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A productive permaculture campus in the desert: visions for Qatar University

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Abstract

In Qatar food and water security are high on the agenda of safe and sustainable development. At the same time, rapid urbanisation which is not integrated with ecological landscape design is contributing urban sprawl, fragmented landscapes and to the loss of biodiversity. At Qatar University, the architecture department has been working for several years on the concept of regenerative cities to develop an integrated approach to planning and design and to increase resource efficiency and quality of life. This has led to research and projects on edible landscapes at the campus to contribute to food supply to the University, while at the same time promoting biodiversity on the campus. Using examples from Edible Campuses worldwide, as well as literature on Permaculture, Food Urbanism and Edible landscapes, students and faculty identified strategies and best practices for implementing this vision for Qatar University. An analysis of the campus and existing and future buildings and landscapes was undertaken, to identify the types of interventions – retrofitting of existing buildings with green roofs and green walls and biodiversity habitats, transformation of existing landscapes, use of empty lands for food production, and modification of the urban design of future buildings with integrated food gardens. The Permaculture approach includes the concept of systems thinking and maximum resource efficiency and is used as the philosophy and framework for all the interventions proposed. This includes water recycling and treatment, organic waste recycling, clean and renewable energy producing. The project also includes awareness campaigns, citizen participation and the collection of quantitative data on the concept of Food Miles, that is the amount of miles food travels until it reaches our plate.

Introduction

Context. Qatar and the university campus

Qatar is located in the Arabian Gulf region and has a dry, subtropical desert climate with low annual rainfall and intensely hot and humid summers. Due to the extreme climate, lack of cultivable land and low water resources, Qatar imports over 90% of its food and obtains 99% of its fresh water from desalination. This implies that food and water security are high on the agenda for achieving sustainable development. Organic waste is not recycled systematically at a large or individual scale, resulting in wasted resources. Rapid urbanisation, which is not integrated into an ecological landscape design approach, is contributing to the loss of biodiversity. Therefore, there is a need to research and develop new approaches to design that create more efficient, regenerative, and resilient urban, architectural and landscape systems. As university campuses worldwide are striving to become more sustainable and resource efficient, some are beginning to also develop the concept of the Edible Campus, which entails implementing spaces to grow food on the university grounds. These initiatives are first and foremost to provide users with healthy and sustainable food, but

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also to educate the university population about the production of food and the resources involved. Producing food on a campus not only reduces the food footprint, i.e. the energy that is required to bring the food from distant fields to the plate, but also allows for more efficient resource use and recycling, for example the recycling of organic waste as compost and the use of grey water in irrigation. Dormant lands (i.e. unutilized green fields) can be used to produce crops, and decorative landscapes can be converted into productive landscapes with food and medicinal plants. Edible boulevards can be constructed with fruit-bearing trees that still have the urban and climatic functions of providing shade. A holistic and ecological approach to food production can also contribute to increasing biodiversity on the campus, with careful combinations of plants that repel harmful insects but attracts multiple other species. (Grichting & Awwad, 2015).

The benefits of permaculture in Qatar

One of the ways we propose to address more efficient resource use, extreme climate conditions, and loss of biodiversity is permaculture. Permaculture is a sustainable and conscious approach to agriculture, and a creative method based on ecology for designing integrated systems of food production, housing appropriate technology and community development. Permanent agriculture offers many solutions for the problems of dimensioning resources on a campus or in a city. This approach allocates space in a sustainable way to various needs, including shelter, food and water, income, community and aesthetic and spiritual fulfillment, as well as other material and non-material needs. By working with (not against) nature, permaculture can be more concerned about the neglected parts of cities and campuses. Permaculture contributes to making spaces sustainable by providing them with clean and safe air and water, clean and renewable energy, healthy biodiversity, healthy and accessible food. Permaculture can contribute to the sustainability and security of Qatar as it utilizes renewable energy technology and other techniques to minimize resource use, for example purifying and using grey water for irrigation, using solar power and potential energy for irrigation pumps, and recycling organic waste. Permaculture improves the natural environment through carbon capture, improved air and soil quality, reducing the urban heat island effect and increasing biodiversity (Baggs, 2014). Permaculture contributes to health and well-being through demonstration and research projects that educate people about the contributions of plants to human health, and how poor food choices contribute to diet-related illnesses, such as Type 2 Diabetes and cancer. Access to organic, permaculture products can reduce the proportion of the income that people need to spend on food, and this can be invested elsewhere to raise the standard of living, especially for those with lower incomes in Qatar. Permaculture gardens can improve understanding of the valuable services provided by ecosystems and how to work with nature rather than against it. It is the hope that collaboration with Qatar nationals especially will lead to research projects that can be sustained into the long-term.

Research Questions

Permaculture and Qatar's research agenda

This study investigates whether permaculture could be a solution to Qatar's research goals and future visions as outlined in the Qatar National Research Strategy (Qatar Foundation, 2014), which is aligned with the Qatar National Vision 2030 (Government of Qatar, 2017). The research is based on the assumption that permaculture methods of landscaping and food production can contribute Qatar's development visions and strategies related to the following themes:

- Helping Qatar to lead innovative and excellent research: permaculture is increasingly being applied to urban areas and Qatar will therefore be at the forefront of research among Gulf countries facing similar climatic conditions by supporting this project. Interdisciplinary collaboration of experts can produce excellent results that will benefit Qatar's future development.
- Sustainability and security of Qatar: permaculture can achieve better water, energy and food security, while improving food quality and accessibility.
- Preserving and improving the natural environment: permaculture can enhance the living environment of urban residents by improving air and soil quality, cooling urban areas and stimulating biodiversity.
- Health and wellbeing: permaculture encourages the growth and use of natural medicines and better nutrition, which can help the health and wellbeing of Qatar's residents.
- Developing the capabilities of Qatar's people and institutions: permaculture gardens can be valuable places for education by improving people's understanding of ecosystems, leading to better conservation and management of natural resources.
- Supporting Qatar's distinctive culture: permaculture as a philosophy and set of design principles is very much in keeping with Islamic principles and laws regarding resource use.
- Building and maintaining a competitive and diversified economy: permaculture can lead to new types of businesses and employment.

