land.

Students interviewed Pima County and Las Artes staff including the Las Artes program manager, the Pima County "End Poverty Now" program manager, and Las Artes education coordinator. From these conversations and site observations, the student designers stated five goals: equity, water sustainability, community cohesion, education, and food production. The students transformed a wide alley behind the school that is currently used as overflow parking (FIGURE 3). Student designers preserved parking spaces while moving the spaces back to make room for a community garden, to provide students and local residents a place to grow food. A second roof top garden was created from a platform places over the other side of existing parking. This roof top garden was a secure space for only student gardeners. As a hinge point between the community garden and the student garden, a shed was transformed into a commercial teaching kitchen for students. This education space ensured job-readiness skills where students learned gardening techniques and then how to use that food in meals. Additionally, the landscape spaces surrounding the school were transformed into a food forest. The project used mainly active water harvesting, as the majority of the site was comprised of a large roof (FIGURE 3). The food forest and community gardens were fed from passive water harvesting when it rained.

los nopales | program + site plan

- site area (buildable) | 156522.96 sqft
1. agriculture field | 3500.58 sqft
 2. agriculture field | 6148.46 sqft
 3. agriculture field | 4824.84 sqft
 4. material drop off space | 10596.40 sqft
- closed pavilions
- a. library | 966.60 sqft
 - b. presentation room | 1179 sqft with 1776.8 sqft outdoor extension
- open-air pavilions
- d. craft space | 1230.51 sqft
 - e. outdoor kitchen | 2360.21 sqft
 - c. plant nursery | 1225.58 sqft
- composting toilets | 400 sqft
- natural playground | 1805.719 sqft
- water retention area | 8604.56 sqft
- packaging station | 120 sqft
- circulation | 26612.696 sqft
- parking | 5795.17 sqft
3 ada spaces near sidewalk
21 regular
4 loading to the far right
28 total
- wells | 5795.17 sqft

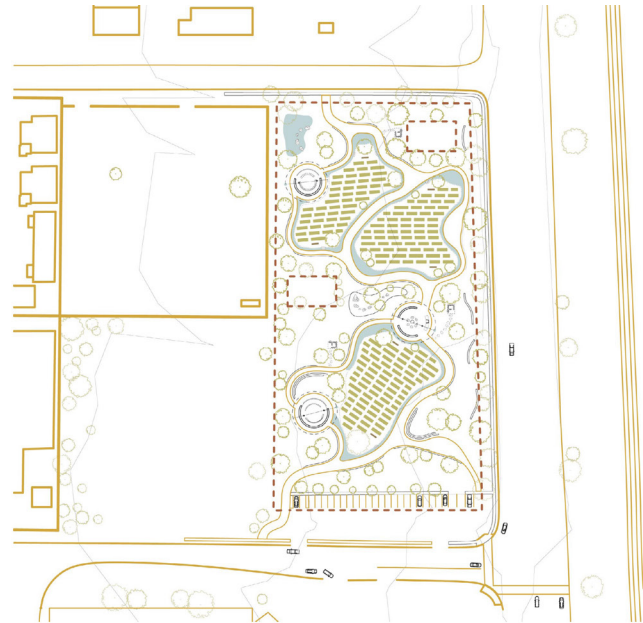
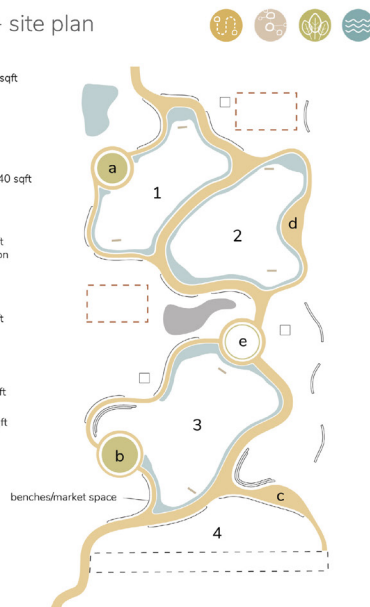


FIGURE 4: Master Plan of Los Nopales Garden (author: ARCH 410f Spring 2021 students Andrea Riehle and Mehli Romero and author)

Community Garden: Community Food Bank of Southern Arizona and Pima County Flood Control (Pima County owned land)

The Community Food Bank of Southern Arizona is a non-profit of over 120 employees and hundreds of volunteers that ensures the people of Southern Arizona have access to the food and programs they need. Although the main program of the food bank is distributing food to those in-need, they also have a robust community garden and rainwater harvesting training programs. They currently run several community gardens. Las Milpitas is their largest. The site would house a new large community garden and education space, comparable to the Las Milpitas existing garden.

