DRAFT REPORT

Community Food Resilience in the Avon-Otakaro Residential Red Zone
Christchurch and its future for community food security

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Community food resilience in the Avon-Otakaro residential red-zone: Christchurch and its future for community food security

By Daniel Gilmour

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Executive summary

New Zealand is seen as a food secure nation due to its world leading agricultural reputation and the fact that it is a net exporter of food. However, a growing literature on relative global food security indicates that it cannot be taken for granted by any nation. Many countries are realising this, and governments are working to improve food security. Urban agriculture – in particular community gardening – is seen as one way of enhancing a community’s food resilience.

A series of large earthquakes in Christchurch, New Zealand, in 2010 and 2011 revealed problems with the current food supply system in that city, and also the importance of existing community gardens as part of the greater food provisioning network. As community organisations began promulgating the idea of expanding the scale of urban food production in Christchurch – and large areas of the central business district and suburbia were cleared and left vacant – a need for research into the suitability of some soils in the area for food production became apparent. This was especially the case for the Avon-Otakaro Residential Red Zone, where extensive housing demolition meant a 400 hectare ‘green corridor’ would soon be created. Food production was touted as one possible ‘interim’ use for the land.
A growth trial using soil from one site within this area concluded that with adequate irrigation crops can be grown in the liquefied soil, which had a higher than predicted organic matter content.
1. Introduction

Food resilience is the ability of a community or system to bounce back after a disturbance of some kind (for example a natural disaster) in relation to the production of food and to retain its capacity to produce food. It is closely related to notions of food security. Food insecurity and scarcity is a global issue which has caused rioting and unrest throughout the world, even in typically food secure places of the developed world (FAO, 2008; King, 2008). Food insecurity is a term which is used to describe the inability of individuals or communities to have steady or reliable access to food resources.

Food security broke down during the major earthquake events in Christchurch during 2010 and 2011 (NZ Doctor, 2011). The potential for natural disasters to interrupt the normal flow of food into the Christchurch community had already been identified by the Christchurch City Council, particularly through its Climate Smart Strategy which noted the importance of increasing the production of food within the city limits (Climate smart strategy, 2010). Immediately after the February 22 2011 earthquake, many supermarkets within the city and its suburbs were shut down. The Council of Social Services and Healthy Christchurch noted in a July 2011 report that there were ‘more hungry children, and single mothers with a lack of food security’ as a direct result of the earthquakes, while ‘demand for food parcels increased.’ It claimed that food banks were ‘struggling to cater for demand’. Some people became isolated within their communities, no longer having the ability to access food.
The same report noted that people in Christchurch had ‘proposed a number of grassroots-focused initiatives to build community resilience and connectedness’, which included community gardens (supporting community recovery 2011). A much smaller earthquake on Christmas Eve 2011 resulted in seven supermarkets being closed throughout the city, again interrupting food supplies temporarily (Christchurch earthquake and what you need to know 2011). A report produced by the Canterbury Community Gardens Association in 2012 claimed that the ‘positive effect of the Canterbury earthquakes is that there is much greater awareness of the importance of community resilience and a large amount of land becoming available that will not be rebuilt on.’ (Peryman 2013)

This project aimed to provide information that could be utilised by groups lobbying for the creation community gardens or larger scale urban agriculture projects in the Avon-Otakaro Residential Red Zone. Was soil that had been affected by the liquefaction material (primarily silt) an adequate growing medium?
2. Christchurch as a Food Basket

2.1 Christchurch History

In thinking about the future for food resilience in Christchurch, it is useful also to consider its history as a food source. Ngai Tahu arrived in the South Island of New Zealand around 700-800 years ago. Some lived in the Canterbury region and frequented the marshy swamplands which now form the suburbs of Christchurch, gathering food resources such as eels, bracken fern and flounder (Christchurch City Council 2005). Their mahinga kai (‘food and other resources and the areas that they are sourced from or in which they grow’ (Environment Canterbury 2012) or ‘the resources of the land, and the resources of the bush and forest’ (Ngai Tahu 2012)) were generally situated along the main waterways.