A Productive and Edible Campus at Qatar University

The University Campus is increasingly being recognised as a living laboratory and a microcosm of a sustainable

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and regenerative city (König, 2013). This research investigates new approaches and methods for creating sustainable and regenerative systems to produce healthy and productive environments using a minimum of natural resources at the Qatar University campus. The main research questions are:

- What is urban permaculture (Urban Permaculture Guild, n.d.) and how can it contribute to a sustainable university campus?
- Can the concept of an Edible Campus be applied in Qatar and throughout the Gulf region, which is characterized by a dry climate?
- How does this project relate to other master plans for University campuses and initiatives for Edible Campuses worldwide?
- What are the different practices and modes of producing food in dry lands and how can they be applied on the Qatar University campus?
- How can this project build on previous research on Food Urbanism in Doha and at Qatar University?
- Can this type of research by design encourage architecture and urban design students to integrate permaculture and edible landscapes into their projects?

Purpose

Permaculture for a sustainable environment

It is anticipated that the widespread adoption of permaculture could help to build and maintain a diverse economy in Qatar, leading to new types of businesses and employment, particularly involving the re-use and recycling of many now wasted resources, and in the growing and processing of useful and healthy products. Existing landscape maintenance skills and knowledge can be developed both for professionals and for individual citizens and communities. In this way, permaculture could indirectly improve the inclusivity, diversity and competitiveness of Qatar's economy and social wellbeing. The permaculture philosophy and principles coincide with Islamic principles and laws regarding resource use, e.g. not being wasteful, sharing according to need, maintaining a balance between give and take, and respecting animal and human rights. Islamic architecture and garden design can also be incorporated into permaculture designs. In addition, permaculture promotion can support the predominantly Islamic culture, as well as the essence and aspirations of the many other religions and cultures represented in Qatar. We hope that by doing this research with students and implementing these concepts at the university campus, more will be understood about the potential benefits of permaculture for Qatar, as well as about how to encourage the application of permaculture principles and techniques to sustainable architecture and urban design in Qatar.

The university campus as a microcosm of the city

As architects and planners of urban landscapes, we play a vital role in the growth of a sustainable community. Food is both a local and global issue. The lack of productive urban land and societal knowledge about food production and preparation, as well as the issues of food insecurity, and uncontrolled urban growth were the main drivers for us to conduct this research and implement a prototype at Qatar University. Universities, as key institutions in processes of social change and development, play explicit role in spreading knowledge and producing highly skilled personnel to meet perceived economic needs (Brennan, King, & Lebeau, 2004). The university campus has been described as a microcosm of the larger community that can provide unparalleled opportunities to teach, conduct research, demonstrate and learn about all aspects of sustainability and environmental issues (König, 2013). This role helps in encouraging and facilitating new social and cultural values supported by the students, who will be the ones to bring about major change to their societies. That is why the issue of food and water security can be addressed through universities, with the aim to encourage students to grow their food on campus. At Qatar University, the author has been working for several years on researching and implementing edible landscapes on campus to contribute to the food supply of the university, while at the same time promoting biodiversity and maximising resource use efficiency. The purpose of this work and research is to create an overall vision of an edible and biodiverse campus in the form of a master plan, as well as to implement experimental permaculture gardens on campus in the future.

Literature Review

Permaculture research

As defined by Henderson, Permaculture is the use of ecology as the basis for designing integrated systems of food production which limit resource waste and promote community development (Henderson, 2014). Permaculture is now being widely recognized as an innovative, creative, adaptable, and practical solution that can be put into practice at many levels. Implementing permaculture on the university campus can help Qatar to lead innovative and excellent research that fills the current knowledge gap in these emerging areas. Permaculture techniques and principles have been developing over the last 40 years, beginning with the work of Mollison and Holmgren in the arid areas of Australia (Mollison, 1979; Mollison, Holmgren, & Barnhart, 1981). It is now becoming a more global phenomenon that is increasingly being applied to urban areas. Systematic re-

search into permaculture is starting, and universities in the United States (e.g. University of Massachusetts Amherst and Oregon State University) have begun to create permaculture demonstration areas, developing the concept of the Edible Campus, and even university courses on permaculture (Harb, 2011; Oregon State University, 2014; Colby, 2014). The Permaculture Research Institute of Australia has produced a Permaculture Worldwide Network website (www.permacultureglobal.org). In addition, the Permaculture Association in the UK, established in 1983, very recently initiated a Permaculture International Research Project and Network to link existing researchers and encourage useful and scholarly research about permaculture (Warburton-Brown, 2014). They carried out a survey which led to the recent publication of a report listing 260 permaculture research projects worldwide, the nearest of which are located in Israel (occupied Palestine), Jordan and Morocco (Schmidt, 2012).

