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Food, water, energy, waste: an examination of socio-technical issues for urban prosumers – Part 1 (Context)

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Abstract

The human relationship with food is an under-acknowledged contributor towards climate change and environmental degradation. However, citizens’ choices and actions regarding food consumption and production in urban settings are shaped by the economic, cultural and infrastructure systems in which they live. The purpose of this paper is to examine, from the perspective of prosumers, the socio-technical factors that affect urban food production and associated energy, water and waste services. A residential development on the urban fringe of Australia’s subtropical Gold Coast was used as a case study. A mixed methods approach was utilised to gather quantitative and qualitative data through estate maps, development planning documents, visual observations, interviews and surveys. Data was analysed around the themes of food production, consumption and development infrastructure (physical and social). The estate’s food production demonstrated high biodiversity and highlighted three common challenges: biological, knowledge and water/climate. Food consumption incorporated self-consumption, sharing/trading and a range of other typical and atypical sources found in cities. An integrated approach to land-use, energy, water and waste was instrumental in enabling food production, highlighting issues that affect the ability of urban prosumers to incorporate sustainability into their food practices. The paper raises the possibility of a ‘sharing-economy’ food production typology for urban areas and proposes an initial performance indicator framework (people, planet, prosperity, governance and propagation) to understand, develop and manage urban prosumers in the context of integrated energy, water, waste and food services.

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Keywords: energy; food production; land use; prosumers; sharing-economy; urban infrastructure; water management; waste management

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1. Introduction

Energy and transport are two urban infrastructure services that are seeing a rise in collaborative consumption / the sharing-economy (1) and prosumption (2). The former is evidenced, for example, in the increasing availability of ride-share and car-share options (3, 4). The latter is evidenced, at least in some countries, by the growing number of prosumers with distributed energy systems (e.g. rooftop photovoltaic systems), giving households and businesses the ability to manage their overall energy balance (consumption, generation and storage) and play a more active role in the energy sector (5, 6). These developments have required (and continue to require) redefining the relationships between actors within these systems, and developing new business and infrastructure models (7-9). But what of the other urban infrastructure services: food, water and waste? To what extent can these services be transformed by, and benefit from, the rise of the prosumer and the sharing-economy? Increasing urbanization and the need to decarbonize the economy to mitigate against, and adapt to, changing climates, presents both challenges and opportunities to reconceive these services as an integrated ‘whole’. This paper presents some urban development and social infrastructure approaches that may require further developments to enhance the integration of food, water, energy and waste services in urban residential developments.

Nomenclature

| Black water | Sewage; water containing human excrement (i.e. wastewater with relatively high organic load) |
| Blue water  | Water withdrawn from rivers, lakes, aquifers for irrigation                                   |
| Green water | Precipitation, rainfall directly utilised in agriculture and for other non-potable and potable uses |
| Grey water  | ‘Used’ water (all wastewater except from toilets, i.e. wastewater with relatively low organic load) |
| Recycled water | For this paper: direct re-use treated sewage effluent (black water)                              |
| WSUD        | Water sensitive urban design (design/engineering for water management, use, supply and quality) |

1.1. Humans, food and urban development

Energy, food and water underpin sustainable development and are inextricably linked: agriculture is the largest consumer (70%) of freshwater resources; one third of energy used globally is expended on food production and supply; and all three are impacted by population growth, economic development, urbanization, growing demand, climate change and resource degradation (10). The dominant food system in industrialized nations is highly dependent on fossil fuels and their derivative fertilizers and is arguably one of the major contributors to climate change and environmental degradation (11-13). It is also responsible for a considerable portion of ‘waste’: inefficiencies in the food chain are estimated to result in approximately 50% of food produced being lost (between harvest and market) and wasted (thrown away) (14). This waste has associated greenhouse gas emissions and water use implications (15). It has been argued that the industrial revolution and urbanization since the 18th century has led to a metabolic rift – “a double separation of agriculture from its biological foundations, and of humans from nature” (16).

