Comparing food efficient design and planning of built environments in Sydney and Miami

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Abstract

Sustainable design and planning could play increasingly important roles in creating food efficient built environments of the future. This paper reviews design approaches and emerging theories in food efficient of design and planning for built environments. This paper aims to measure and to compare morphologies and spatial dimensions of three typologies of small local food production spaces: urban small farms, community gardens and home gardens in two low density suburban residential neighbourhood case studies in Sydney and Miami. 'The Transect', an integrated form based zoning code adopted for the City of Miami in the USA, provides design and planning guidelines for six zones across urban to natural areas. A case study from Sydney is selected as different zoning controls could drive different morphological characteristics of urban forms. Results indicate that morphological analysis can assist significantly in design and planning of built environments and planning policy formulation. Extending this research to larger cross sectional analysis will be beneficial for sustainable community planning.

Keywords: *local food; sustainability; suburban; morphologies; gardens*

Introduction

Population growth and land availability are two important factors which will significantly impact the food demand and production in future. By 2050, a population growth of an additional 2.7 billion people will create an enormous pressure on global food systems (UNEP, 2009, p.6). By 2030, two third of the world's population will be living in urban areas (Population Reference Bureau, 2011). Morphologies of urban and suburban areas are shaped by socio-economic profiles; peoples' life style preferences and awareness; local economies; spatial geographies of access; locations and interrelationships of functions (Gleeson, 2006; Forster, 2004; Whitehand et. al., 1999). Availability of spaces for food production varies across different density patterns at regional, city and local urban scales. A 'local food shed' is defined as an area of land which could supply all the food demand of the resident population (Feagon 2007). Food produced in different typologies of food production sites located within this defined boundary can be measured at a regional scale. A community scale 'landscapes of localized food systems' includes mapping food production areas, food distribution outlets and even locations of markets, fruit trees and communities assets (Coley and Duany, 2011). Alternative food systems, such as growing food locally in community, allotment and home gardens and in small urban farms can initiate short food supply chains (SFSCs); provide nutritious produces; enhance social connections and community engagement, environmental benefits, rise of localism, and values for traditional, healthy and fresh local food (Daniels et al., 2008; Gaynor, 2006; Ghosh, 2012). Understanding these positive changes and innovative food efficient design and planning of built environments will be essential to retrofit existing neighbourhoods and to design new developments for improved urban performance. Current research is increasingly focusing on exploring connections of local food, spatial morphologies and role of urban planning policy in creating healthy communities and sustainable cities. Sustainable design and planning is vital to creating food efficient built environments of the future.

This paper reviews main food efficient design approaches and emerging theories that recognise local food production spaces as important elements of design and planning for built environments. It also reviews the zoning code and planning controls of Miami and Rockdale city in Sydney. This paper aims to measure and to compare morphologies and spatial dimensions of three typologies of small local food production spaces: urban small farms, community gardens and home gardens in two low density suburban residential neighbourhood case studies in Sydney and Miami. City of Miami in Florida is selected as a detailed form based zoning code Miami 21, has already been adopted for the City of Miami in the USA. It provides design and planning guidelines for six urban to natural zones along a rural-urban continuum (The City of Miami, 2013). A case study from Sydney is selected as different zoning regulations within Australian planning system could drive different morphological characteristics of urban and suburban forms. It is possible to accommodate other typologies of food production, roof top gardens, street gardens, agricultural lands etc., within human settlements. As these are not within the scope of this paper, therefore, are not included.

Backgrounds of the cities

Two cities: Miami, USA and Sydney, Australia vary in population density, demographic profiles and their locations. The City of Miami is located in northern hemisphere in the state of Florida in the eastern part of United States. Miami has a total population of 433,136 people; a population density of 4647 people per square kilometre and covers a total area of 93.2 km² (City-data.com, 2013). Miami has a subtropical climate and is an important tourist destination. Sydney is the largest city and a major economic hub of Australia. It is an important tourist destination in southern hemisphere. The case study in Sydney is located in Turrella Bardwell Valley and is under the jurisdiction of Rockdale City Council. This council has a total population of 102,843 people over an area of 28 km² and a population density of 3673 persons per square kilometres (Rockdale City Council, 2013a). In 2006, 70.9% 'separate house' dwelling type increased to 75.8% in 2011 (Rockdale City Council, 2013b and 2013c).