Pima County Regional Flood Control District uses floodplain management practices to minimize flood and erosion damage. They use flood monitoring, flood control, and natural resource activities. The site for this garden is on land acquired by Pima County Flood Control District with the intent to give the land to the Community Food Bank of Southern Arizona to steward through a community garden. The site was the receiver of considerable runoff flooding from the Tucson airport, which is across Nogales Highway from the site, but the airport recently has invested in a large stormwater project as part of a construction project. The site soil was tested for contamination, and none was found. The site has been deemed appropriate for food cultivation.

Students met with the Outreach Director of the Community Food Bank of Southern Arizona and the Deputy Director of Pima

County Flood Control to receive feedback on the current conditions of the site and their visions for the site. Students then went to several neighborhood meetings with the surrounding community and conducted a survey to codify immediate community needs. With this input, student designers named the garden “Los Nopales” and outlined six goals for the project: a defined path to connect across the community, space for events, education, food production, rainwater harvesting, and sound mitigation from the adjacent Nogales Highway. Los Nopales Garden was designed with three major open-air but securable structures: a library, outdoor kitchen, and community meeting and presentation area. A playground for children was also provided. Plots for food cultivation were designed to absorb available passive water harvesting across the site through directional irrigation canals (FIGURE 4). Buildings were each equipped with active water harvesting and large underground storage tanks. The paths around the garden plots were designed with benches so that the garden could be easily transformed into a marketplace for the community to sell produce (FIGURE 5). The site is located in an area of town without an existing farmers market.

Indoor Controlled Agriculture: Merchant’s Garden (City of Tucson owned land)

Merchant’s Garden uses the science of aquaponics and hydroponics to grow greens for Tucson and surrounding residents. The current site is a series of controlled agriculture greenhouses. It also has a drive-thru where produce is sold everyday on limited hours in the afternoon. During Covid, the garden lost



FIGURE 5: Render of a farmer's market at Los Nopales Garden (author: ARCH 410f Spring 2021 students Andrea Riehle and Mehli Romero and author)

many of its restaurant customers and pivoted to this successful and growing method of sales. It is on a decommissioned Tucson Unified School District site. Merchant's Garden leases the land from the City of Tucson.

Students met with the co-owners of Merchant's Garden and the onsite staff that run the aquaponics and hydroponics. Students received the specifications for these systems, the business's recent water bills, and specifications for the swamp coolers that currently condition the garden and use a significant amount of water. Students crafted three goals for the project: water use reduction, expanded food production, and community outreach. The design included a second large greenhouse, duplicating the current growing capacity of the site. A community garden and grove with a space for weddings or events was also added. Finally, a parking lot, a drive-thru with a covered sales area, and a formal gateway to the garden were developed. Rainwater harvesting off the greenhouse roofs connected to a set of large cisterns was added. Passive water harvesting was included throughout the site masterplan.

CONCLUSION

Food deserts and urban water stress are two challenges facing many cities across the world. Architects and designers can offer solutions for addressing food deserts through the relocalization of food, engagement of communities, and the use of site-specific sustainable water supplies. This project proposed four typological solutions for Tucson working with community partners: river adjacent (Mission Garden), urban

alley (Las Artes), community garden (Community Food Bank of Southern Arizona and Pima County Flood Control), and indoor controlled agriculture (Merchant's Garden).

These four real projects serve as a hopeful template for the expansion of the urban food system. Ultimately, if these design typologies were implemented across the 711 acres of available municipal land in current food desert areas, over 100% of the nutritional needs of these food desert areas would be met (Tong et al. 2020). The work culminated in an outdoor exhibition of the designs and calculations in an historic garden in Tucson. Over 100 community members attended to learn about the potential for food system expansion through responsible water sources. Currently, Pima County Flood Control and the Community Food Bank of Southern Arizona are moving forward on the construction of the community garden in a food desert area designed as part of this project.