One way of tackling the problems associated with the current food system is for households to grow their own food and source their food sustainably (13). According to Wise, 52% of Australians claim to be growing some of their own food and interest in buying local food at events like markets is on the rise (17). Whilst not able to quantify what proportion of a household diet is sourced from self-grown or local market sources, Wise surmises that their increasing popularity may be attributed to a growing public awareness of the various social, health and environmental problems posed by the globalized food chain. Urban agriculture (in the form of household gardens and community gardens) may also be popular because of real or perceived individual benefits such as health and nutrition outcomes (18), access to nature and social opportunities (19). Voluntary consumer decisions regarding food consumption, however, can be shaped by the economic and infrastructure systems in which they live (20). Planners and developers are responsible, to a large degree, for the forms of human habitation we experience. Historical approaches to urban development processes, as well as different forms of, and approaches to, urban development (e.g. compact cities, eco-cities, neo-traditional development and urban containment) and the housing types promoted by these forms, appear to present differing potentials for sustainability (21-23). The objectives of this paper are to (i) investigate the impact of urban...
and social infrastructure in enabling food production, processing and purchasing in residential estates and (ii) propose frameworks to further develop synergies between water, food, energy and waste infrastructure in urban precincts.

2. Materials and Methods

2.1 Case study context

The physical context of the case study is a residential estate in sub-tropical Queensland, Australia (latitude 28°S). The 110-hectare urban-fringe site is nestled on flat and undulating ex-farmland on the north face (equatorial facing) of a narrow and relatively short east-west valley. It consists of diverse landscapes including a permanent creek that runs into the Pacific Ocean about eight kilometers downstream, a riparian corridor, forests (rainforest, eucalypt and Hoop Pine), ridges and small valleys. Fifty percent of the estate is an environmental reserve for the protection of abundant and diverse native flora and fauna, and a further 30% is open space for recreational and horticultural activities. These areas are collectively owned. The area zoned for housing (20% of estate land) is divided into lots of various sizes (450 – 8000 m²) to encourage a mixed demographic and to reflect the three distinct geographic profiles within the estate: creek flats, gentle to moderate sloping terraces, and undulating highlands (Figure 1). Housing allotments (lots) are typically organized into small neighborhoods (Ecohamlets) to encourage social interaction (Figure 2).

![Figure 1](image1.png)

Figure 1. Estate Master Plan showing three distinct precincts based on topography and protection of forests / waterways
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The estate is a developer-implemented residential estate that aimed to provide opportunities for residents to live sustainably. Typical for green-field residential developments in Australia, the developer provided the core infrastructure (energy, water, waste, roads / laneways, telecommunications) and subdivided the land into common areas and individual housing lots. Individuals/families selected a plot of land for purchase and made their own arrangements for the design and construction of a house of their choice, within the constraints of state and municipal building regulations and local estate covenants, including a ‘lot layout’ (Figure 3).

Tied in with this purchase of an individual housing lot is a share in common property, similar to purchasing an apartment within a body corporate structure. The vision of the developers of this estate was to inspire sustainable living and inform further ecologically sustainable development. To achieve this, a comprehensive Architectural and Landscape Code was developed that encompasses environment protection, resource management and social cohesion, reflecting the triple bottom line of sustainability (Table 1). The extent of this ‘building code’ is not typical of urban developments but it is legally binding on all individuals who purchase a property within this estate and all families (owners and renters) who live in the estate. Free market forces determine who lives within this estate (as owner-occupiers or as tenants): there is no pre-condition to live sustainably. The implementation of water sensitive urban design (WSUD) means that the estate is not connected to the city’s water supply or storm-water drainage systems. Each house has a dual water supply: their own rainwater (green water) storage tanks (25-45kL) for indoor and outdoor purposes, including drinking water) and reticulated recycled water from the estate’s sewage treatment plant that includes anaerobic septic treatment, anoxic and recirculation tanks, bio-filtration, microfiltration and UV disinfection (24) (Figures 4, 5). This plant can supplement recycled water with blue water from a bore. Construction practices aimed to minimize compaction of the soil and the interruption of the hydrological flows. At the time of this study (2014), 96 houses were completed and occupied (out of 141 housing lots), and the population was estimated at 300 persons.
Figure 3. House lot plan showing building footprint limits, food production area and avoidance of solar overshadowing