'The Transect' and Miami 21, City of Miami

'Transect' is a geographical concept. It aims to measure systematically varying physical or natural or human environments along a selected cross section (Gerlach 2008). In this paper, 'The Transect' is defined to contain varying morphological characteristics of human habitats. It presents 'an index of diversity' (Duany, 2002: 257) and provides a realistic zoning regulations for planning urban and suburban areas following new urbanism design principles (New Urabanism.org, 2013) along a rural-urban continuum (The City of Miami, 2013). 'The Transect' varies with different cities and each city has its specific cross sectional characteristics. 'The Transect' has six broad zones: natural (T1), rural (T2), sub-urban (T3), general urban (T4), urban centre (T5) and urban core (T6). Transect zoning has been applied in other cities of USA, for example, Nashville, Mississippi, Texas and many others.

'*The transect approach is a planning strategy that seeks to organize the elements of urbanism—building, lot, land use, street, and all of the other physical elements of the human habitat—in ways that preserve the integrity of different types of urban and rural environments'* (Talen, 2002).

'Miami 21 is a highly detailed integrated zoning code developed based on conceptual framework of 'The Transect'. This zoning code considers various morphological and community variables of urban and suburban patterns and provides guidelines case by case basis for development in the City of Miami. 'The Transect' is not always a linear concept of changing human environments from the core to the periphery of a settlement. 'The Transect' zones can be found to exist in mosaic patterns as seen in Miami in combinations with different zones defined by their morphologies, local characteristics, architectural and heritage qualities, street networks and others (City of Miami, 2013a). Within Miami 21, each zone of 'The Transect' regulates building disposition, street configuration, density patterns, landscape regulations (e.g. increasing the tree canopy cover up to 33%) and parking considering overall design of the public realm (The City of Miami, 2013a). Each zone of 'The Transect' is further subdivided into sub zones, for example, urban core (T6) has six sub zones; considering three dimensional aspects of massing, inner city urban forms vary from eight storied buildings to sixty storied buildings within one T6 zone.

The case study in Miami is located in T3 Sub-Urban zone and a case study with similar characteristics has been selected from Sydney. T3 zone is generally a low density zone with residential as the predominant land use pattern (Fig 1). Built form is generally single detached and two family residential houses, with ample open spaces around the buildings representing garden suburbs. This zone generally has larger setbacks, linear or irregular or grid iron road networks (roads are at right angles to each other) with natural and historic or heritage features. There are altogether three subzones in T3 Sub-Urban: T3R (restricted), T3L (limited) and T3O (open) (The City of Miami, 2012, IV.5). Planning regulations for these three sub-zones vary. 'T3 Sub-Urban' zone is selected as it has significant potential to transform from Sub-Urban (T3) to General (T4) or Rural (T2) to Sub-Urban (T3) zones. This zone is susceptible to significant morphological changes within shorter periods of time. T3 zone is strategically important; needs balanced design and planning of natural and the built environments (Metro Government of Nashville and Davidson County, 2012) and provides significant opportunities for embedding food efficient urban design elements into the built fabric. In addition, new urbanism principles of walkability, connectivity, mixed use and traditional neighbourhood structure could be also translated in the design as sustainable life style patterns (NewUrbanism.org, 2013).

Fig 1: Examples of Sub-Urban (T3) zones, Miami (Photos by: Sumita Ghosh)

Land use zoning, Rockdale City Council, Sydney

Rockdale City Council Local Environmental Plan 2011 identifies six different land use zones: Rural (RU4 Primary Production Small Lots), Residential (R2 Low Density; R3 Medium Density; R4 High Density); Business (B2 Local Centre; B4 Mixed Use; B6 Enterprise Corridor); Industrial (IN2 Light Industrial); Special Purpose Zones (SP2 Infrastructure; SP3 Tourist) and Recreation (RE1 Public Recreation; RE2 Private Recreation) (NSW Government, NSW Legislation, 2013). Rockdale Development Control Plan (DCP) 2011 outlines general principles of development such as site planning; streetscape and site context; landscape planning and design and sustainable building design (Rockdale City Council, 2013). Rockdale City Plan 2013 – 2025, long term community plan outlines community aspirations and goals and provides a framework. Rockdale City Council zoning follows a 'Euclidean Code' based zoning pattern where use of land is regulated by the permitted and prohibited activities on that land. 'Euclidean' or 'traditional' zoning codes regulate development of urban and suburban morphologies by regulating different land use districts such as residential, commercial etc. while 'form based' zoning code such as Miami 21 focusses on achieving a specific urban form considering interrelationships of streets, built form and open spaces and takes a spatial scale (neighbourhood, city and region) based approach (City of Miami, 2013a). Thus 'traditional' zoning code in Sydney has different zoning controls compared to the 'form based' zoning code in Miami. Outcomes of built environments could also very different when these codes are implemented.

