Trade-offs between high class land and development: Recent and future pressures on Auckland’s valuable soil resources

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ARTICLE INFO

Article history:
Received 2 August 2013
Received in revised form 21 February 2014
Accepted 23 February 2014

Keywords:
Elite and prime land
Soil natural capital
Ecosystem services
Urbanisation
Population increase
New Zealand

ABSTRACT

Sustainable land management is essential to meeting the global challenge of securing soil and water resources that can support an ever increasing population. In Auckland, New Zealand’s largest city, population growth is forecast to increase from 1.5 to 2.5 million by 2040 which will put immense pressure on the region’s soil resources. The objective of this study was to robustly quantify the amount of high class land (Land Use Capability Classes 1–3) that has been converted, and what is likely to occur, to urban development in Auckland using both long term trend records and future growth projections.

Spatial analysis indicated that over the various spanning datasets 10,399 ha (or 8.3%) of Auckland’s high class land has been converted to urban development through incremental urban extension, operative/approved greenfields and building consents. Of this, 10,080 ha of high class land was converted to development between the years, 1975 and 2012. The rate of urban extension onto high class land has accelerated since 1996. Furthermore, the majority of land allocated to urban extension since 1996 has been high class land. Looking into the near future, lodged/future greenfield developments equate to an additional potential development of 6010 ha (or 4.8%) of current high class land. Future growth pressures indicate that this trade-off will continue.

There is a real need to analyse the economic benefits and long term sustainability of future development against the protection of high class land for current and future production requirements. Further research should account for the true cost of lost provisioning, regulating and cultural soil ecosystem services to ensure that these values are recognised and considered not only by urban planners but also by both policy and decision makers.

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Introduction

Securing adequate food supplies for an ever increasing global population is an emerging international challenge, and healthy soil and water ecosystems are fundamental to ensuring that these needs are achieved (Busscher, 2012). However, the value and importance of soil is often overlooked (Daily et al., 1997; Robinson et al., 2013). Soils are natural capital assets and are a non-renewable resource once lost through irreversible damage and degradation they are effectively lost forever (Haygarth and Ritz, 2009; Mackay et al., 2011). The global population is projected to reach 8.1 and 9.6 billion by years 2025 and 2050, respectively (UNESA, 2013), putting immense pressures on our natural resources to meet basic human needs. More than half of the global population currently reside in cities and it is estimated that 60% of the global population will live in urban areas by 2030 (Pickett et al., 2011). High quality agricultural soils are increasingly under pressure to meet the land demands of these growing cities (Tóth, 2012). Tóth (2012) reports that for several European states, urban development occurs at the cost of highly productive croplands.

In New Zealand, there are growing concerns about the competition of high class land on the fringe of large cities for rural versus urban use (Andrew and Dymond, 2012; Mackay et al., 2011; Rutledge et al., 2010). High class land has been defined by some practitioners as Land Use Capability (LUC) Classes 1–2 and other practitioners as LUC Classes 1–3 (Blommer, 2011). Class 1 (or elite land) is the most versatile, multiple-use land on flat to undulating land. Classes 2 and 3 (or prime land) are also very good prime agricultural and horticultural land with slight (Class 2) or moderate (Class 3) physical limitations to arable use (Lynn et al., 2009). Classes 1–2 land represent 5% of total New Zealand land areas and Classes 1–3 land represent 14% (Rutledge et al., 2010).

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http://dx.doi.org/10.1016/j.landusepol.2014.02.020
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Domestic retail sales of fresh and processed vegetables are estimated at NZ$1 billion each year while export earnings range between $500 million and $600 million (Ministry for Primary Industries, 2013). These operations are only suitable on multiple-use, highly versatile land. However, Rutledge et al. (2010) report that urbanisation disproportionately affects New Zealand’s most high class and productive soils which could have a negative impact on New Zealand’s primary production capacity in the future. These authors report that urbanisation rates in New Zealand were highest for LUC Class 1 (5.86% converted land) and Class 2 (3.96%) compared with LUC Classes 3–8 that ranged from <0.01 to 2.0%. Furthermore, non-productive rural community lifestyle blocks currently cover 187,000 ha of land and occupy 10% of New Zealand’s high class land (LUC 1–2) (Andrew and Dymond, 2012). Both urban encroachment and lifestyle block extension onto high class land have the potential to constrain future land productivity and other soil ecosystem services (Daily et al., 2000; Dominati et al., 2010; Haygarth and Ritz, 2009; Metzger et al., 2006).