Permaculture in the Middle East and Qatar

Influenced by the new Global Sustainability Assessment System (GSAS) (Gulf Organization for Research and Development, 2017), Gulf countries, and Qatar in particular, are increasingly designing energy and water efficient buildings and landscapes. However, there is still a lot to be done regarding retro-fitting buildings and improving existing landscapes. There are a handful of small permaculture projects taking place in or near the Gulf, but the practice is neither well-known nor widespread as of yet, and the benefits have not been measured in the arid climate of Qatar. To date, very little systematic research has taken place to assess the suitability of permaculture for the Gulf region and identify the particular techniques and species that could be used. The projects at Qatar University will therefore be at the forefront of research into urban permaculture in the arid Gulf countries. With the advice and collaboration of many experts in various fields, this interdisciplinary research can produce results that inform and benefit the future sustainable development of Qatar.

Regional case studies

The number of permaculture projects in the Middle East and North Africa, although small, has gradually been increasing over the last few years in particular. The geographically closest examples of permaculture applied to urban, arid contexts include a back garden, house, and compound garden near Al-Waab Street, Doha, involving educational work with children and run by the NGO Sprout Middle East. According to the constantly updated Permaculture Worldwide Network Site, there is a school garden project in Dubai (Permaculture Worldwide Network, n.d. b) and another in Saudi Arabia, the Al Khobar Desert Balcony (Permaculture Worldwide Network, n.d. a). Both urban and rural permaculture projects have now become established in quite arid areas of Egypt, Jordan, Tunisia, and Morocco, and there are plans for a permaculture pilot project at The Royal Jordanian Botanical Gardens. Others exist further afield, many of which are in urban areas across a range of tropical and subtropical climates, such as in areas of Central and South America, the Caribbean, East and West Africa, Pakistan, Thailand, the Philippines, Indonesia and Australia. The Permaculture Worldwide Network is a good resource that brings together permaculture projects from across the globe, including in urban and/or tropical and arid areas, and some lessons can be learned from the case studies presented on their website (permacultureglobal.org). Some of the projects and research in the fields of agroforestry, agro-ecology and organic agriculture could also be relevant to the research.

Previous Phases of the Research in Qatar

From previous research undertaken by students and faculty on Food Urbanism in Qatar (Grichting, Ball, & Awwaad, 2014), we can confirm that permaculture can and is being implemented in Qatar, and can have significant benefits to both food security and biodiversity, as well as consume less of scarce resources (eg. water and soil) and recycle organic waste and water. Thus, we can make the following assumptions:

- Permaculture techniques can help increase food security in Qatar
- The implementation of permaculture practices helps to improve soil structure with the use of compost, manure, straw, and a diversity of plants
- Natural pest management practices can be used instead of harsh chemicals
- Biodiversity can be increased with a mix of vegetables, herbs, fruit trees, and beneficial plants , which can also decrease pests and bring beneficial insects to the site

The basic elements of the permaculture approach used in the cases studied in Qatar are:

- Soil building (compost and manure)
- Trees for wind breaks
- Companion planting
- Grey water recycling
- Crop rotation
- Composting
- Chickens for soil turning
- Planting nitrogen-fixing trees
- Creating a food forest
- Mulching with straw to decrease water usage and add nutrients to soil
- Soil beds are prepared to ensures a full utilization of the organic wastes

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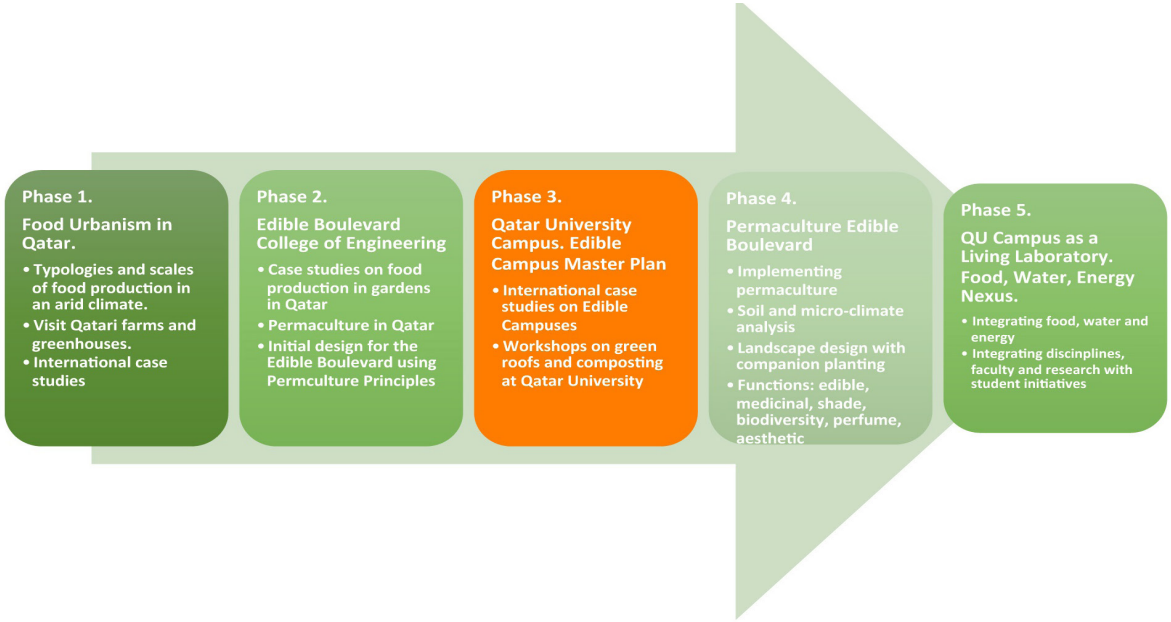

Figure 1: Phases of the Research Project

Methodologies

Approach to theresearch

This research was carried out as part of an undergraduate course in Urban Planning and Design, building on the work of students in the previous year and also projects produced by graduate students in Urban Planning and Design. The work also integrates projects and research carried out with student grants that were used to create an Edible Garden at the Female College of Engineering and exhibitions on Landscapes for Food Security Biodiversity with associated student workshops on green roofs, soil and composting held on the campus.