European settlers, arriving from the 1840s, were equally drawn to the river margins. They brought crops and animals from their home nations and found that these introduced species acclimatised and eventually adapted very well to the Christchurch climate. The Deans brother’s farm, situated alongside the upper portion of the Otakaro (Avon River), was laden with fruit trees which bore fruit heavily unlike anything they had seen before (Morris 2006). The settlers faced hazards from the environment around them including floods from the Waimakariri, strong gusty winds and earthquakes (Christchurch City Council 2005). Otautahi, later known as ‘The Bricks’ (also on the Avon River) was an area used for food production or cultivation of food producing plants and an area of mahinga kai. Ngai Tahu rangatira, Hakopa te Ata o Tu, made a claim for the land in the Native Land Courts, based on its traditional use as mahinga kai. Previously the area was frequented by Te Potiki Tautahi, a Ngai Tahu chief who resided at Port...
Levy and who used the area seasonally as a food resource. In the 1850s the land was used by the nurseryman (later the Mayor of Christchurch) William Wilson, who used the land to cultivate vegetables and useful trees for the people of Christchurch (Morris 2006). Further along the Avon numerous other gardens flourished, often with the primary focus being on food production. Market gardening and orcharding are also believed to have been prevalent along the river to the east of the central city (Pers. Comm. Diana Madgin, 2012).

Map 1: The Avon Otakaro Residential Red-zone of Christchurch city (shown in red)

2.2 The Avon-Otakaro Residential Red Zone and Growing Food

After the Christchurch earthquakes, the area now referred to as the Avon-Otakaro Residential Red-Zone (see Map 1) was deemed unfit to rebuild on in the immediate future and properties, bought by the government, are slowly being cleared from this area. Mayor Bob Parker expressed interest in creating a food forest initiative within the city based on the Beacon Food
Forest in Seattle. His belief was that a food forest would bring people back to the city and provide food for the community (Christchurch Mail). Various community organisations such as Avon Otakaro Network (AvON) have also put forward ideas concerning food cultivation throughout the red zone as a means of feeding the community, bringing people back to the city and enhancing food security (AvON 2012). Such initiatives, increasing accessibility to a healthy food resource, would allow the city to be utilised as more than just a business hub, a move that Bob Parker believes is ‘what Christchurch is naturally moving towards’ (The Christchurch Mail).

The Christchurch City Council’s Integrated Recovery Planning Guide (2011) included a section on food security, asking the question: ‘Can new vacant sites be prioritised for community food production?’ (Climate smart strategy)
3. International Food Security Issues and Solutions

3.1 Urban Food Deserts

There is an urgent need to establish food security or resilience, as ‘green deserts’ or ‘food deserts’ are appearing across the world (Fukuoka 2012). Green deserts are areas mostly suburban but also rural where the area is green but devoid of biodiversity, for instance suburban areas planted with introduced grasses instead of native flora. Rural areas can also be green deserts where mono cropping with plantation forestry (pines, eucalyptus and others) and pasture for ruminants occurs whilst restricting the area for native flora or fauna which are unable to obtain resources in these modified ecosystems. Food desert areas which are usually urban, are areas that could potentially be food secure in terms of arable productivity, but the majority of the population have limited or no access to healthy vegetables and fruit (Kreitlow 2009 and Whelan et al. 2002). Food deserts are ‘a geographic area with low food security that is measured using physical distance, availability or price’ (Kreitlow 2009). Access to healthy food is dwindling, and health problems associated with this are on the rise (FAO 2008).

3.2 Climate Change Issues for Food Security

Another issue that is likely to affect food security is climate change. Brooks and Loevinsohn (2011) addressed how climate change may affect future measures to enhance food security. Small holder farms in developing countries are the mainstay of food production, so prolonged drought, or unusual seasonal weather patterns could spark famine across many nations.

3.3 Food Security and Sustainable Farming
It would appear from the literature that the more resilient food systems tend to be ones where sustainable land and water management are practiced. Three phases for shifting towards sustainable management are described in King (2008). The first phase, ‘engineering resilience’, sees people and nature as separate, ecosystems are static, and there are no allowances for disturbances. In the second phase, ‘ecological resilience’, resilience is measured by how much disturbance the ecosystem can take before it changes state. In the third stage, ‘adaptive capacity’, people and nature are one, states can be reversible but others are irreversible. These sustainable management measures can be achieved through the use of organic agriculture, permaculture, community supported agriculture, biodynamics, farmers markets and community gardens. Reganold et al. (2010) also shows this growing trend in public awareness to shift from conventional farming methods to more organic or natural farming methods. Reganold et al. (2010) explain how American consumers are buying organic foods due to the perceived benefits to health and to the environment, and less pesticide residues. Two thirds of American consumers buy products labelled as organic produce at least occasionally and ‘28% buy organic products weekly’ (Reganold et al. 2010). This reflects shifting public attitudes towards organic, as the United States of America is the fourth largest producer of organic foods. The New Zealand organic market is reflecting the trend in the United States of America, increasing 7.5% between 2009 and 2011, with an estimated domestic value of $133 million (The New Zealand organic market report 2012).