Auckland is the largest city in New Zealand with a population of about 1.5 million at 2012. The population is projected to reach between 1.8 to 2.5 million by 2040 according to Statistics New Zealand’s low and high population projections, respectively (Auckland Council, 2012; produced from a custom built order by Statistics NZ (2006)). The medium population projection for Auckland by 2040 is 2.2 million. The Auckland Plan (a 30 year strategic spatial plan for Auckland to 2040) is based on the high projection, which translates to a population increase 5.5 times the population in Auckland half a century ago (Mayer, 1962). The conversion of high class land to urban development will be a highly political land use planning issue in Auckland with the forecast growth driving demand for a possible additional 400,000 new dwellings by 2040 (Auckland Council, 2012). In line with this, two satellite towns have been proposed for future growth, namely Warkworth and Pukekohe (Auckland Council, 2012). Pukekohe is located where the majority of Class 1 or elite land in Auckland is and is an area that supports a significant proportion of New Zealand’s outdoor vegetable production (Fresh Facts, 2011; Hunt, 1959; Statistics NZ, 2011). Future growth identified in the Auckland Plan also requires the need for additional greenfield developments over and above what is already planned and have been noted as ‘Greenfield Areas for Investigation’ in the plan’s Development Strategy (Auckland Council, 2012).

Loss or development of highly productive agricultural and horticultural land in and around Auckland caused by the continuous extension of the urban frontier can be traced back to the early to mid 1900s (Hunt, 1959). However, there have been few in-depth, evidence based investigations of this long-standing land use issue in Auckland. While some studies in New Zealand and overseas have focused on the encroachment of urbanisation onto productive agricultural or horticultural land, datasets have been limited to broad scale or short spanning records of between 6–18 years (Andrew and Dymond, 2012; Töth, 2012). For example, Andrew and Dymond (2012) calculated that 4.1% of high class land was converted to urban use in Auckland between 1990 and 2008. However, high class land was defined as LUC Classes 1 and 2, and national datasets were used to assess urban growth (Andrew and Dymond, 2012). Although such research provides a useful indication as to what has occurred, the datasets used were not necessarily designed for analysing urbanisation trends (Rutledge et al., 2010). Additionally, future growth projections are often not accounted for. The aim of this study is to address this gap for New Zealand’s largest city.

The objective of this study is to robustly quantify the amount of high class land (LUC Classes 1–3) that has been converted to urban development, and explore what is likely to occur in Auckland using both long term trend records and future growth projections. Urban development categories and corresponding datasets are based on four inter-related criteria: (1) the progressive extension of the built-up core urban area of Auckland over time; (2) greenfield developments (operative/approved and lodged/future) defined as large scale developments, primarily on the city edge, converting land that has previously been used for rural-based purposes to urban use; (3) building consent footprint; and (4) greenfield areas for investigation for future growth. Following the quantification and presentation of findings, the paper will discuss the planning and policy implications of the research findings.

Data and methodology

The spatial assessment of the long term trend in the conversion of high class land to urban development was based on several datasets. The 1970s/1985 Land Use Capability (LUC) layer from the New Zealand Land Resource Inventory (NZLRI, 2009) was used to measure the proportion and spatial distribution of high class land in Auckland. For the purposes of this study, LUC Classes 1–3 are defined as high class land, with Class 1 land defined as elite and Classes 2 and 3 land defined as prime land in accordance with the ACRPS (2008b). Land Use Capability mapping became effective in and around the 1980s and therefore parts of the core urban area were not mapped because of pre-1980 urban development i.e. land was already developed upon before the LUC concept came in effect.

Four other datasets and layers held by Auckland Council were used to determine the recent and anticipated conversion of high class land to various urban developments. These datasets include (with length of dataset establishment in parentheses):

1. Extension of the urban boundary (1915–2010):
   - The periodic incremental extension of the urban boundary was mapped from 1915 to 2010 (hereafter referred to as ‘urban extent’ or ‘extension’). The dataset has been continuously updated over time and was last updated in 2010. Older urban extents contained in this dataset were captured using historical data, and illustrate urban extension since 1915. The new aerial photography captured for the region is digitised at the parcel/property level.

