Documentation of assumptions for 2009 LTCCP Impervious Surfaces Growth Model

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Background

The impervious component of the growth model provides an estimate of the area of impervious surfaces in the urbanised areas of Christchurch City and Banks Peninsula District. Impervious surfaces are important in the context of surface water and stormwater runoff, as the more impervious surfaces in a catchment the greater the quantity and intensity of runoff. In addition the area of impervious surfaces in a catchment is a good indicator of pressures on the quality of an urban waterway.

A base data set of impervious surfaces was required for this project. At the start of the project the Council did not have information on impervious surfaces available for the whole of the City and Banks Peninsula District. So this needed to be collected before the projections could be modelled.

For the development contributions policy only the amount of business zones impervious surfaces were required to be projected. However impervious surfaces were calculated for all growth areas

Base data

Christchurch

Christchurch City Council has been working with Landcare Research (initially partially funded by FoRST[1]) to estimate the amount of impervious surfaces in the City using satellite imagery. This work provided a base line of impervious surfaces that was used for the Development Contributions Growth Model. Figure 1 shows a map of the percentage impervious surfaces in the City. This was obtained from a Landsat 7 image collected in February 2000.

The Christchurch impervious base layer is a GIS raster file with 25 metre grid cells and a value of the percentage impervious for each grid cell. Therefore a grid cell with a value of 60 percent would have 15 square metres of impervious surfaces. For additional information on the accuracy and creation of this GIS layer refer to the Landcare Report: "Accuracy Assessment of Christchurch City Impervious Surface Maps Derived from Satellite Imagery" by Heather North and Stella Bellis published April 2005, LC0405/088).

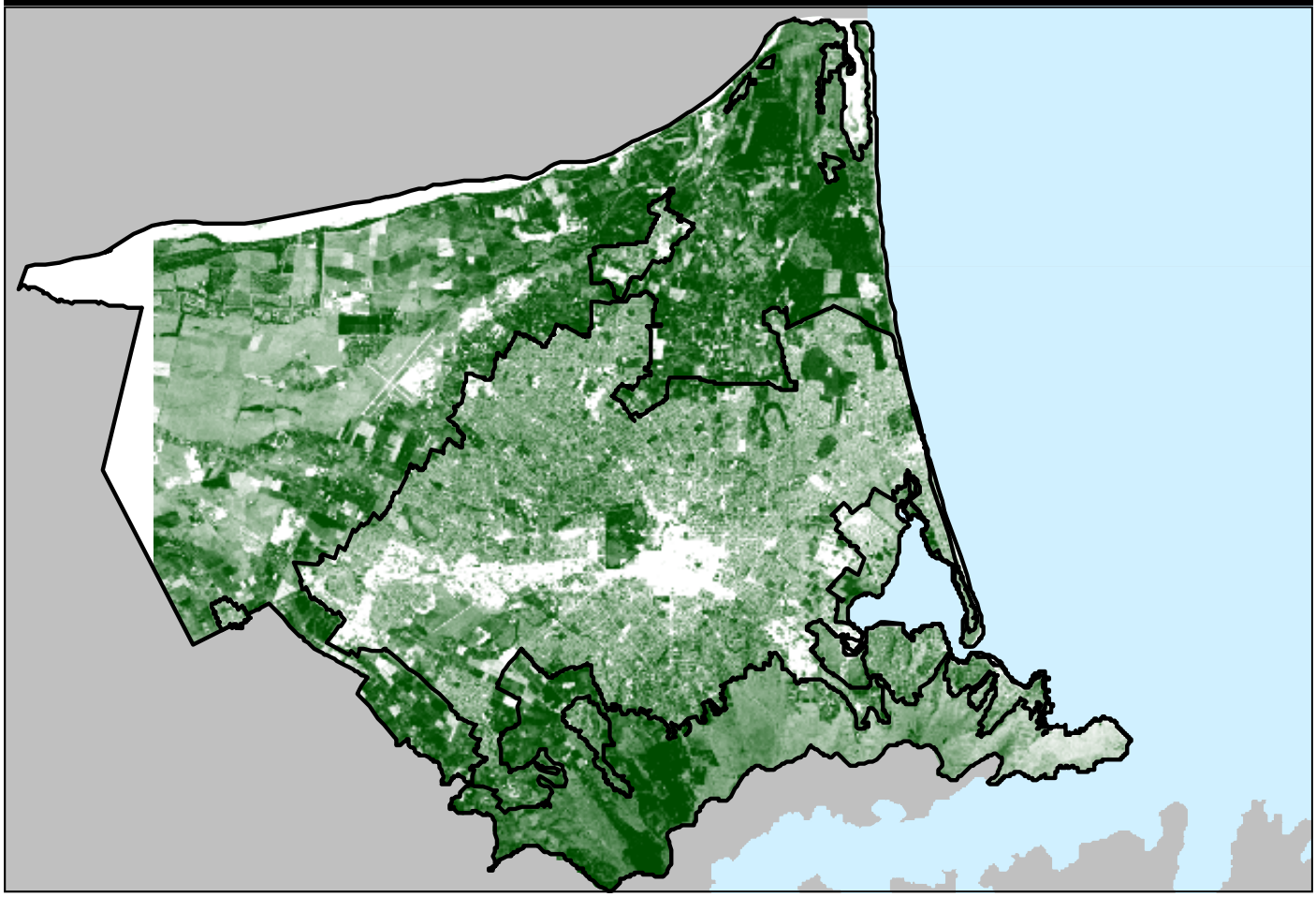
This raster file was then aggregated to a vector layer providing the average percent impervious for each meshblock and zone. Usually most meshblocks will only have one zoned area, but many will have more than one zone within it (5,585 meshblock zones compared with 2,710 meshblocks in the City). This enabled the impervious surfaces calculations to be consistent with both the household projections and business projections which were used to determine the changes in imperviousness. Also because each zone has potentially distinctive development patterns it was appropriate to build the model at this level.