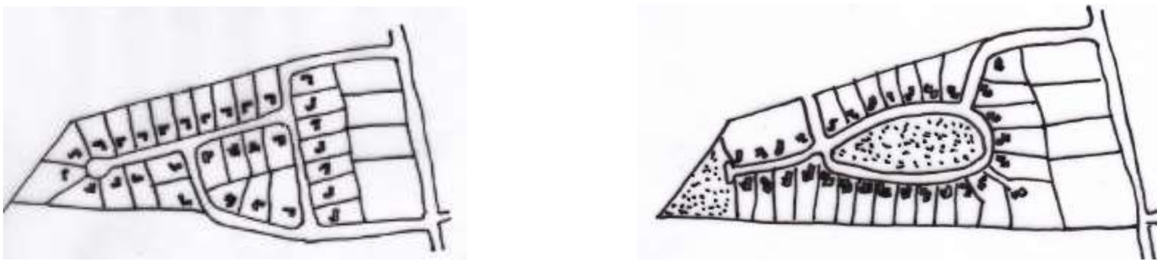
Urban morphology and food efficient urban design and planning approaches

Moudon (1997) identified the three fundamental morphological components: form; resolution and time that drive evolutions of urban and suburban forms. Form refers to physical characteristics of buildings, related open spaces, lots, streets and vegetation. Resolution is hierarchical and can vary across building/lot; the street/block; the city and the region levels of resolution.

Time relates to transformative or adaptive capabilities of urban and suburban forms and evolution into new forms (Moudon 1997). The smallest ‘Cell’ of the city is a combination of an individual parcel of land and building(s) and open spaces on that land. This combination has a profound impact on the food efficiency of an urban pattern at larger spatial scale. In a high density development, a larger population lives on a smaller piece of land compared to that in a low density development. The qualities and spatial dimensions of spaces or different types of cells change with changing patterns of developments. These elements guide the decisions on specific typologies of food production spaces that could be fitted within different urban morphologies. This conceptual understanding has significant connections to the ‘The Transect’ and implementation Miami 21 code.

Within an inner city higher density environment, roof top gardening, urban farm on brownfield sites could provide solutions for integrating food efficient designs. In a case study in Bronx, New York, using Estimated Roof Area Analysis (EVRAP) method, it was calculated that a total of 693 hectares of building roof areas equivalent to two central park areas would be available as green roofs for food production (Maantay and Ziegler 2006, p. 363). At a community scale, best practice examples such as Village Homes, California, USA (low density) (Arendt, 2010, pp. 42-43), Earthsong Eco-neighbourhood, New Zealand (medium density) (Earthsong, 2013) and BedZED, UK (high density) (One Planet Communities, 2013) incorporate edible landscaping, home gardens and community gardening practices to promote food efficient designs. At a plot scale, a home garden of a size of 97m² (7.6m X 12.8m) in the USA is sufficient to produce almost all the annual vegetable demand for a two person household (North Carolina State University, 1996).

There are different approaches for food efficient design and planning of different patterns of human environments. In a case study in Story County, Iowa, USA, a ‘typology of continuous productive landscapes’ was formulated considering availability of six types of local food production sites: private residence garden, community/allotment garden, food boulevard, institution (religious/education/non-profit), neighbourhood farm and urban farm and their scales of operation, location and sizes and other factors are defined for integrating local food production (Grimm, 2009).



a) 30 lots organised using conventional approach (b) 30 lots organised using conservation approach
(Source: Arendt, 2010: 60; Ghosh, 2012b)
Fig 2: ‘Conservation subdivision’ approach

‘Conservation subdivision approach’ to designing human environments can protect and connect natural areas to food production spaces through design and can improve biodiversity and sustainability performance of settlements (Arendt 2010). Figure 2 (a, b) demonstrates how a conventional design could be efficiently redesigned to create better food production spaces in new developments using conservation subdivision design approach.