3.4 Government Programmes for Local Food Resilience

Marchione (2005) described how targeted nutrition programmes by governments with adequate information on the situation of the people can enhance food security. In Australia, the government has established the ‘Stronger Families and Community Strategy’ which aims to help
those in the community ‘with a particular focus on those at risk of social, economic, and geographical isolation’ (Australian Government 2004). The strategy funded by the government has $225 million at its disposal to mitigate potential effects from food insecurity among other issues. This strategy promotes working together in partnerships, building capacity, supporting people through life’s transitions, encouraging a preventative and early intervention approach, and developing local solutions to local problems – and community gardens are posited as one of the possible ways to meet these aims (Australian Government 2004).

3.5 Community Gardens

One response to these issues is community gardening. Community gardens are beneficial drivers of developing food security by providing a space for a range of different crops, allowing for a nutritious diet, or complementing a staple diet for those who use it. Buchmann (2009) describes how during the food crisis in Cuba, the people took their own initiative and started gardens (mainly home gardens) to obtain the nutrients needed that were not supplied in food nutrition programmes to curb the crisis. Community gardens in Havana also contributed to food accessibility; some neighbourhoods purportedly produce up to 30% of their own food needs within the neighbourhood (Novo and Murphy 2013). This added nutrition from gardens, and especially community gardens, has helped to relieve malnutrition and reduce food deserts all over the world (Whelan et al. 2002, Kreitlow 2009, Australian Government 2004).

Community gardens ‘create eco-spaces on once derelict land making them productive, whilst increasing the biodiversity in the area in both the flora and the fauna’ (Australian Government 2004). They also reduce carbon emissions by removing the need to transport produce, as well
as reducing the carbon footprint of the community. The plants absorb carbon in the air and produce oxygen.

Community gardens also create social cohesion between neighbours throughout the community (Firth et al. 2011). Families increase their nutritional intake, and gardening is an exercise which helps reduce cholesterol and blood pressure. Gardening is therapeutic and the psychological benefits of community gardens are also known as many see these spaces as tranquil and calming. Horticultural therapy is used in prisons and mental institutions as these activities ‘reduce anxiety, depression and promote relaxation’ (Australian Government 2004). Harris (2009) establishes that community gardens save the community economically, reducing youth crime rates. This gives youth and adults within the community a purpose or a sense of belonging. Community gardens have been shown to create a community inside a community. Establishment of community gardens throughout the red zone area would help to bring the community together and create a social environment which can enhance food resilience.
4. Soil Testing in the Avon-Otakaro Residential Red Zone

Given the changed nature of the soil in the Avon-Otakaro Residential Red Zone, and some anecdotally expressed concerns about its suitability for food production, experiments were designed to determine whether the soils at selected sites throughout the Avon-Otakaro Residential Red Zone could be suitable for creating community gardens or other forms of urban agriculture.

4.1. Obtaining soil samples

Four areas within the Avon-Otakaro Residential Red Zone were selected due to their proximity to highly versatile soils (identified by Landcare Research Report, 1970), and local community interest (identified by the community group AvON and members of local the community gardens association). The areas fell within one segment of the red zone bounded roughly by the Avon-Otakaro River to the south, Stanmore Road to the west, and Lake Terrace Road to the north and east. Four properties from each area were chosen to be analysed. The properties had been cleared and did not feature temporary ponds. Top soil (0-7cm) was sampled as this depth is the most likely soil depth for gardeners to utilise and interact with. The ‘Z’ sampling pattern was used to collect ten cores from each of sixteen properties to give an average of the soil composition at each property. The technique was replicated across the area. The ten cores from each individual property were mixed to create evenness of the soil composition. Thus, a total of sixteen samples were gathered (each consisting of ten cores). The sixteen samples were then placed in individual ziplock bags and were analysed in the lab. The samples for the glasshouse growth trial were collected with a stainless steel shovel and then placed into heavy duty bags.
4.2. Experimental Design

The samples of soil were analysed by growth trials in the glasshouse environment, and ‘loss on ignition’ for soil samples was conducted in the lab. The results of each analysis were compared with previous literature and environmental standards.