In addition to the impervious information being aggregated at meshblock zones, a subset of this information was created for each meshblock zone which contained only the impervious surfaces information for the areas of road and areas associated with roads such as footpaths (non parcel areas). The reason for separating this out was to enable it to be excluded from the analysis as it is assumed to remain unchanged over the time of the projections, and if it did change it would be difficult to anticipate what form this change would be.

This method assumes that trees overhanging impervious areas are treated the same as grass and other vegetative surfaces, From a hydrological perspective they will behave differently to impervious surfaces in that they will intercept rainfall, which will either evaporate or trickle and drip to the ground. Unfortunately without any information about what is underneath trees and also what type of tree there is, it is extremely difficult to treat these areas any differently. Also when you include the fact that the time of the year and the intensity and amount of rainfall also determine the runoff behaviour of trees. This would be a complex task to do anything differently, and would be beyond the scope of what is required for the development contributions.

1. FoRST—Foundation for Research, Science and Technology

Figure 1. Proportion Impervious Surfaces in Christchurch (Green 100% - White 0% impervious, Black areas Excluded from



Source: Landcare Research, NASA Landsat 7 Satellite Imagery.

Banks Peninsula

The base information for the Banks Peninsula District was collected from the digital orthophotos covering the district. Data was only collected for the urbanised parts of the District as it was assumed that rural area would not change significantly to effect storm water infrastructure and in most cases have natural watercourses for runoff. The average proportion of impervious surface was calculated by randomly sampling properties (or all properties in small zones) in the different zones and aggregating this up to give an average figure for the whole zone in each township.

In the future it is intended that the satellite imagery will be extended to include the rest of the Peninsula to provide a single source of impervious data for the whole of the new Christchurch City Council area post amalgamation.

Projection Methodology

The methodology for Christchurch and Banks Peninsula area projections are the same although the collection of base data was different.

Impervious surfaces were projected out for residential and business zones. It was assumed that other zones such as open space and conservation would not change significantly over time. For these areas with assumed no growth the current areas of impervious surface were kept constant for future projection periods. This may not necessarily be the case but without additional survey work and time series analysis of impervious surfaces the relative size of any of this change cannot be determined. In addition any changes in residential and business areas are likely to have significantly more impact on City's impervious surfaces than changes in these zones. Zones assumed to stay constant over time were:

- Open space
- Cultural
- Conservation
- Rural
- Special Purpose (except Airport, Awatea and Wigram).

Residential and Business zones were calculated separately, but effectively used the same general methodology. Each meshblock zone area is divided into the area covering land parcels and areas of roading and associated non parcel features, such as footpaths and grass verges. The non parcel features are assumed to remain constant over time, so any change due to growth is applied to the area covered by land parcels only.

Initially relationships between current impervious surfaces and other variables such as number of dwellings / households, socio economic status (NZ deprivation index) , building footprint area, geographic location were examined both in combination and separately to attempt to produce a regression based model to predict future impervious surfaces from the household and business projections. Unfortunately the results showed that there were no relationship strong enough to confidently use this methodology for projecting out impervious surfaces.

These results show that even within similar parts of the City there is a wide variation in the nature of dwellings and commercial buildings, and combined with the additional variation in the site size, personal preferences in landscaping and additional buildings means that the urban fabric of the City is incredibly diverse.

Subsequently, it was decided to use a methodology based on proportionally increasing the amount of impervious surfaces based on the proportional growth in either households or commercial building floor area for each meshblock zone area. This method is based on the assumption that the nature of impervious surfaces of any additional development within a meshblock zone should be consistent with the current nature of existing development. That is in suburban residential areas where there is additional infill, it will generally be in keeping with the existing proportions of impervious surfaces. Note this may not be the case in areas that are undergoing significant change especially for areas with a high amount of elderly persons housing development for example. This would need to be investigated in the future when time series of impervious surfaces in the City is available.

Projected impervious surfaces are increased to a maximum level of imperviousness for each zone. This is calculated as the 90th percentile of meshblock mean percent impervious for each zone. This allows for the fact that in most zones when densities increase above a particular level there will still be a requirement for some vegetative surfaces especially in residential areas, also at medium to higher densities increased residential density results in vertical development - which does not change the impervious surfaces. Some commercial zones such as the Central City are likely to be or approach 100 percent impervious, and any additional development will not have any effect.

In meshblocks where there was no households in 2001, that is areas of green field development, the impervious surfaces of new areas will be different to what is already there. To estimate the amount of impervious surface due to the projected number of households in green field areas the proportion of impervious surfaces and mean site size on green field areas that had been developed on vacant residential land since 1998 was assessed (1998 was the first year GIS based vacant land information was collected). This was then applied to green field areas which were projected to have future development.

Growth in impervious surfaces as a result of business growth is treated essentially the same way, except instead of proportioning out growth using households, business floor area is used instead.

This information is aggregated together at a meshblock and zone level and then to a census area unit level and then rounded to the nearest 10 metres for the growth model input. The data is rounded because otherwise it would give the impression of a level of accuracy that is not achievable.

Summary of Impervious Assumptions:

- It is assumed that future development within each meshblock zone area will be consistent with existing development at the local scale.
- Impervious surfaces in green field developments will be similar to those in recent development in green field areas.
- Growth in impervious surfaces will generally not exceed the 90th percentile of current levels of impervious surfaces for each zone.