   - Greenfield developments are large scale developments, primarily on the city edge, that convert land that has previously been used for rural-based purposes to urban use. The greenfield developments dataset includes spatial information for current and proposed developments. For the purposes of this study, the greenfield developments dataset has been divided into two categories; (i) operative/approved and (ii) lodged/future. The former describes those developments that have been approved. Any greenfield developments approved prior to 2010 have been captured in the urban extents dataset. Lodged greenfield developments are those that have been lodged with Auckland Council for planning consent consideration.

   - The building consents dataset is a compilation of building consents data between 1991 and 2012. The data have been collated following the enactment of the Building Act in 1991 (DBH, 1991) when building consent reporting became mandatory, complementing the new planning regime created under the Resource Management Act 1991 (RMA, 1991). The growth of impervious built up areas was recorded in terms of floor area or footprint of new building structures.

   - Greenfield areas for investigation for future growth have been identified in the Auckland Plan’s (2012) Development Strategy to accommodate up to 90,000 dwellings (using the high growth scenario) outside the current urban extent. The proportion of high class
Table 1
Breakdown in hectares and percent (%) of Land Use Capability Classes 1–8 in Auckland.

<table>
<thead>
<tr>
<th>LUC class</th>
<th>Hectares</th>
<th>Percent of region</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>4397</td>
<td>1</td>
</tr>
<tr>
<td>2</td>
<td>55,356</td>
<td>12</td>
</tr>
<tr>
<td>3</td>
<td>65,090</td>
<td>15</td>
</tr>
<tr>
<td>4</td>
<td>79,641</td>
<td>18</td>
</tr>
<tr>
<td>5</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>6</td>
<td>174,067</td>
<td>39</td>
</tr>
<tr>
<td>7</td>
<td>52,420</td>
<td>12</td>
</tr>
<tr>
<td>8</td>
<td>12,886</td>
<td>3</td>
</tr>
</tbody>
</table>

elite and prime land occupied in these areas will not be quantified but have been highlighted to provide some context as to where future growth has been earmarked.

Spatial analysis was carried out using ESRI ArcMap GIS software (version 9.3.1). All datasets were mapped to the Auckland regional boundary, and spatial analysis was carried out to quantify the proportion of high class land converted to development, for the period of time each dataset was available. For the purposes of this study, the conversion of high class land to development/building footprint is defined as that lost to impervious surface. The term ‘development’ encompasses both residential and urban development. The term ‘conversion’ of high class land to development can also, to some extent, imply that ‘lost’ to development because the conversion of land to non-agricultural or non-horticultural use can be effectively irreversible.

It was possible to discriminate between the conversion of Classes 1–3 land for the urban extension and greenfield development analyses. The conversion of Classes 1–3 land was also determined both within and outside of the current (2010) urban extent. This was also determined for building consents but it is was not possible to discriminate the conversion of Classes 1–3 land to this development type.

The coordinates provided for each building consent are taken from a centre point of the parcel boundary and are not spatially explicit or reflective of the actual location of the development; therefore it was not possible to discriminate which LUC Class (1–3) the building consent was associated with, particularly when more than one LUC Class (1–3) occupied a land parcel. Furthermore, it should be noted that the LUC layer, at the 1:50,000 scale, was not designed to be used at the property level and, as a result, there will be issues with accuracy (Lynn et al., 2009). However, it does provide very useful information when used appropriately at the regional level. Another limitation regards the lack of building consent records for land parcels prior to 1991 which have not been digitised. To investigate building consent footprints prior to 1991 fourteen randomly selected land parcels were used as case studies to determine the nature and extent of pre-existing buildings and dwellings. The building footprint within each land parcel, which includes house area, sheds, additional buildings and driveways, were digitised using 2010 aerial photography for the 14 land parcels. The developments were assessed against the building consent granted for the parcel of land to determine the extent of potential pre-existing (prior to 1991) building footprints on Classes 1–3 land.

Results

Land Use Capability Classes 1, 2 and 3 occupy 4397 ha (<1%), 55,365 ha (12%), and 65,090 ha (15%), respectively, of land in Auckland (Fig. 1 and Table 1). The majority of Class 1 land is in south Auckland, particularly in and around Pukekohe, representing about 86% of Class 1 land (Fig. 1).