Duany et al.’s (2010) research identified a total of four models: ‘agricultural retention’, ‘urban agriculture’, ‘agricultural urbanism’ and ‘agrarian urbanism’ of local food production for planning and designs of settlements and possibilities to integrating these models within a human habitat. While ‘agricultural retention’ relates to protection of farmland at a regional scale, ‘urban agriculture’ refers to local food production on any available land such as vacant land, brownfield sites, home gardens etc. at a local scale within a settlement (Duany et al. 2010, pp.7-8). ‘Agricultural urbanism’ visualises a working farm which feeds the community and the community and businesses are is economically dependent on agriculture. It originated from garden cities conceptual framework by Ebenezar Howard where green belt zones could be utilised for food production for the residents. Southlands development has an area of 538 acres or 218 hectares in Vancouver, British Columbia. It is an example of ‘agricultural urbanism’ where ‘food production’ forms the basis for urban density’ (DPZ, 2013a). Various typologies of food production sites are integrated within the design and master planning of this community.

‘Agrarian urbanism’ principles link food efficient designs to new urbanism principles and initiate an intentional sustainable agrarian society and community development with a complete food system processes such as production, distribution and others (Duany et al. 2010, pp. 7-8). It focuses on food as the basis of creating a life style and integrates design and planning of human environments responsive to these principles (Duany et al., 2010). Hampstead is an area of 416 acres or 168 hectares of traditional neighbourhood development in Montgomery, Alabama, USA has been developed following the principles of ‘agrarian urbanism’ and ‘smart code’ or a transect-based planning and zoning model in 2006. Hampstead represents a new food efficient design thinking where Hampstead farms could produce fresh food for supplying to local residents and food outlets. A farmers market has been designed as a food distribution outlet to reduce the farm to plate distance (DPZ, 2013b). Adjacent to the farms, adequate sizes of subdivisions were designed to create a neighbourhood committed to agricultural production. The mixed use built forms are designed to enhance walkability and urban design qualities (DPZ, 2013b).

All these approaches and emerging theoretical frameworks discussed in this paper highlight the importance of food efficient design and need for multidisciplinary knowledge integration for design and planning for future settlements.

Selection of case studies

Two case studies in Miami and Rockdale, Sydney are located at approximately ten kilometres distance from central business district (CBD) with residential as a predominant land use pattern. Selection criteria for two case studies are based on these four factors:

- residential as predominant land use and may include some public recreational spaces;
- representative of typical suburban development patterns for the city;
- close proximity to a transport network;
- project site is a community scale neighbourhood with a size is larger than a single block;

Case study one, in the City of Miami is located in the southern part of Miami. According to the Miami 21, the selected case study area has T3O suburban zoning and is located in Miami-Dade County. Planning controls of T3O zone permit a maximum density of eighteen dwellings per acre or seven dwellings per hectare, fifteen meters permissible minimum lot width and a minimum lot size 465m^2. A maximum of fifty per cent of the lot area can be covered as first floor and twenty five per cent of the lot area can be allocated as green space. Front and rear setbacks are 6.1 meters each while a side setback of minimum two meters is allowed (City of Miami, 2012, p. V.11). The case study in Miami has a suburban traditional neighbourhood pattern of development characterised by detached separate houses.

The case study two - Sydney is located close Wolli Creek railway station connecting to two rail networks: Wollongong and Campbelltown. It is in the Turrella - Bardwell Valley under the jurisdiction of the Rockdale City Council (Rockdale City Council, 2013a).The Council’s Local Environmental Plan (LEP) 2011 identifies that the case study two in Rockdale, Sydney has R2 zoning or low density residential zoning. Some of the open spaces within the site are zoned as RE1 or public and recreational zoning. These spaces could be effectively transformed into food producing spaces such as community gardens or urban farms depending on their spatial dimensions.

Data collection and methodology

Research methodology consists of four steps: a brief review of food efficient design and planning approaches; selection of two suburban case studies; generation of new morphological data and a comparative analysis to identify potential local food site typologies and research directions. A literature review, was conducted to review the concept of 'The Transect', T3 zoning in the form based code in Miami 21, zoning in LEP 2011 and relevant research on food efficient design and planning approaches such as 'agrarian urbanism'. Two suburban neighbourhood case studies were selected from Miami and Sydney following the selection criteria as mentioned in the earlier section in this paper. A visual analysis was conducted to understand important urban design elements such as enclosure, block length, streetscape, built form, pedestrian environments etc. in these two case studies.