4.3. Growth trials

*Picture 1: Growth trial soil collection*
The soil samples collected for the growth trial (picture 1), in heavy duty bags were placed into pots and labelled by the location that the sample came from (for instance s1-s45). Ninety kg of soil was gathered and used for the growth trial because two kg per pot was an adequate amount of soil to ensure high retention of water and adequate root space. Lettuce was used as an indicator crop for this trial, as lettuce is quick growing and can be used as a standard for other salads and vegetables. The lettuce used for the growth trial was sown directly in the soil sample. Fifteen pots per treatment were used to start off the trial to ensure that at least ten pots would have good germination (picture 2). The seeds were sown directly into the pots in triplicate to also ensure germination. The most vigorous seedlings were kept and the smaller ones were thinned out. The seeds were then tested for emergence per treatment of cotyledons and results recorded. The pots were then labelled as per the water treatment of the pots. The
water irrigation treatment was as follows; Pots 1a-1j 50ml each, Pots 2a-2j 150ml each and Pots 3a-3j 250ml each (picture 3 and 4). The irrigation trial was carried out using a measuring cup (250ml max) to obtain the correct measurement of water. These pots were placed in a random order to ensure even light distribution over each of the pots. The pots were then shifted around the glasshouse each week to further allow for an even light distribution of all treatments.

The trial was run for 35 days (5 weeks) to ensure an even growing time. The lettuce plants were then weighed first with the soil and then cut at the base and removed. The above ground growth was then weighed. The lettuce plants were then placed in a drying oven at 70°C for two days. The lettuce was then removed from the drying oven and weighed; this was the first dry weight. The lettuce was placed back into the oven to sit for two hours to see if any weights had changed due to water weight being evaporated out of the plant tissue. The dry weights were continued to be taken until there was no change in weight. This occurred on the second dry weight recording. The below ground growth was then measured. The roots were removed from the pot carefully and the remaining soil was washed off using a hose. The roots were then dried in the drying oven at 70°C until no weight change occurred.

*Picture3: Treatment three pot with measuring cup*
The growth of each plant was measured over the five weeks using a ruler for height as this gives an approximate idea of the richness of the soil profile (nutrients and microbial activity) and a growth chart over the weeks was constructed. The results of the growth trial was then analysed statistically using R and plotted on a graph to show the difference between each treatment.

4.4. Loss on ignition

Some of the sample soil was placed into crucibles (16 in total) and weighed. The crucibles were then placed into a ‘loss on ignition’ oven at 450°C for two days. The soil changed from a brown to a pale orange colour when organic matter had been removed. The crucibles were then weighed again to see changes in weights that had occurred. The formula (Instruction for users, n.d), L.O.I. (weight %) = 100 x ((n₂ - n₃) / (n₂ - n₁), was then used to calculate the percentage of loss on ignition (where n₁ = crucible weight, n₂ = soil + crucible weight, n₃ = final weight).
4.5 Results

Figure 1 illustrates the differences in root length between treatment two and three. The overall trend shows that bigger lettuces had bigger roots. Paired t-tests were used to analyse the data between the two treatments, which identifies the difference between the means of the treatments. The root difference between the treatments was significant \((p=0.01737)\) therefore the treatment had an effect on root growth, rejecting the null hypothesis. Figure 2 also displays that higher levels of above ground growth were seen in treatment three.

**Figure 1: Root Length of each lettuce plant**

**Figure 2: Total growth of each lettuce plant after 35 days**
Treatment two in terms of growth significantly differed from treatment three (p= 0.02584) again rejecting the null hypothesis that treatment had no effect on lettuce growth. The dry weight of the lettuce is shown to differ between treatments in figure 3. Lettuces with more growth were heavier and had more dry weight than those in the lower growth treatment. The initial weight difference before drying the lettuce plants and after drying the lettuce plants were shown to be significant only in the treatment three group (p=0.03766). Treatment two showed no significance between initial weight and dry weight (p= 0.07046). Figure 4 illustrates how root development (measured in weight) did not differ significantly (p= 0.221). Treatment three showed better root development compared with treatment two. The trend seems to be that bigger plants produced longer and heavier root systems.