Conversion of high class land through urban extension

A total of 7172 ha (5.7%) of Auckland’s high class land has been converted for urban development since 1915 as a result of peri-
odic urban extension, with the majority of development (6853 ha) occurring between the years, 1975 and 2010 (Fig. 2 and Table 2). This represents 4.8% (343 ha) Class 1, 67% (4823 ha) Class 2 and 28% (2005 ha) Class 3 land (Table 2).

The conversion of Classes 1, 2 and 3 land within the current urban area represent 214 ha, 4435 ha and 1871 ha, respectively. The rate (ha/yr) of urban extension onto high class elite and prime land has accelerated since 1996 (Table 2). Furthermore, the majority of land being allocated for urban extension is high class land, representing a 62% average for the five urban extent periods from 1996 onwards (Table 2).

Conversion of high class land through operative greenfield developments

The conversion of high class land through operative greenfield developments represents 1832 ha of land, the majority of which is LUC Class 2 (73%) (Fig. 3 and Table 3). This represents 1.5% of Auckland’s total available high class land.

Conversion of high class land through building consents

A total of 52,980 building consents were granted since 1991 across 44,852 land parcels containing high class land (Fig. 3). This equates to a total floor area and development of 1395 ha of high class land (or 1.12% of total available LUC 1–3). Of this, 31,528 building consents were granted within the current urban area, equating to a floor area of 980 ha which potentially overlaps with high class land converted to urban extension (Fig. 3). Therefore, 415 ha of floor area representing 21,452 building consents provides a better estimate of the development of high class land to building consents.

Eighty percent of the building consents represent the building category that includes new (and pre-built) houses, units, and beach cottages, and had an average floor area of 223 m². To investigate the nature and extent of building footprints prior to 1991 fourteen case study assessments were undertaken (data not shown). Eight of the 14 case studies were occupied by pre-existing buildings prior to 1991, all of which were located on high class land. The digitised pre-existing building footprint for these eight case studies amounted to 1.79 ha of Classes 1–3 land, representing 59% of the total impervious surfaces for the 14 case studies. Thirty-nine percent of the pre-existing 1.79 ha building footprint was occupied on Class 1 land. These case study examples support the notion that the conversion of high class land to building consent footprint is underestimated due to a lack of records prior to 1991.

Future pressures on high class land

Lodged/future greenfield developments equate to an additional 4.8% of total available high class land (Tables 1 and 3). Whilst the majority of this 6010 ha is Class 2 land, it includes 206 ha of Class 1 or elite land.

Furthermore, while the majority of the 400,000 dwellings expected to be required to accommodate future growth in Auckland is envisaged to occur within the existing urban boundary through intensification, greenfield areas for investigation have been identified to accommodate up to 90,000 new dwellings in rural Auckland (Fig. 3). Apart from greenfield areas for investigation for future growth identified as A and B in Fig. 3, which contain small areas of Class 3 land (Fig. 1), the majority of land occupied in greenfield investigation areas C–G is Class 1–3 elite and prime land, with Class 1 land occupying parts of greenfield investigation area G.
Fig. 1. Distribution of Land Use Capability Classes 1–3 across Auckland (CBD denotes Central Business District).

(Figs. 1 and 3). The area of Class 1 or elite land occupying greenfield investigation area G, or namely Pukekohe, is over 480 ha. Noting that while the latter greenfield area for investigation will not entirely be converted for urban use (and that urban development already occupies some of the 480 ha elite land as quantified in the current study), future growth will continue to encroach onto finite elite and prime land resources.

Discussion

Over the various spanning datasets, a total of 10,399 ha (or 8.3%) of Auckland’s high class land has been converted to urban development. Between the years, 1975 and 2012, 10,080 ha (or 8.1%) of Auckland’s elite and prime land was converted to development. The rate (ha/yr) of urban extension onto high class land has accelerated since 1996 (Table 2). Furthermore, the majority of land allocated to urban extension since 1996 has been high class elite and prime land (Table 2). Future growth pressures indicate that the conversion of high class land to development will continue to be the trade-off to accommodate future growth (Figs. 1 and 3, Table 3).