Aerial photographic data on Sydney case study was sourced from SKM imagery data and City of Miami aerial photos were obtained from google earth and cross-checked with other aerial data providers. The aerial geo-referenced photographs were used for new spatial data generation on suburban morphologies. New data on typologies of food production spaces available onsite within these two selected case studies were measured from these aerial photographs using Geographic Information Systems (GIS) methods. GIS analysis assisted in objective assessments of the sites. Three typologies local food producing spaces: urban small farms, community gardens, and home gardens - rear garden spaces were analysed in two case studies. Rear gardens were selected as utilisation of these spaces has been comparatively higher for vegetable production purposes. This analysis was conducted to identify and to compare morphologies, spatial dimensions three food production typologies and possible integrations of these typologies in two case studies within existing built environments. Spatial dimensions of these selected typologies of food production spaces were determined based on analysis of international and national case studies on typologies of local food production spaces (Ghosh, 2013a). Other relevant information on the case studies such as development controls or planning regulations and others, are collected from relevant research reports, Australian Bureau of Statistics (ABS) and US Census, and other internet resources.

Results and discussions

Case Study One – Miami

Case study one in Miami, consisting of a total of six blocks, presents a typical grid iron pattern of street networks and thus, provides flexibility, higher permeability and ease to get around within the site. Visual analysis indicates that overall area retains a traditional residential development pattern with detached single to double storied houses on narrow parcels. There are ample open spaces in most of these houses in the front which is used for parking more than one vehicles or cars. The architectural styles clearly reflect local pattern and dominance of sub-tropical style of houses. Some of the plots have land uses such as offices, shops and other uses and are mainly located transportation route along the western side of the site. Wider road with larger front setbacks create appreciation spaces. In some blocks, street trees create better enclosures and urban design qualities although lack of trees is noticed on some of the streets. Fig 3 details some of photographs of the site.


Built form


Pedestrian environment

Fig 3: Visual analysis of case study one - Miami (Photos by: Author)

Using GIS methods typologies of food production spaces available within the selected case study in Miami was assessed from aerial photographs. There are only two plots between two adjacent roads which suggest houses are placed on the street frontages and absence of long driveways for access.

Case Study One – Miami can be divided in to six blocks, numbered from A to F as detailed in Fig 4**.** An analysis on subdivision patterns indicates that most of the lots have rectangular configurations and total areas of plots vary in different blocks. Spatial distributions of three typologies of food production spaces in the case study one is mapped and presented in Fig 4. Fig 5 presents frequency distributions of plots in two blocks A and F as examples and distributions of areas of home gardens in different blocks. In Block A, plot sizes vary from 477m² to 1050m² while the plot sizes in Block F vary from 356m² to 602m². In Block C, plot sizes vary from 323m² to 1266m² while the plot sizes in Block D vary from 519m² to 718m². The plot sizes in Block B vary from 448m² to 1001m² and the same in Block E vary between 502m² to 659m². These values suggest that there are variations plot sizes and larger plots generally have larger backyards for home gardens. Total area of the site is 120703 m² or 12.1 hectares. The total area of land in plots is calculated to be equal to 93416 m² or 9.3 hectares or 77% of the total site. Approximately 2.77 hectares or 23% is devoted to roads, grass verges with footpaths within the site area.

GIS analysis shows that blocks have rear garden spaces that could be effectively utilised a local food production. However, each block although have similar rectangular configuration, has different potential to accommodate backyards gardening for growing food. Some of the reasons for these are dominance of impervious surfaces such as ancillary structures, larger building footprints and impervious surfaces, driveways and pathways. Some front gardens are large enough for using as community gardens. Total community or small urban farm area is calculated to be equal to 2182 m² and the individual spaces with potentials to establish community gardens vary from 215m² or 0.02 hectares to 637m² or 0.064 hectares in area. An analysis on spatial extents of different food production sites indicates that approximately 0.2 to 0.5 hectares of land is required for urban small farms while community gardens could be set up on 0.004 to 1.0 hectares of land (Ghosh 2013a). Home gardens vary with density of developments and street gardens could be accommodated within a few m² to 100m² of land area (Ghosh 2013a). Details of the home garden spaces in six different blocks in case study one has been included in Fig 5.