This paper presents one phase of the on-going research on Food Urbanism, permaculture and the Edible Campus at Qatar University. While we foresee many benefits of permaculture in an arid climate, as has been demonstrated in various case studies worldwide, this research focused on the design aspects of permaculture, and not on experimental research involving analysis of climate, evapotranspiration and soil. While the students took these into consideration, they were not measured. However, in the subsequent phases of the project, a small prototype garden was studied and soil and climate analysis were carried out. This will be the subject of an upcoming publication. In this year's research program, students will evaluate the results of the prototype and then operate a critical analysis of the designs for the Edible Campus, and integrate the findings of this research to improve the Edible Campus master plan, as well as to further develop the nexus between the food, energy and water resources.

This phase of the research (**Figure 1**) is focused on the Urban Design of the university campus, and is based on a research by design or design-led research method, building on previous research at Qatar University as well as case studies in the region and worldwide. In design-led research, the product of the research is often a plan or design that synthesises the knowledge and information collected. The research questions are addressed through a project and design process.

Research

This research was carried out as part of an undergraduate course in Urban Planning and Design, building on the student work of the previous year and also projects produced by graduate students in Urban Planning and Design. The work also integrates projects and research carried out on an Edible Garden at the Female College of Engineering and workshops and exhibitions on Landscapes for Food Security Biodiversity and a student workshop on Green Roofs held in the department design studios.

Case studies of Edible Campuses worldwide were studied, as well as literature on Permaculture, Food Urbanism and Edible landscapes, to identify strategies and best practices for implementing the plan. The research also looked at systems to maximise resource efficiency, including water recycling and treatment, organic waste recycling, clean and renewable energy producing. The project development includes awareness campaigns, citizen participation and the collection of quantitative data on the concept of Food Miles, that is the amount of miles food travels until it reaches our plate.

An analysis of the campus and existing and future buildings and landscapes was undertaken, to identify the types of interventions – retrofitting of existing buildings with green roofs and green walls and biodiversity habitats, transformation of existing landscapes, use of empty lands for food production, and modification of the urban design of future buildings with integrated food gardens. The Permaculture approach includes the concept of systems thinking and maximum resource efficiency and is used as the philosophy and framework for all the interventions proposed.

Research Methodology

Organization of the Research Framework and the Research Group

The aim of this research was to produce an Edible Campus Master Plan. To achieve this, students worked in groups to identify the different components of the Master Plan. These included:

- General campus master plan
- Productive landscapes in green fields
- Productive green roofs
- Transforming decorative landscapes into edible landscapes
- Central park and biodiversity reserve (**Table 1**)

Study of Precedents

Students were asked to research case studies of Edible Campuses worldwide, as well as find literature on permaculture, Food Urbanism and edible landscapes to identify strategies and best practices for implementing the plan. The research also looked at systems to maximise resource use efficiency, including water recycling and treatment, organic waste recycling, and clean and

Table 1: Outline of the Framework for the Edible Campus Project

1. Master Plan	• Work on master plan, land use, functions and future scenarios. • Integrating the other projects into one vision and master plan. • Look at the overall network of green and productive spaces created by the Food Urbanism Master Plan. • Study other Master Plans for Edible Campus' worldwide.
2. Transforming Decorative Landscapes into Edible Landscapes	• Divide the campus into sectors and work on transforming Existing Landscapes into • Edible Landscapes. See the example of the CENG Edible Garden by the UREP team. • Identify areas and landscapes that can be transformed from decorative landscapes to Edible Landscapes and propose plantings.
3. Productive Green roofs	• Mapping the potential for Green Roofs at Qatar University. • Identifying different Land Uses – Crops – for the roofs. • Explaining the systems – Water recycling, organic waste recycling, etc
4. Productive landscapes in green field	• How to use and propose planting food in the undeveloped land within the University campus. • Can be temporary – for sites with future projects, or permanent. • Can include greenhouses or open crop as well as livestock and fruit trees, dates, etc.
5. Central Park and Biodiversity Reserve	• Develop the concept of the Central Park • Develop the Wadi as the backbone of a biodiversity corridor • Connect these Green Spaces as a network of green spaces with the surrounding areas.