These pressures include lodged/future greenfield developments that currently amount to an additional potential conversion of 6010 ha (or 4.8%) of high class land (Table 3). Furthermore, the Auckland Plan is based on a 1 million population increase by 2040,
Fig. 2. Illustration of increasing urban extension from 1915 to 2010.

putting additional pressures on high class land to accommodate future growth (Auckland Council, 2012). These include the need for additional greenfield developments over and above what is already planned; these areas are noted as ‘Greenfield Areas for Investigation’ in the plan’s Development Strategy (Auckland Council, 2012). While the majority of the projected 400,000 dwellings required to accommodate future growth will be found within the existing urban boundary through intensification, it is being proposed that these greenfield areas under investigation will accommodate up to 90,000 new dwellings over the next 30 years. In contrast to the opening up of greenfields in Auckland to accommodate future growth, Bibby (2009) reported that although there was a common perception that development was encroaching into rural settlements in Britain, the majority of development occurred within the urban limit, and tended to be at the expense of recreational land. The loss of green spaces in urban areas has been reported to affect the overall levels of physical activity for the public as well as limiting the ability of the green space to reduce the ‘heat island’ effect of cities (Keenleyside et al., 2009). Green spaces in cities also offer a variety of habitats for biodiversity and provide both mental and physical human health benefits (Chiesura, 2004; Jokimäki, 1999; Manes et al., 2012; Williams et al., 2013). Bibby (2009) estimated that the conversion of greenfields to development was about 5000 ha/yr with the majority of this land being
developed for residential use rather than commercial, industrial or other use in Britain.

In Auckland, Pukekohe has been identified as a potential satellite town to accommodate up to 50,000 dwellings, an area where the majority of Class 1 or elite land is located. It is a renowned powerhouse in terms of outdoor vegetable production (Fresh Facts, 2011; Hunt, 1959; Statistics NZ, 2011). Various factors render Pukekohe a highly efficient production system including its highly fertile and well-structured soils (Ministry for Agriculture and Fisheries, 1975; Molloy, 1993), its proximity to a multitude of freight options and the supply of labour. Vegetable growing is a significant source of economic activity and employment in Pukekohe. While the number of people employed in vegetable growing has been declining in Auckland between the years, 2000 and 2010, the number of vegetable growing employees in 2010 was highest amongst all other regions in New Zealand (Ministry of Economic Development, 2011). Other factors that afford Pukekohe a significant vegetable growing region are the availability of irrigation water and it’s unique and effectively frost free climate. It is therefore not uncommon to produce three crops a year within these parts, or three crops of potatoes on the same piece of land within 14 months (Hunt, 1959). This puts immense value on the provisioning soil ecosystem services in Pukekohe’s soils. However, Hunt (1959) reports that from the 1940s-mid 1950s several thousand ‘acres’ of valuable and highly productive market gardening land within Auckland had gone out of production as a result of urban growth. The land use capability classification was not in effect in the 1950s so it was not possible to quantify or combine the conversion of highly productive land reported by Hunt (1959) with the current study because of definition inconsistencies. While the majority of conversion was predominantly occurring within and around Auckland central, urban development was also annually encroaching onto some of the best, vegetable growing land in Pukekohe (Hunt, 1959). Hunt (1959) concludes that ‘to make good the loss’ of the productive market gardening land that was rapidly occurring within Auckland central, there was ample supply of this land in the Franklin and Pukekohe county. However, considering that the Auckland Plan has identified Pukekohe as a satellite town to accommodate some future growth, this highly productive land continues to be the trade-off over 50 years later.

Currently the remaining high class land that is occupied in Auckland’s land parcels is not solely being used for intensive primary production purposes related to commercial gain. Andrew and Dymond (2012) reported that 21% of Auckland’s lifestyle blocks occupy high class land, which amounts to 35% of total high class land in the region. The majority of land being occupied within greenfield areas for investigation A–G in Fig. 3 is pastoral land, representing 71% of the total area (Newsome and Pairman, 2012), with some of this land comprised of lifestyle blocks. This is followed by cropland/orchard/vineyards, native bush, exotic forest and urban parkland/reserves representing 8%, 4%, 3% and 2% of land area, respectively, the difference being built up area (Newsome and Pairman, 2012). While the majority of rural activity occupying this land is not restricted to LUC Class 1–3 land, cultivated cropping and market gardening is exclusive to elite and prime land (Lynn et al., 2009). Further depletion of this finite resource will ultimately reduce market gardening and horticultural activity within these areas. This was particularly the case in southern provinces in China which identified the need to shift intensive cropping activity to land areas in northern provinces of lesser versatility, that could ultimately jeopardise their self-sufficiency in food supply (Jiang et al., 2013). Auckland’s ability to produce adequate food supplies for local, national and international markets could also be jeopardised in the future. The proportion of the region’s total high class elite and prime land resources that has been, and what could potentially be, converted to development is summarised in Table 4.