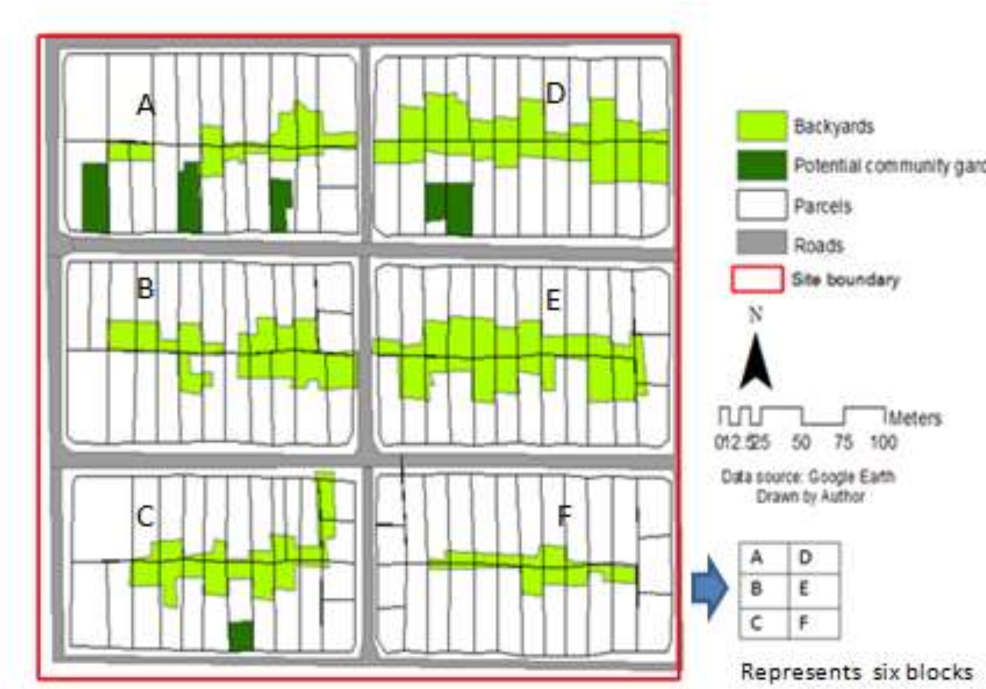
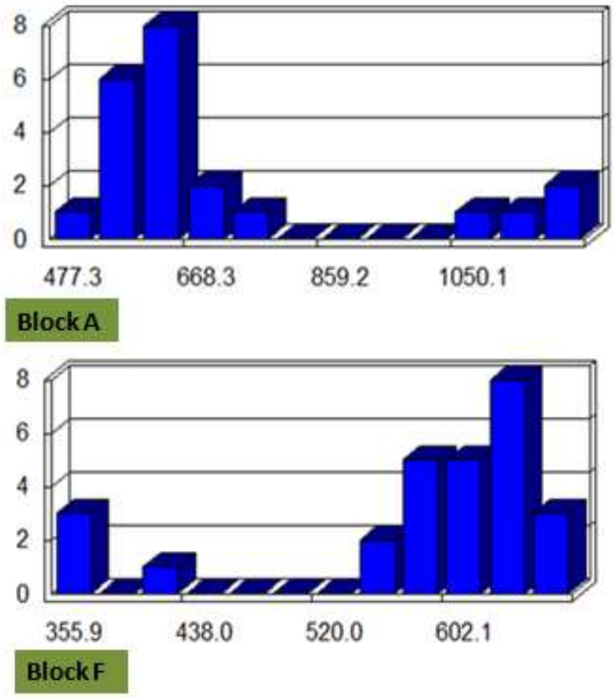


Fig 4: Case Study One – Miami – potential local food production typologies (Community scale)

A detailed analysis of land use patterns of Block D indicated that 23.2% of the overall site area is covered by building roof areas with ancillary structures such as garages and sheds etc. while tree canopy covers 14.5% and road area including half road width of peripheral roads is 24.0%. A higher percentage or 29.5% of the site is impervious surfaces driveways and footpaths in the front and other uses. Average building roof area is 168 m² except an ancillary structure and density is 14 dwellings per hectare (Ghosh 2013b).

According to Miami 21, this case study area has a Sub- Urban T3O zoning. The area is still evloving to incorporate characteristics of suburban T3 zoning. Retrofitting this existing form to adapt to any one of the food efficient design models would happen over time and at different resolutions such as block, community and regional scales. Spatial scale plays an important role and comprehending morphological variations in different scales will be very important. The transformations of built environments using food efficient design need to be calibrated case by case basis considering local characteristics, existing morphologies, community aspirations, establishment of social networks and sustainability. Out of four models (Duany et al., 2010), 'Urban agriculture' may be a better model for retrofitting existing forms intially which may over time could evolve to adapt intentional 'agrarian urbanism' principles.



