Future land use projections for transport modelling

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Abstract & Introduction

Travel is largely a derived demand which occurs due to a desire to participate in activities in different locations or to shift goods to a different location. Any projections or forecasts of future travel rely upon implicit or explicit assumptions about spatial projections of what activities will take place where. In this paper they are referred to as land use.

This paper firstly discusses a number of methods of producing future land uses and the situation in which their use is appropriate. Particular attention is paid to land use / transport models as these have not been widely applied in New Zealand. It then discusses Statistics New Zealand's future population projections at a Regional Council level and uses these to review where land use/ transport models might be appropriate in New Zealand.

Methods of projecting land use[1]

The following methods have been applied in New Zealand to produce land use projections for transport modelling:

1. Factoring up of observed travel matrices based on historical trends or projected increases in land use.
2. A committee of "wise people" to produce projections for use in three or four stage models.
3. Demographic projection models.
4. Forecasts of growth in tourism, forestry and freight movement.
5. Land use / transport models.
6. Combinations of the above methods (e.g. regional population projections generated by demographic projection models with distribution by "wise people").

The method which is most appropriate depends upon the complexity of the area being modelled and the rate of change which is expected to occur. It also depends upon the budget available. For simple cases where limited change is expected (e.g. a bypass around a small town which is not expected to change much) method one is appropriate.

In cases where specific industries are driving growth (e.g. Forestry), but other change is expected to be limited, specific projections of activity in the industries involved would be appropriate.

For more complex situations where a three or four stage transport model is being developed methods two (committee of "wise people") or five (land use/transport models) would be appropriate. While pure demographic projection models (method three) have been used in these circumstances the author doesn't favour their use on their own for small spatial areas such as a transport model zone, especially where the area is undergoing rapid change. I think they are most appropriately applied at a regional or national level.

Demographic projection models take as input the population in the base year and then project future population by making assumptions about fertility, mortality and migration in and out of the area. Developing appropriate migration assumptions for

small areas (especially those undergoing rapid change) is difficult due to factors not included in these models – such as development restrictions under the District Plan – which affect how many people can live in an area.

Committee of "wise people"

The committee of "wise people" approach has the benefit of drawing upon peoples' knowledge of an area and their ability to integrate a variety of information which is often difficult to build into a mathematical model. This approach falls down where complex areas undergoing rapid change (e.g. the Auckland region) are involved. In these situations it can be very hard for people to understand the nature of changes numerically and to reconcile the macro picture with the micro picture.

An example of this has been in Auckland when we were developing future dwelling capacities for the regional ASP land use model. On several occasions we found that the dwelling capacities that have come out of a process which added up currently zoned capacity with assumptions about future capacity from judgements made by Territorial Authority (TA) staff and the modellers has resulted in inadequate dwelling capacity to meet Statistics NZ future population projections for the Auckland region. As a result of this we have had to revise the dwelling capacities upwards. A process which didn't compare the macro (Stats NZ regional population projections) with the micro (the sum of dwelling capacities by spatial zone) would have resulted in zonal level projections which were too low.

There is also the issue of what planners wish to happen versus what is likely to happen. Some planning is conducted on the basis of trying to make things happen that the market wouldn't otherwise make happen. When producing land use projections it is important to be thinking about what is likely to happen and not to be seduced by what you would like to happen.

In my experience this method also needs a reasonable amount of background information to work properly. Production of zonal level employment projections in Auckland without a model would have been very difficult as there is limited knowledge among TA officers and others about the dynamics of employment capacity and location.

Land use / transport models

In the New Zealand context land use / transport models are most appropriate in complex areas, especially where they are undergoing rapid change. In the UK they have also been used in areas with a large population, but slow growth. This is probably because concern about the type of environmental, transport and planning issues they can provide information on is greater in the UK than in NZ. In both cases they provide a lot of information to assist in making tradeoffs between different planning and infrastructure policies.

They aim to represent spatial processes in a more comprehensive and integrated framework with a sounder theoretical basis. They allow the testing of policies whose effects are not well understood as we don't have direct experience of their effects. For example the land use impacts of: transport infrastructure improvements; or road congestion pricing. They have often been used to test whether new roads encourage urban sprawl.

The transport model (usually four stage) is only one component of the model system, with there also being components which cover the property market (including development), labour market and the product market.

The land use models usually start with:

- base year data for the location (usually by some type of spatial zoning system) of households, population, employment and floorspace (or "buildings").

The future year land use projections at a zonal level are then produced using:

- future demographic inputs for the area under consideration (this is often part of the land use model).
- future employment inputs for the area under consideration (an economic projection model is often used to produce these).

The following factors are then often used to allocate the future demographic and employment projections around the model area:

- a price or rent mechanism for land and/or development space. Each activity will have a "willingness to pay" for space and activities willing to pay a higher price for space will tend to crowd out activities willing to pay a lower price.
- inter-zonal travel costs.
- a spatial representation of the economy of the area being modelled. This will show that product A (e.g. washing up liquid) is being produced in location Z and being shipped to location Y where it is consumed by households or used in some other industry (e.g. catering). This spatial representation changes in the future in response to projected economic growth for the model area, the cost of locating in a given area (e.g. it may become too expensive for washing up liquid factories to stay in their current location and they may shift to another cheaper location on the edge of the city) and the inter-zonal travel costs (which affect the cost of shipping goods to market and the cost of workers accessing employment opportunities).
- restrictions imposed by town planning zoning and other development restrictions (e.g. areas of water). These affect the amount of development space available in each area.

The land use model then produces a future year location for population, households and employment which is then used in the transport model to generate trips.