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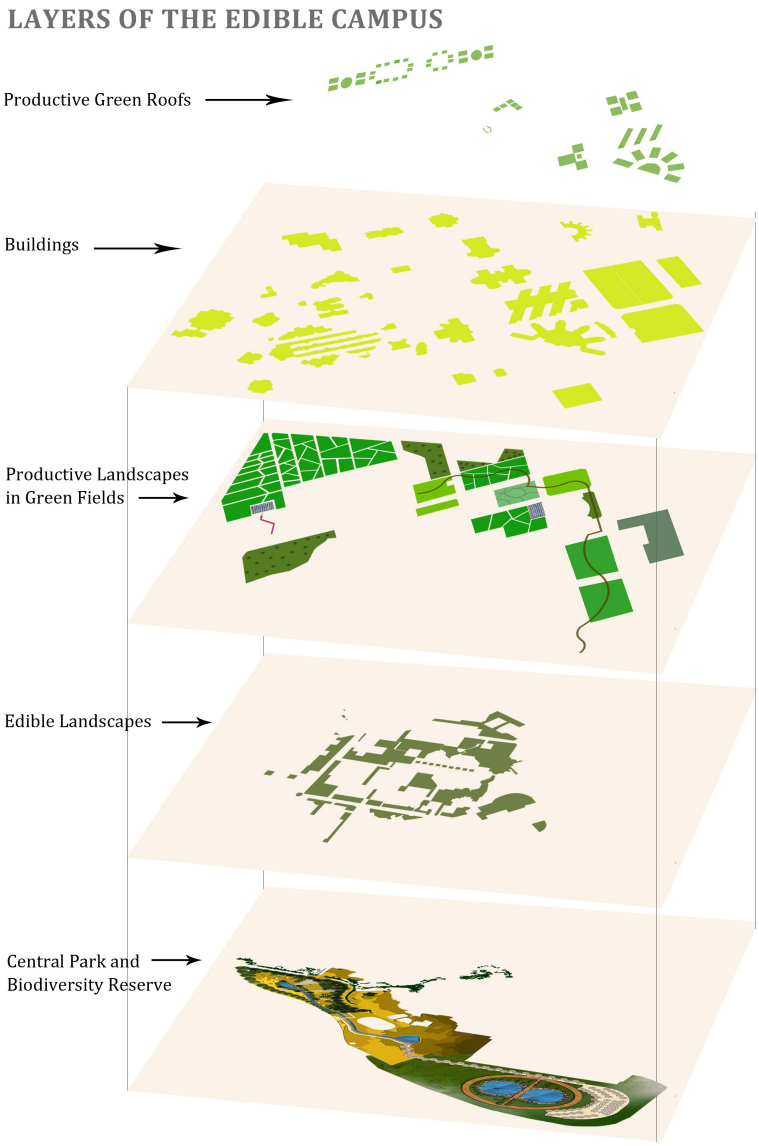

Figure 2: The Master Plan for the Edible Campus at Qatar University

renewable energy production. Students were asked to include awareness campaigns, citizen participation and the collection of quantitative data on the concept of Food Miles, which is the amount of miles food travels until it reaches our plate.

Site Analysis

An analysis of the campus, including existing and future buildings and landscapes, was undertaken to identify possible types of interventions, such as retrofitting existing buildings with green roofs, green walls and biodiversity habitats, transformation of existing landscapes, use of empty lands for food production, and modification of the urban design of future buildings with integrated food gardens. This also included a climate analysis as well as analysis of the campus users.

Permaculture

The permaculture approach was introduced to the students as an efficient way to address the challenge of growing healthy food with scarce resources, while at the same time promoting biodiversity. The permaculture approach includes the concept of systems thinking and maximum resource use efficiency and was utilized as the philosophy and framework for all the interventions proposed. The students had a lecture by a certified permaculturist, who participated in the development of the project and also attended the review of the projects.

Findings and Results

The result of the research and the student work was a series of plans and designs for an Edible Campus at Qatar University. The plans and designs are not intended for implementation as such, but as a tool and vision to initiate interdisciplinary and multi-stakeholder involvement in a strategy and plan to promote food production and biodiversity on the campus. The plans consider the

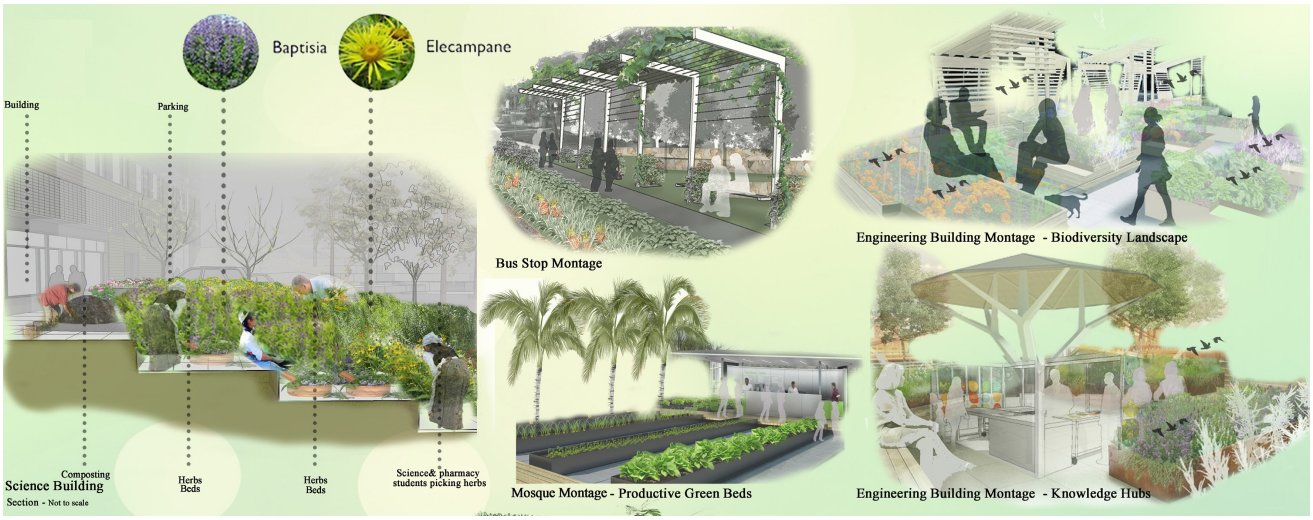

Figure 3: Transforming Decorative Lansdcapes into Edible Landscapes

optimal use of scarce resources such as water and energy, as well as recycling of waste (organic waste in particular). The students produced a series of posters and an integrated Master Plan containing all the parts of the project, as outlined in the research framework, and are listed below.