Blocks	Area of home gardens in m²
A	1651
B	2823
C	2574
D	4449
E	4292
F	1297
Total	17086

A	D
B	E
C	F

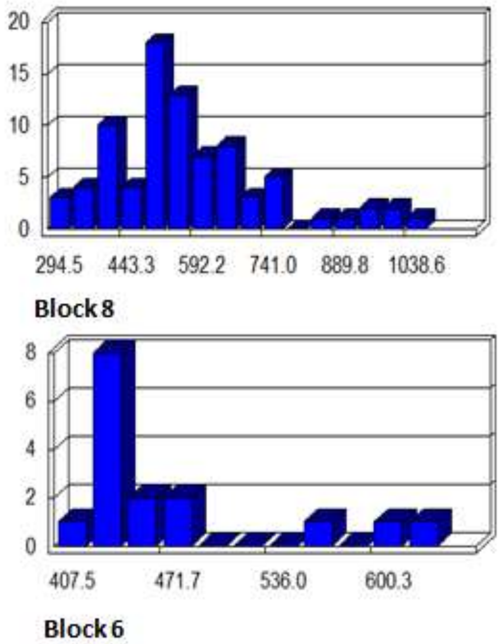
Fig 5: Frequency distributions of plot sizes in two blocks and garden spaces – case study one

Case Study Two – Sydney

Visual analysis of the case study two in Sydney shows that the development pattern is predominantly low density residential with detached single to double storied houses. There are ample open spaces around the houses and the form reflects a typical Australian traditional suburban development pattern. As the site is located close proximity to the railway station some medium densities are seen within the site area. Street network is irregular with curvilinear streets within the site. Land uses such as offices, shops and other uses are mainly located near the railway station. Street trees create enclosures at human scale and provide better urban design qualities. There are public recreational spaces or parks, parts of which could be effectively used as small urban farms and community gardens. Many of the houses have larger backyards that are useful for local food production.

The block sizes vary and some of them are too long compared to case study one and to promote walkability as shown in Fig 6. There are several narrow single plots facing roads on either side of the plots. Backyards spaces create continuous biodiversity corridors in most of the blocks. The open spaces within the site could be connected to form an open space network. Total site area is calculated to be equal to 268,775 m² or 26.8 hectares. Total area of land in plots is 206,567m² or 20.6 hectares or 77% and rest 6.2 hectares or 23% is devoted to roods and footpaths. Land area distributions in plots, roads and footpaths are similar in both Miami and Sydney case studies. The plot areas in case study two – Sydney vary as the site has medium density housing in addition to predominant low density residential and public recreational spaces..

Fig 6: Case Study Two – Sydney – potential local food production typologies (Community scale)



Typologies local food production spaces	Area of home gardens in m²	Area of community garden/urban small farm (m²)
1	10667	7490
2	679	-
3	7487	-
4	288	2957
5	9955	-
6	1798	-
7	3443	11593
8	17511	-
Total	**51828**	**22240**

Fig 7: Frequency distributions of plot sizes in two blocks and garden spaces case study two

In Block 8, plot sizes vary from 295m² to 1039m² while the plot sizes in Block 6 vary from 408 m² to 600m². Block 1 has larger variations as medium density housing and public recreational park is located in this block with low density residential plots.

Total backyard spaces available for food production is calculated to be equal to 51828m² or 5.2 hectares and spaces for community gardens and urban small farms is 22240m² or 2.1 hectares. All three typologies of food production spaces: community gardens, urban small farms and home gardens are identified within the site in case study two (Fig 7). Total community or small urban farm area is calculated to vary from 2957m² or 0.296 hectares to 11593m² or 1.16 hectares in area. Small urban farms and community gardens could be accommodated within these spaces. A comparison of overall morphologies of two case studies is presented (Table 1).