Table 1: Twelve key areas addressed by the estate’s building code (in addition to State and municipal building regulations)

<table>
<thead>
<tr>
<th>Environment protection/enhancement</th>
<th>Resource management and monitoring</th>
<th>Social Cohesion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Buildings (size and scale to minimise site impacts)</td>
<td>Energy (energy efficiency, renewable energy)</td>
<td>Community (enhance casual &amp; organised social interaction)</td>
</tr>
<tr>
<td>Land (protection, restoration and stewardship)</td>
<td>Water (self-sufficiency; rainwater; recycled water)</td>
<td>Home Office (lifestyle; reduce transport needs)</td>
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Table 1: Twelve key areas addressed by the estate’s building code (in addition to State and municipal building regulations)

| Ecovillage Architectural and Landscape Code: Ethos, purpose, considerations, requirements                                                                 |
|---|---|
| Environment protection/enhancement | Resource management and monitoring |
| Social Cohesion | Buildings (size and scale to minimise site impacts) |
| Energy | (energy efficiency, renewable energy) |
| Community | (enhance casual & organised social interaction) |
| Land | (protection, restoration and stewardship) |
| Water | (self-sufficiency; rainwater; recycled water) |
| Home Office | (lifestyle; reduce transport needs) |
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| Privacy, security, safety | (visual, physical and acoustic) |

Figure 4. Estate rainwater capture, wastewater treatment and reticulation schematic (24)

Figure 5. Schematic of wastewater treatment plant (24)
2.2 Methodology

A mixed methods approach was utilized to gather data for analysis, including both quantitative and qualitative data. Utilizing estate maps, a Land Use Map was developed by viewing each private house lot from the street, looking for evidence of food production (e.g. fruit trees, vegetable gardens and chicken coops). Development planning documents (e.g. the Architectural and Landscape Code; Infrastructure Plans; Estate Landscape Plans; Staged Development Plans) were viewed to evaluate qualitative data from the perspective of the urban development plans and implementation.

Qualitative methods, essential when describing and seeking to understand people (25), consisted of interviews and surveys. Semi-structured interviews (60-90 minutes) were conducted with 22 residents (23% of the resident families). Interviewees were recruited via snowball sampling (26), starting with residents known to be involved in some level of food production. This technique may have led to a biased sample because the initial interviewees may have shaped the structure of the interview which followed (25), however this was limited by seeking out interviewees independently and having a reasonable sample size. Interviews were conducted within private homes and typically included a tour of the garden. Participant ages ranged from 30 - 70 years and included both males and females. Participants were unemployed, self-employed, employed and retired individuals. Those interviewed had lived in the ecovillage between one and six years. Interviews were audio-recorded and transcribed. An anonymous online survey was available to all residents through the community’s intranet. This survey included both quantitative and qualitative questions relating to food production and consumption. The results (n=16; 17% of households) were analyzed using Microsoft Excel and utilized to supplement the land use survey and the interview data. It is unknown the level of overlap between interviewees and survey respondents.

Taking into account the Land Use Map and available development documentation, the transcribed interviews, observation notes and survey responses were analyzed around the themes of food production (what is grown), gardening practices (strategies deployed to produce the food), food consumption and development infrastructure.

3. Results

Part B of this paper presents the results of the study as well as discusses the implications for urban and social infrastructure. Acknowledgements

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References