The General Master Plan:

- The first step in the development of the Master Plan for Qatar University was to have a clear vision and mission for QU edible campus, and relate it to Qatar National Vision 2030.
- The second step was to analyse the food cycle process and show its aim in addressing local food security.
- The third step was studying a case, McGill University's School of Architecture, to understand and see what strategies and methods they have implemented to have an edible campus.

The result was a master plan of Qatar University campus showing the land uses and functions, supported by different types of charts showing the existing and the proposed design for the future. The last and the most important step was to compile and arrange all the layers of the other students into one master plan to produce the overall vision. The final master plan combines the existing plan in addition to the future plans, covering all types of buildings, rooftops, productive and edible landscapes and the central park (**Figure 2**).

Transforming Decorative Landscapes into Edible Landscapes: The main steps of the design process to transform the existing landscapes at Qatar University into Edible Landscapes are listed below (**Figure 3**).

- Identifying the areas where the existing landscapes were located:
  1. Studying the existing landscapes and the surrounding public spaces, buildings, and facilities (if any)
  2. Categorizing existing landscapes into zones with similar surrounding facilities (zoning phase 1)
- Generating a strategy that will help identify the types of edible landscape that will be incorporated into the campus
- Identifying the edible landscape typologies from the strategy that will be used for each category of existing landscape (final zoning phase)
- Selecting one area within each typology to be transformed and used as an example for each typology
- Proposing Food Knowledge Hubs that provide information about the food's footprint and the nutritional components of each food source, as well as information relating to microclimate and soil. The hubs also provide information and links to other Edible campuses worldwide allowing an exchange of knowledge and best practices.

Productive Green roofs:

- Students started researching green roofs, including how they could be applied on different types of buildings, what systems could be implemented, what types of crops could be grown, and how biodiversity could be encouraged.
- The students visited existing buildings on the campus, and also looked at the designs of new buildings to see where green roofs could be implemented.
- They then mapped the green roofs that were identified as suitable on the master plan layer, as well as those that were accessible to the public and/or to different users.
- The students attended a seminar on green roofs and biodiversity and learned about different sys-

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Figure 4: Productive Green Roofs