Table1: Morphological characteristics of suburban environments in two case studies

Parameters (m²)	**Case Study One** (% of total site)	**Case Study Two** (% of total site)
Total site area	120703 (100%)	268775 (100%)
Total area in plots	93416 (77.3%)	206567 (76.8%)
Total area in roads and grass verges with footpaths	27287(22.6%)	62208 (22.2%)
Total area of rear home gardens	17086 (14.1%)	51828 (19.3%)
Total area of community gardens/small urban farms	2182 (1.8%)	22240 (8.2%)
Total area of other spaces driveways, surfaces, front & side gardens etc.	74148 (61.4%)	132499 (49.3%)

Following these, a further visual and GIS analysis of morphologies of another high density urban form in Sydney at local scale has been conducted. Fig 8 represents spatial mapping of the urban form, built form structure and visual representation of areas of land areas locked in the neighbourhood parks. In this site, communal open spaces cover 19% of the total site area (10.3 hectares) which could be effectively transformed into food production spaces. These typologies of spaces are different from the potential spaces that are available in low density urban forms as measured in case study one and case study two in this paper.

Fig 8: High density - local food typology

'Grow Your Park' program run by National Recreation and Park Association (NRPA) in the USA assists in development of community gardens in urban parks (NRPA 2013). Patterson Park, a 155-acres or 63 hectares park in southeast Baltimore, offers rental garden plots for City Farms Program (NRPA, 2013, p.15). There are a number of case studies in different parts of the USA such as Iowa, Minneapolis, Illinois that actively revitalises the park with community gardens for food growing activities (NRPA, 2013). This program could be effectively incorporated within low, medium and high density developments. This process could assist in sustainable community building and better social interactions.

In this research, a comparison of two low density residential suburban forms from Miami and Sydney highlights how morphological variations in development patterns could generate different typologies of food production spaces. Case study two in Sydney represents morphologies of a traditional suburban development with curvilinear streets and low densities with some medium densities. The typologies food production spaces available in this case study two are able to accommodate all three typologies: urban small farms, community gardens and home gardens. Case study one in Miami with smaller block length, grid iron pattern could accommodate only home gardens. Detail analysis of morphologies from aerial photographs at block scale allows calculation of approximate areas of available productive land for plots in different densities considering tree canopy cover, impervious surfaces such as driveways, swimming pools etc. At a community scale, a variety of other food production spaces could be included. At a regional scale, extensive green space networks can be assessed. Methodologies and outcomes between different spatial scales can be linked but resolutions will be different in different scales. Form specific solutions will be necessary. An analysis at a larger city level or at an urban to rural cross sectional level would require applications of remote sensing applications in addition to GIS models. Author's previous research had formulated a GIS based model to assess local food production potential of different density urban forms considering food demand of resident population, onsite productivity and deficit or offsite food production needs and this research has already been published as separate paper. This paper is focussed on comparing morphological capabilities of two suburban patterns to accommodate three typologies of food production spaces within their built environments. Therefore, only initial or small part of the model is applied in this paper to calculate spatial dimensions of these local food production spaces and estimations on volumes of food produced are not included.

A significant research is going on in this field. Currently local authorities and government organisations are developing policies to initiate local food production in community gardens, small urban farms and schools. In Australia, City of Sydney community garden policy has initiated development of community gardens within the city (City of Sydney, 2013). Appropriate policies will be essential for the uptake of initiatives to create food efficient urban and suburban forms. This paper highlights the importance of understanding local morphologies for spatial planning and design of food efficient human environments. Further analysis using a larger number of case studies will be essential to formulate standards on typologies of potential food production spaces at different densities within urban environments. A geospatial database on different types of local food production spaces such as home gardens, community gardens, small verges on the street and public spaces to small and large areas of farm land could be developed for cities. Sustainability performance assessments and applications of multidisciplinary methods and models could assist in creating successful food efficient built environments of future. Food production in local production sites can promote active and healthy life style and physical exercise opportunities; provide therapeutic benefits and can improve food security. Emergence of new theoretical frameworks such as 'agrarian urbanism' and their applications in master planning of communities' highlight food efficient design will play an important role. 'The Transect' as a holistic planning strategy will be able to create an order. It will provide advocacy for integrating local food production sites as important parts of design in all six zones of 'The Transect' with varied requirements and can be implemented through form based zoning code. In addition to these, there are several other factors such as soil quality, access to sunlight, orientation of the plots and peoples' aspirations to adapt this life style and participation could impact actual food production. Future research should focus on understanding all these factors individually as well as comprehensively.

Conclusions

This paper focuses on analysing morphologies, spatial dimensions and distributions of small scale urban food production spaces two suburban case studies in Sydney and Miami. Results indicate that morphological analysis could assist significantly in design and planning of built environments and informed planning policy formulation. Extending this research to a larger cross sectional analysis with different zones will be beneficial for reconnecting human habitats to nature and for improving social networks for sustainable community development.

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