**Figure 3: Dry Weight of lettuce**

**Figure 4: Dry weight of roots for each lettuce plant**
Table 1: Samples and loss on ignition percentage

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<th>Samples</th>
<th>Loss on ignition percentage (%)</th>
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<tr>
<td>D1</td>
<td>10.4547</td>
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<tr>
<td>D2</td>
<td>7.6314</td>
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<td>D5</td>
<td>4.7371</td>
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<td>D6</td>
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<td>D7</td>
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<td>D8</td>
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</tr>
<tr>
<td>D16</td>
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</table>

‘Loss on ignition’ testing showed that the soils lost 6.8876% on average in organic matter (Table 1). The range of loss varied from 10% at the highest range to 5% at the lowest range. This determined that the liquefied soil had a high organic matter content which was unlike results of a previous study conducted on liquefied, sandy soils in one property in the vicinity (Hills report 2012).

4.6 Discussion

The growth trial showed that lettuce could grow in liquefied soil as it appears that liquefied soil is relatively inert. People in the community had differing opinions on the effects of liquefaction
within the soil profile. Some people in the community said that it was the best crops they had ever seen, and others suggested that liquefaction didn’t change a lot or the crops weren’t the best that year (Pers. Comm. Dr Matt Morris, 2012). The ‘buttercrunch’ lettuce variety was used as a good indicator crop, a variety that is often utilised for contaminant uptake sampling. This variety is quick growing and matures in about 46 days. Time constraints did not allow for the lettuce to be grown to maturity although some lettuces did grow very quickly and became very large for instance 2i, 3a, 3f, and 3h. The light levels within the glasshouse were not measured although the pots were moved around and put in a randomised order every week to ensure they all had an even distribution of light during the experiment.

![Figure 5: Temperature within the glass house daily fluctuations](image)

The heat of the glasshouse during summer would also not be apparent in the field as temperatures in Christchurch city do not exceed 50°C. Figure 5 shows the temperatures that the glasshouse reached on a daily basis for 31 days, measured using a temperature analogue. During this time period the glasshouse reached 50 °C three times. Watering the pots was done by hand using a measuring jug every two days. This could have possibly been the reason for no germination result for the 50 ml treatment group due to evaporation capacity. The other two
treatments had 100% germination rates and it appeared that a minimum of 150ml of water is pertinent to ensure plant survival. Field testing would have allowed more of a direct result to the community concerning the land, however the environment in the field is uncontrolled as opposed to the glasshouse which was a controlled environment. There were also issues of access to the field testing site which would not allow for testing to occur on a regular basis. The testing for the growth trial was conducted in the glasshouse to show an analogous situation to the red zone soils, however microclimates and other factors such as nutrient supply or disturbance within the area may create differing results.

The above and below ground weights accurately complemented the results shown in the growth trial. Generally, the more water available to the lettuce, the bigger it was able to grow. The bigger lettuces had a larger proportion of below ground roots as opposed to above ground roots. The hypothesis for root length was that if the lettuces were given less water the roots would grow more in order to search for available resources. This was not observed in the trials and may have been an artefact of the lettuce plants being grown in pots rather than in soil beds. Therefore above and belowground growth was dependent on water treatment. Water treatment three showed the best growth on average compared to treatment two. Treatment one showed no growth. Treatment three pots, when watered, leaked out and water would sit on the surface of the bench, treatment two pots’ soil generally dried out during the day after watering had occurred. The lettuces of treatment two were sometimes wilting when the next watering took place. Treatment three lettuces usually stayed in a constant turgid state and soil only dried out twice during the experiment. The lettuce plants of all treatments were watered two days in a row on the 9th and 10th of January 2013 as watering by hand could not be done till 12th of January. The plants did not seem (observationally) to be affected by this change in
watering regime, however this was not analysed. More treatment levels in between treatments one and two, or two and three could be tested in future to see what optimal water level treatment should be used by urban agriculturists in the residential red zone to obtain the highest growth whilst conserving water. The statistical analysis showed mostly that there were significant differences between treatment two and three.