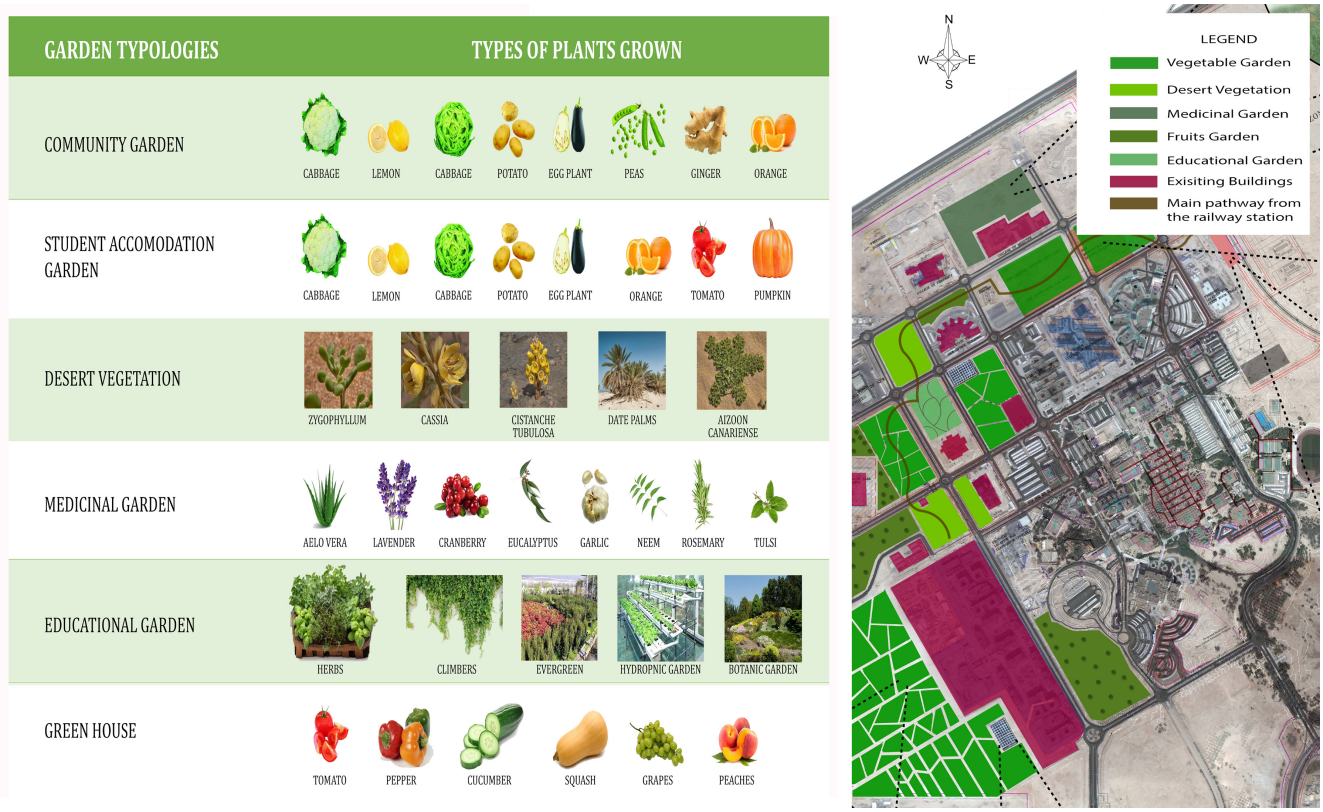

Figure 5: Productive Landscapes in Green Fields

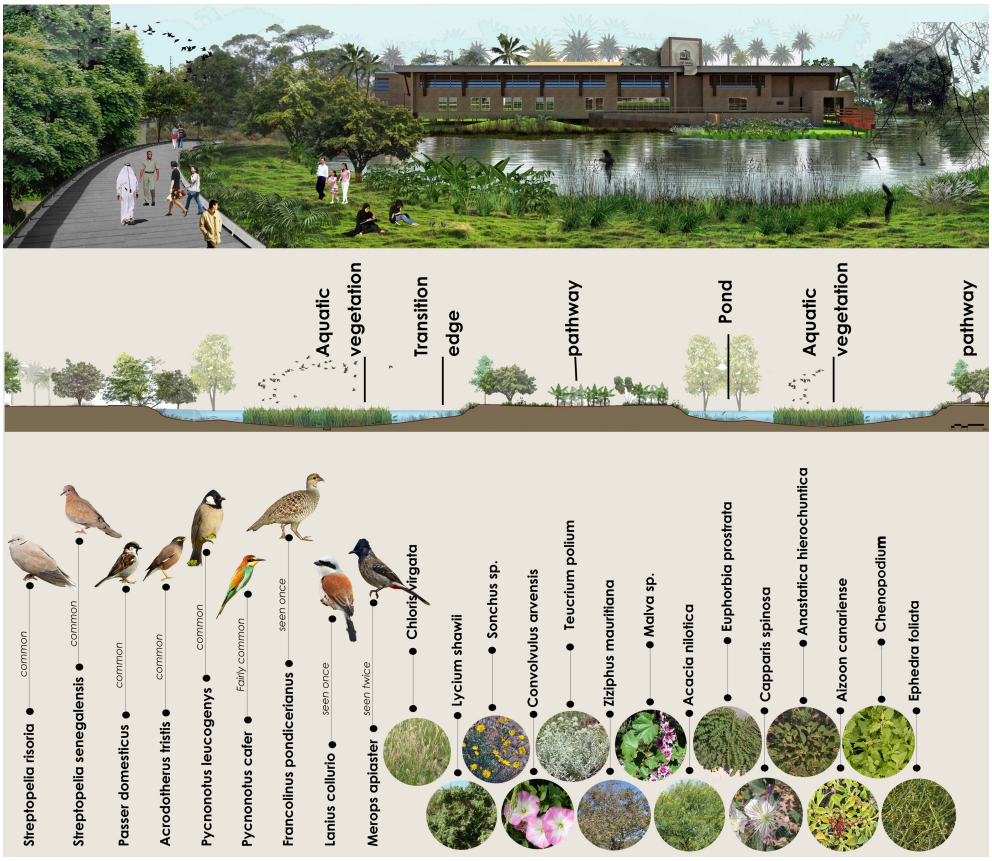

Figure 6: Eco-Wadi, Central Park and Green Network

tems for green roofs and how to encourage biodiversity.

- The green roofs are designed for a variety of uses- as places for informal recreation that are less crowded, polluted and noisy. Therefore, they will increase the interactions in the community and the activities on the campus. Moreover, they will improve the air quality by filtering airborne particles in the leaves and branches (**Figure 4**).

Productive landscapes in Green Field:

The approach for the Green Fields included identifying the reserve land in the University campus that was not yet developed to propose temporary agricultural uses that would also create green infrastructure for the future urban and landscape designs for the campus development (**Figure 5**).

- First, students located the unused and unproductive fields on the master plan of the campus.
- They also located the new metro station and incorporated it into their design with a building that can grow food inside. In this way, when people arrive at the station, they will have a new kind of experience in which they can select fresh fruits and vegetables to consume.
- Subsequently, students started to allocate the different typologies of food production to the new gardens and fields (greenhouse, fruits garden, medicinal garden, crop fields, etc.) and categorized the different kinds of fruits and vegetables that can be grown in the different types of structures and landscapes.

Central Park and Biodiversity Reserve (**Figure 6**):

- The design process focused on the Qatar University central park, including where it should be located and how it could be developed within the framework of an edible campus, permaculture and biodiversity.
- The existing Wadi conservation was chosen as the backbone of a new green network at Qatar University.
- The areas surrounding Qatar University were also studied to connect the new green spaces to a larger green network.
- An important step was to obtain the topographic information for the site, in order to maximise the water efficiency in the landscape.
- The students worked on the biodiversity of our campus and identified species, including herbs, plants, and birds that are part of the ecosystem.

Conclusions

Edible campus projects are effective ways to demonstrate how sustainability, environmental quality and

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food security can be linked through a creative design which produces food. This has been confirmed through the literature review, and some design strategies were taken from case studies such as the McGill University and Cornell University edible campuses (McGill University, 2017; Cornell, n.d. a). Through all the case studies, students learned many things to apply to their campus, such as edible areas, green roofs, a central park, green network connections and biodiversity corridors, as well as social spaces with informative digital hubs to educate the campus users about the systems, foods and species on the campus. While they did not have practical experience with the application of permaculture techniques, they used the principles of permaculture to guide their designs, and learned about the concept and benefits of permaculture in the process. In the case of the Qatar University campus, there are challenging urban and climatic settings. However, with the study of permaculture, the use of adapted climatic species and landscape design, and the help of previous research and case studies, it is possible to develop this type of project in Qatar.