Cultural and regulating soil ecosystem services also need to be considered. Continued population growth and development, resulting in habitat loss and fragmentation, can potentially pose a huge threat to global terrestrial biodiversity (Bettigole et al., 2013; Brown et al., 2013). In the face of an increasing population growth of 1.2 m, equating to half a million new dwellings in Vermont, New Hampshire, and Massachusetts, USA, the occupancy of five forest dependent bird species was predicted to decrease by as much as 38% by the year 2050 (Brown et al., 2013). It was concluded that such trade-offs between urban development and forest-dwelling wildlife species should be considered for planning purposes; otherwise future wildlife distribution patterns may face uncertain change as a result of urban development to accommodate future growth (Bettigole et al., 2013; Brown et al., 2013). Furthermore,

### Table 2
Rate of high class land converted to urban extension, urban extent growth and proportion (%) of Land Use Capabilities 1–3 of urban extent.

<table>
<thead>
<tr>
<th>Period</th>
<th>Land Use Capability Class</th>
<th>Urban extent growth (ha)</th>
<th>% LUC 1–3 of urban extent</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1915</td>
<td>–</td>
<td>5039</td>
<td>1</td>
</tr>
<tr>
<td>1945</td>
<td>–</td>
<td>8601</td>
<td>1</td>
</tr>
<tr>
<td>1964</td>
<td>9</td>
<td>13,149</td>
<td>1</td>
</tr>
<tr>
<td>1975</td>
<td>18</td>
<td>10,206</td>
<td>5</td>
</tr>
<tr>
<td>1987</td>
<td>20</td>
<td>3021</td>
<td>21</td>
</tr>
<tr>
<td>1996</td>
<td>41</td>
<td>4369</td>
<td>46</td>
</tr>
<tr>
<td>2001</td>
<td>103</td>
<td>2405</td>
<td>60</td>
</tr>
<tr>
<td>2006</td>
<td>20</td>
<td>2717</td>
<td>47</td>
</tr>
<tr>
<td>2008</td>
<td>31</td>
<td>382</td>
<td>80</td>
</tr>
<tr>
<td>2010</td>
<td>101</td>
<td>932</td>
<td>76</td>
</tr>
<tr>
<td>Total (ha)</td>
<td>343</td>
<td>50,821</td>
<td>–</td>
</tr>
</tbody>
</table>

### Table 3
Converted (operative) and potential (lodged) development of high class land to greenfields (ha).

<table>
<thead>
<tr>
<th>Development stage</th>
<th>Land Use Capability Class</th>
<th>Total (ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Operative (ha)</td>
<td>16</td>
<td>1339</td>
</tr>
<tr>
<td>Lodged/future (ha)</td>
<td>206</td>
<td>4404</td>
</tr>
<tr>
<td>Total (ha)</td>
<td>222</td>
<td>5833</td>
</tr>
</tbody>
</table>
Fig. 3. Extent of built up area including the 2010 urban extent, operative greenfield developments and building consents occupying high class land, and greenfield areas for investigation for future growth. Note: A = Warkworth; B = Silverdale; C = Kumeu; D = Whenuapai; E = Drury; F = Paerata; and G = Pukekohe.

Table 4
Converted land and potential development on Land Use Capability Classes (LUC) 1–3, and proportion (%) of total available LUC Classes 1–3.