Two lettuce plants (2d and 2j) perished during the course of the experiment and the last recorded height for these two plants was taken on the 17th of January. The plants began to wilt the next day and by the end of week the two plants had perished. The reason as to why this occurred is unknown; the lettuces did not show any signs of insect herbivory nor fungal disease. Weedy species such as chickweed (*Stellaria media*), fat hen (*Chenopodium album*) and black nightshade (*Solanum nigrum*) continued to grow in these pots during this time. Competition may have been a factor, however many pots of all treatment levels contained these three weed species and these did not seem to be affected by competition. The fifteen pots which grew lettuce plants in them as replacements earlier on the experiment had lettuce plants in them, except the treatment one replacement pots. When the experiment had begun and the replacements were no longer needed, some plants from the replacement stock were transplanted into the replacement one group pots. These pots were given 250ml every two days and the replacement transplant plants thrived. This shows that the soil for treatment one had the capacity to grow lettuce plants but was dependent on water resources, which the treatment one pots in the experiment lacked. This was not analysed as it was an interest rather than part of the experiment.
The ‘loss on ignition’ testing showed that the soil of the Avon-Otakaro Residential Red Zone consisted of about 6-7% on average of organic matter. Sands typically consist of 1-2% organic matter (Pers. Comm. Dr Justin Morgenroth, 2013) although differing values can occur as the upwelling of liquefaction can bring up organic matter which was sitting on top of it. Organic matter content in the soil is good for growing most vegetables, although high organic matter soils are not the best for growing root crops like carrots (Daucus carota). Comparisons between non-liquefied soil and liquefied soil were not analysed in this project although further research could be undertaken to show how liquefaction affects soil organic matter content.

The literature review helped to shed light on the growing problem of food insecurity throughout the world. The potential for food resilience break down was present in Christchurch pre-earthquake and the earthquakes exacerbated the problem. The literature review showed that the problem of food insecurity can happen in developed nations where the gap between the poor and rich is much narrower than the gap between rich and poor in the developing world. Malnutrition is occurring for many poorer people who do not have access to healthy nutritious food sources. These people will be affected the most during weather extremes brought about by global warming and climate change. Food deserts occur more frequently even in areas which are suitable for growing food. The limitation of access to healthy food is the main cause of food deserts in the developed world. Consequently people in the developed world are more likely to buy convenience foods which are not usually healthy such as foods from dairies, petrol stations and convenience marts.
Food insecurity can be mitigated and the governments of many countries are aiming to enhance food security. The community are strong drivers in creating a food resilient environment and they can make or break the efforts of organisations to create food resilience. People can also show innovation to impending food crises for instance in Cuba the people created gardens to supplement the food rations received by the government to curb malnutrition (Buchmann 2009). There were many themes in the literature that stood out concerning mitigation techniques for food insecurity. The main one was the creation of community gardens. Community gardens created an environment of social cohesion within the community which could be implemented within the red zone. The creation of community gardens throughout the red zone in a large scale urban agricultural system could bring the community back as many have left the community (picture 5) splintering it into smaller groupings across the city. Community gardens are also tranquil and therapeutic which could help the residents who have faced such a stressful on-going situation of earthquakes and the rebuild.

The community which remains could benefit greatly from the establishment of community gardens as the infrastructure such as the roads and buildings are damaged (and waiting to be demolished), creating accessibility problems especially for elderly who may not drive. Community gardens can provide food and create a sense of community within the red zone and can attract people from outside the red zone which can create social bonds and expand the community. The gardens can also help to reduce crime in the area which is riddled with graffiti and sometimes a target for arson. Youth may feel part of the community and the gardens may give them a sense of purpose. Local government has an increasing interest in food production and initiatives could be formed to create food resilient communities throughout the Avon-Otakaro Residential Red Zone.
5. Conclusion

Christchurch has a rich food history which should be continued for many years to come. Parts of Christchurch, particularly in the eastern suburbs became food deserts after the earthquakes where food and water were scarce throughout the city and supply lines of food were adversely affected. Enhancing food security could be achieved with the help of the government and the willingness of the community to create food resilience.

The results of this project showed that crops could be grown in the Avon-Otakaro Residential Red Zone soil as the soil remains fertile, and with adequate irrigation produces strong growth. The interest from the community in establishing food resilience initiatives like community gardens can help them in the long term. Such initiatives would help the community during further disturbances in the hopes that one day the area will be thriving again with the people of Christchurch and have a sense of community.

[PLEASE NOTE: THIS REPORT IS STILL IN DRAFT STAGE]

Matt Morris, July 2013]
Recommendations

- Local and central government should aid the enhancement of food security to create a food resilient city.
- The establishment of community gardens could greatly benefit the wider Christchurch community and create new opportunities for many Christchurch residents.
- Local government needs to look holistically at this when addressing the issue of food security to make sure everyone will benefit from this.