Research through design: innovations and limitations

This research was conducted as part of an elective course, and not as a design studio. Therefore, the depth and elaboration of the design was at a conceptual level. The project designs offer solutions on how to weave productive plantings into urban spaces without diminishing their utility or functionality. They take into consideration the needs of the Qatari context of the campus in terms of food security and biodiversity, which are high on the agenda of the country's research and development priorities. The master plan of this project can be a leading step to more future edible campuses in the country and in the region. Additionally, the plan acknowledges the importance of the social and community aspects within the campus. It looks at different ways to integrate edible landscaping into both the existing and the non-existing landscapes, as both temporary and permanent plantings. Finally, it uses methods like permaculture to create a sustainable edible landscape for the campus, which will be beneficial not only for the occupants of the campus but also to nature since it follows natural processes. Overall, the results achieved the objectives of creating a vision of the University as a productive campus using permaculture methods for increased resource use efficiency, climate adaptation and biodiversity, and at the same time enhancing and improving the bioclimatic and aesthetic qualities of the campus. Some of the innovative ideas that the students introduced included the future Qatar University metro station as a vertical farm, which becomes a gateway for the Edible campus, and where people arriving at the University are immediately immersed in the productive landscapes. Another highlight of the project is the proposal of Digital Food Knowledge Hubs that provide information about the food's footprint and the nutritional components of each food source, as well as information relating to microclimate and soil. The hubs also provide information and links to other Edible campuses worldwide allowing an exchange of knowledge and best practices.

While there is an ongoing debate about the Research through Design method, and questions as to whether the product of spatial design (the design itself) can be considered knowledge following basic criteria used in traditional research, there are also an increasing number of funding agencies that are looking for more applied and integrated results from research, especially in the field. The European Union introduced the concept of Living Labs in their funding projects. In terms of implementation, the European Network of Living Labs (European Network of Living Labs, n.d.), launched in 2006, is a community of Living Labs with the objective to support co-creative, human-centric and user-driven research, development and innovation. A Living Lab involves four main activities: 1. Co-Creation: co-design by users and producers; 2. Exploration: discovering emerging usages, behaviors and market opportunities; 3. Experimentation: implementing live scenarios within communities of users; and 4. Evaluation: assessment of concepts, products and services according to socio-ergonomic, socio-cognitive and socio-economic criteria. This research can be placed in the first two activities of Co-creation and Exploration, although it does not cover all the aspects of these activities, it is a foundation to build further research.

Future research

This research and design project developed with architecture and urban design students shows how they envision the future of their campus – one where the students, faculty and staff will be proud of a sustainable and green environment and all benefit from it. It should therefore become a project that involves all the communities in its design and elaborations, through a process of participative design. As recognized by contemporary researchers, the university campus is a micro society where production, consumption, disposal and other social activities occur, and where the physical spaces provide for vital aspects of campus life (König, 2013).

An enhancement of all the projects would necessitate more technical data and knowledge of the sites and buildings, as well as measurements of the soil and microclimates. The projects' success depends on creating a better symbiosis between the buildings and the landscapes, and designing these as a regenerative system. Additionally, a phasing plan, showing how this can be implemented over time, would be necessary to see this as a transformative process and as a long-term vision.

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A community of permaculture practitioners as well as an interest group is slowly emerging in Qatar, and the author is also collaborating on a project for a permaculture farm in Qatar, where different techniques for creating watersheds and natural irrigation through permaculture techniques of micro catchments for dry landscapes are being tested. These can all contribute to the knowledge and research for the future Edible Permaculture Campus vision.

In the subsequent phase of the project (Phase 4. See Figure 1.), students conducted practical permaculture research and designed at a smaller scale, working on the permaculture boulevard garden at the Department of Architecture and Urban Planning at Qatar University. They conducted soil analysis, climate and microclimate analysis, and consulted specialists in native and edible plants in collaboration with the Environmental Science Center at Qatar University. According to the microclimate and soil analysis, and the knowledge on plant species that can grow in Qatar and in different microclimates, the students proposed companion planting schemes for the Garden. Students also participated in a workshop on soil and composting organized as part of an international workshop on Sustainable Urbanism organized by the author, which was led by soil specialist and activist Nance Klehm (Sustainable Urbanism Qatar, 2016).
This research is being carried out in in phases, corresponding to the calendar of courses and research grants. The next phase (Phase 5 in the diagram) is the Qatar University Campus as a Living Laboratory which will consider the Food, Water and Energy Nexus and integrate disciplines, faculty, students and research centers. A living lab is a research concept: a user-centered, open-innovation ecosystem, often operating in a territorial context (e.g. city, agglomeration, region), integrating concurrent research and innovation processes within a public-private-people partnership (European Network of Living Labs, n.d.). This phase would necessitate bringing the vision to the University Presidency and creating an interdisciplinary and inter-departmental group to develop the project and implement it with the Building Services and University Administration. Through more interdisciplinary and interdepartmental collaborations, it would be possible to have additional analysis and information on existing climate, microclimate, evapotranspiration, soil, and biodiversity on the climate, and to foresee and model how these would be modified through the implementation of the permaculture vision. A research grant is being developed to further the research and project work and the researchers, faculty and students are all convinced that this idea needs to be pursued at Qatar University and in the Gulf Region.

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Conflict of Interests

The author hereby declares that there are no conflicts of interests.

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