<table>
<thead>
<tr>
<th>Total LUC (ha)</th>
<th>Converted land by urban extension and operative greenfields (ha)</th>
<th>Potential (lodged) development (ha)</th>
<th>Total (ha)</th>
<th>% of total LUC</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>359</td>
<td>206</td>
<td>565</td>
<td>13</td>
</tr>
<tr>
<td>2</td>
<td>6162</td>
<td>4494</td>
<td>10,656</td>
<td>19</td>
</tr>
<tr>
<td>3</td>
<td>2482</td>
<td>1310</td>
<td>3792</td>
<td>6</td>
</tr>
</tbody>
</table>

Note: Building consents and greenfields areas for investigation for future growth occupying LUC Classes 1–3 are excluded.
intangible landscape ecosystem services, such as landscape aesthetics and recreational use, were reported to rival tangible services in some peri-urban areas around Copenhagen (Vejre et al., 2010). Rural landscape and character are valuable ecosystem services in the Pukekohe area which has had a significant horticultural history that marked it as a permanent vegetable growing region after the Second World War (Coleman, 1967).

The encroachment of urban growth into rural communities has also been reported to potentially have ‘reverse sensitivity’ impacts and social consequences which can drive agricultural activity away (Andrew and Dymond, 2012; Berry and Plaut, 1978). To accommodate urban neighbours in a rural community, farmers and growers can be faced with new problems which include regulation of routine farming activities such as time constraints when operating noisy machinery or restrictive pesticide or fertiliser use. Farmers will either adapt to these requirements or potentially sell out (Berry and Plaut, 1978). Prime agricultural land can also become vulnerable when farmers’ or growers’ progeny choose not to enter the business (Keepleye et al., 2009) and the land gets sold to local or central government or private developers. The benefits of the latter are often realised by the original farmland owners in European countries such as The Netherlands and Germany. In contrast, the selling of land is a far more profit-making process felt by the government and not the original farmland owner in China due to the weak farmland property rights of Chinese farmers and growers (Tan et al., 2009).

New Zealand’s Resource Management Act (RMA, 1991) is the principle national legislation for environmental planning and management in New Zealand. It acknowledges the value of sustaining natural and physical resources, and highlights the importance of ‘safe guarding the life supporting capacity of soil’. However, it does not refer directly to the value of high class land. The Auckland Council’s Regional Policy Statement does refer to the value of elite and prime land, but only Class 1 or elite land is protected from development (ACRPS, 2008a). In spite of this, hundreds of hectares of Class 1 or elite land have been converted to various development types throughout the Auckland region, particularly in recent years, and future growth pressures indicate that this trend will continue. If stricter controls on the development of high class land are not set, the future of Auckland’s most high class land is at risk at continually being the trade-off for future urban growth reducing options for crop growth and other primary production. Alongside future pressures confronting these provisioning soil ecosystem services, regulating (Blouin et al., 2013) and cultural services (Daniel et al., 2012) soil natural capital support such as rural character, recreation, storm protection and the filtering of pollutants also need to be acknowledged. The value of all soil ecosystem services needs to be considered by not only urban planners but by both policy and decision makers in Auckland.

There is a real need to analyse the economic benefits and long term sustainability of future development against the protection of high class land for current and future production needs to provide prolonged benefits to the wider and future communities. Further research should account for the true cost of lost provisioning, regulating and cultural services soil natural capital supports to ensure that these values are recognised and considered by not only urban planners but by both policy and, more importantly, decision makers in Auckland, and New Zealand as a whole.

Acknowledgments

We would like to acknowledge the suggestions, helpful advice and support from many colleagues including Dr. Martin Neale and Gregory Holland in the Research Investigations and Monitoring Unit (RIMU), Auckland Council. Editorial assistance by Alison Reid (RIMU) was greatly appreciated. The study was supported by Auckland Council. We would also sincerely like to thank the anonymous peer reviewers for their valuable comments all of which have improved the quality of the manuscript.

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Conclusion

The population of Auckland is forecast to increase from 1.5 to 2.5 million by 2040 which will put immense pressures on the region’s soil resources to accommodate future growth. We analysed that 10,399 (8.3%) ha of high class land has been converted to various development types in Auckland. Of this, 10,080 ha (or 8.1%) of Auckland’s elite and prime land was converted to development between the years, 1975 and 2012. The rate (ha/yr) of urban extension onto high class land has accelerated since 1996. Furthermore, the majority of land allocated to urban extension since 1996 has been high class elite and prime land. Future growth pressures indicate that the development of this elite and prime land will continue to be the trade-off to accommodate future growth.