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References

WEBSITES


Christchurch mail, Thursday the 24th of January 2013. Obtained Friday the 25th of January 2013. Article 1, page 1


ARTICLES


Harris, E. (2009). The role of community gardens in creating healthy communities. Australian planner, 46, 24-27


Appendix One: Soil trace element concentrations on Christchurch red-zoned properties

Introduction

The 2010 and 2011 Canterbury earthquakes caused significant land damage in some areas resulting in the decision to red-zone land deemed unfit for rebuilding on. One of the options being proposed by community groups for properties in the red-zoned areas is the establishment of community vegetable gardens. These red-zone sites may be redeveloped for housing in the future once appropriate remedial techniques have been identified.

Potential sources of trace elements in urban soils include lead paint, treated timber (arsenic, copper and chromium), historic pesticide use (arsenic, lead and copper), galvanised building materials (zinc) and disposal of ash. Lead paint was used on New Zealand houses until the 1980s (Ministry of Health, 2008).

A pilot study was undertaken to determine if trace element concentrations in soils in the Avon-Otakaro Residential Red-Zone exceed the national environmental standards for contaminants in soil. This pilot study was undertaken by Daniel Gilmour, a University of Canterbury summer student supervised by Sally Gaw (Chemistry), Matt Morris (Sustainability Office) and Justin Morgenroth (Forestry).

Methods

Soil samples were collected from the top 7.5 cm on 16 properties located within the Avon-Otakaro Residential Red-Zone in December 2012. The houses had been removed from all of the properties sampled. A composite soil sample consisting of 10 cores collected using a “z” sampling pattern was obtained from each property. The soil samples were dried (70 °C), sieved (<2mm) and acid digested for analysis using a modification of USEPA 200.8. The digested soil samples were analysed by ICP-MS for arsenic, cadmium, copper, lead and zinc. The recoveries for a certified reference material (NIST SRM2702 Marine Sediment) ranged from 81 to 108%.
Results and comparison to National Environmental Standards for contaminants in soil

The trace element results for the soil samples are presented in Table 1. The trace element concentrations are compared to the background concentrations in Christchurch urban soils as well as the soil contaminant standard (SCS) for residential properties with 10% home grown produce. Concentrations of lead on three properties exceeded the SCS of 210 mg kg\(^{-1}\). Lead was the only trace element to exceed a soil contaminant standard.

Table 1: Trace element concentrations (mg kg\(^{-1}\)) measured in Avon-Otakaro Residential Red-Zone property soils.

<table>
<thead>
<tr>
<th></th>
<th>Arsenic</th>
<th>Cadmium</th>
<th>Copper</th>
<th>Lead</th>
<th>Zinc</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soil Contaminant Standard(^1)</td>
<td>20</td>
<td>3</td>
<td>&gt;10000</td>
<td>210</td>
<td>-</td>
</tr>
<tr>
<td>Range</td>
<td>5-14</td>
<td>0.1-0.5</td>
<td>9-31</td>
<td>39-260</td>
<td>67-270</td>
</tr>
<tr>
<td>Mean</td>
<td>8</td>
<td>0.2</td>
<td>17</td>
<td>123</td>
<td>131</td>
</tr>
<tr>
<td>Exceedances of SCS</td>
<td>0/16</td>
<td>0/16</td>
<td>0/16</td>
<td>3/16</td>
<td>-</td>
</tr>
<tr>
<td>Background levels for Christchurch urban soils(^2)</td>
<td>5.6 – 15.3</td>
<td>0.06-0.2</td>
<td>8.8-23.3</td>
<td>22.3-101</td>
<td>54.9-149</td>
</tr>
</tbody>
</table>

\(^1\) Soil contaminant standard for residential properties with 10% produce (Ministry for the Environment, 2012)

\(^2\) Proposed level 1 background levels (Environment Canterbury, 2007)

Recommendations

- Red-zoned land should be assessed for soil contamination prior to redevelopment occurring.
- Land in former urban areas should be assessed for soil contamination prior to the development of community gardens.
- Care will need to be taken during earthworking activities to ensure that potentially contaminated soil from red-zoned properties does not enter waterways.
- Sections elsewhere in Christchurch where pre-1980 houses are being demolished and replaced due to earthquake damage may require assessment for soil contamination.

References


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