ENDNOTES

1. Allcott H., R. Diamond, J.-P. Dubé (2017) The Geography of Poverty and Nutrition: Food Deserts and Food Choices Across the United States. National Bureau of Economic Research.
2. Amos C.C., C., A. Rahman and J.M. Gathenya (2016). Economic analysis and feasibility of rainwater harvesting systems in urban and peri-urban environments: A review of the global situation with a special focus on Australia and Kenya. *Water*, 8(4), 149
3. Arizona Administrative Code, R18-9-701.4. 2016.
4. Barnidge E.K., P.R. Hipp, A. Estlund, K. Duggan, K.J. Barnhart and R.C. Brownson (2013) Association between community garden participation and fruit and vegetable consumption in rural Missouri. *International Journal of Behavioral Nutrition and Physical Activity* 10: 128
5. Bao Y. and D. Tong (2017) The effects of spatial scale and aggregation on food access assessment: A case study of Tucson, Arizona. *The Professional Geographer* 69(3): 337-347
6. Carney P.A., J.L. Hamada, R. Rdesinski, L. Sprager, K. R. Nichols, B. Y. Liu, J. Pelayo, M.A. Sanchez, J. Shannon (2012) Impact of a community gardening project on vegetable intake, food security and family relationships: a community-based participatory research study. *Journal of Community Health* 37: 874-881
7. Corrigan M.P. (2011) Growing what you eat: Developing community gardens in Baltimore, Maryland. *Applied Geography* 31(4): 1232-1241
8. Cummins S., E. Flint, and S.A. Matthews (2014) New neighborhood grocery store increased awareness of food access but did not alter dietary habits or obesity. *Health Affairs* 33(2): 283-291
9. Elbel B., Moran A., Dixon LB., Kiszko K., Cantor J., Abrams C., T. Mijanovich T (2015) Assessment of a government-subsidized supermarket in a high-need area on household food availability and children's dietary intakes. *Public Health Nutrition* 18(15): 2881-2890
10. Feeding America. "Map the Meal Gap." <http://map.feedingamerica.org/>. Last accessed on May 13th, 2022.
11. Dubowitz T., B. Ghosh-Dastidar, D. A. Cohen, R. L. Beckman, E. D. Steiner, G. P. Hunter, K. R. Flórez, C. Y. Huang, C. A. Vaughan, J. Sloan, S. N. Zenk, S. Cummins, R. L. Collins (2015) Diet and Perceptions Change with Supermarket Introduction in a Food Desert, but Not Because of Supermarket Use. *Health Affairs* 34(11): 1858-1868
12. Hynes H. and G. Howe (2004) Urban horticulture in the contemporary United States: personal and community benefits. *Acta Hort* 643:171-181
13. Lupia F., V. Baiocchi, K. Lelo, and G. Pulighe (2017) Exploring rooftop rainwater harvesting potential for food production in urban areas. *Agriculture* 7(46) doi:10.3390/agriculture7060046
14. Mabry J.B., J.P. Carpenter, and G. Sanchez. (2008) Archaeological models of early Uto-Aztecan prehistory in the Arizona-Sonora borderlands. In *Archaeology without Borders: Contact, Commerce, and Change in the US Southwest and Northwestern Mexico*, edited by L. Webster and M. McBrinn, University Press of Colorado, Boulder. pp.155-183.
15. Parsons L. R. (2018) Agricultural use of reclaimed water in Florida: Food for thought. *Journal of Contemporary Water Research & Education* 165: 20-27
16. Pedrero F., I. Kalavrouziotis, J.J. Alarcon, P. Koukoulakis and T. Asano (2010) Use of treated municipal wastewater in irrigated agriculture – review of some practices in Spain and Greece. *Agricultural Water Management* 97 (9): 1233-1241
17. Seager R, Ting M, Held I, Kushnir Y, Lu J, Vecchi G, Huang H, Harnik N, Leetmaa A, Lau N, Li C, Velez J, Naik N (2007) Model projections of an imminent transition to a more arid climate in southwestern North America. *Science* 316:1181-1184
18. Tong, Daoqin, Courtney Crosson, Qing Zhong, and Yinan Zhang. "Optimize urban food production to address food deserts in regions with restricted water access." *Landscape and Urban Planning* 202 (2020): 103859.
19. Tucson Water (2018) Water Conservation Program Annual Report. https://www.tucsonaz.gov/files/water/docs/FY17-18_TW_Conservation_Report_FINAL.pdf Last accessed May 25th, 2022.
20. Tucson Water (2015) Water Program from a Foundation of Past Success. Arizona Water Reuse Symposium. https://watereuse.org/wp-content/uploads/2015/10/S4B2_Biggs_Arizona-Reuse-2015-Symposium-07-28-2015.pdf. Last accessed May 25th, 2022.