There is only one land use / transport model in New Zealand; the Auckland Strategic Planning (ASP) model, which works in conjunction with the Auckland Regional Transport (ART) model, a conventional four stage transport model. These models work as a pair with ART taking its land use inputs from ASP and ASP using travel costs from ART as one of its factors in allocating growth and decline around the Auckland region. Other factors that ASP uses include: the amount of development capacity for that activity in a zone, the existing amount of that activity in that zone. The travel costs are used in a way where they measure access to other activities (for example: for households access to employment or the likelihood that different types of employment will tend to locate near each other)

There are no land use / transport models in use in Australia and the number of applications world wide is relatively limited when compared to the number of four stage transport models in use.

Future population projections

The previous sections reviewed different methods for producing future land use projections for transport modelling. It was concluded that the more complex methods were most appropriate in more complex areas, especially where they are undergoing rapid growth. This section reviews the Statistics NZ population projections by Regional Council area and discusses which method would be appropriate for different parts of New Zealand.

Statistics NZ produces a range of population projections which essentially extrapolate current trends. This section looks at the medium regional population projections out to 2021 and compares them. Stats NZ also produces high and low projections which are not discussed here.

Regional Council	Projected Population at 30 June					Change 2001-2021	
	2001	2001 % of national	2011	2021	2021 % of national	Number	Percent
Northland Region	144,400	3.7%	152,400	157,900	3.5%	13,500	9%
Auckland Region	1,216,900	31.4%	1,457,200	1,651,700	36.6%	434,800	36%
Waikato Region	369,800	9.5%	393,200	409,700	9.1%	39,900	11%
Bay of Plenty Region	246,900	6.4%	281,300	307,700	6.8%	60,800	25%
Gisborne Region	45,500	1.2%	44,300	42,600	0.9%	-3,000	-6%
Hawke's Bay Region	147,300	3.8%	147,600	145,500	3.2%	-1,900	-1%
Taranaki Region	105,700	2.7%	101,600	95,400	2.1%	-10,400	-10%
Manawatu-Wanganui Region	227,500	5.9%	228,200	225,500	5.0%	-2,000	-1%
Wellington Region	440,200	11.3%	460,800	469,200	10.4%	29,000	7%
Tasman Region	42,400	1.1%	47,900	50,400	1.1%	8,000	19%
Nelson Region	42,900	1.1%	47,300	50,400	1.1%	7,500	17%
Marlborough Region	40,700	1.0%	44,200	45,700	1.0%	5,000	12%
West Coast Region	31,100	0.8%	29,400	27,400	0.6%	-3,700	-12%
Canterbury Region	496,700	12.8%	529,500	550,200	12.2%	53,500	11%
Otago Region	188,300	4.9%	195,400	196,500	4.4%	8,200	4%
Southland Region	93,300	2.4%	87,200	79,400	1.8%	-13,900	-15%
Total	3,881,601	100.0%	4,247,500	4,507,221	99.8%	625,300	16%

Table 1 – Medium scenario projected population of Regional Councils[2]

Table 1 shows the 2001 population of New Zealand by Regional Council area and the projected population in 2011 and 2021 under the medium scenario assumptions. Six regional councils (Gisborne, Hawke's Bay, Taranaki, Manawatu-Wanganui, West Coast and Southland) are projected to decline in population over this period, six (Northland, Waikato, Wellington, Marlborough, Canterbury and Otago) are projected to grow slower than the national average and four (Auckland, Bay of Plenty, Tasman and Nelson) are projected to grow faster than the national average.

The region which is projected to undergo the greatest change – both numerically and in percentage terms - is Auckland with a 434,800 (36%) increase in population and a

5.2% increase in its share of national population. The numerical increase projected is greater than the 2001 population of thirteen of the Regional Councils!

However in the author's opinion Statistics NZ projections for the Auckland region are probably a bit on the high side as it assumes immigration into the Auckland region continuing at a very high rate until 2006, a possibility that seems unlikely due to net migration into New Zealand declining at the time of writing.

At the other end we have three regions (Taranaki, West Coast and Southland) where a 10% or greater decrease in population is projected.

The areas that are growing and declining strongly will face problems, although of different types. Auckland (and Bay of Plenty) are facing increasing traffic congestion, inadequate infrastructure, problems with housing affordability and pressure on environmental quality.

Conversely declining regions are likely to face having to pay for infrastructure and services with fewer people to spread the cost over and are likely to have a population aging faster than the national average.

For our purposes the regional council areas fall into three groups in terms of projected growth: those that are growing strongly; those that are growing, but at a slower rate; those that are static; and those that are declining. In terms of size they are in three groups in 2001: a million+ (Auckland); a third to half a million (Canterbury, Wellington & Waikato); and the rest which vary in size from around 40,000 up to Bay of Plenty at just under 250,000.

The two regions that are growing faster than the national average are Auckland and Bay of Plenty. Within Bay of Plenty two TAs are projected to have exceptional growth with Western Bay of Plenty District projected to have 36% growth in population between 2001 and 2021 and Tauranga District projected to have 46% growth over the same period. In Auckland the biggest disparity is between Papakura District at 18% and Rodney at 50% over this period. However the main Auckland urban TAs are projected to have fairly similar growth rates over this period.[3]

The large urban areas (Auckland, Wellington & Christchurch) and Tauranga have three or four stage transport models. The Auckland model relies upon the ASP land use model, the Wellington model relies upon a demographic projection model whereas the Tauranga model relies upon a "committee of wise people" at a zonal level, with demographic projections for the whole model area. Both these methods are appropriate, subject to the limitations discussed in an earlier section.

Apart from Auckland, a land use / transport model could be appropriate in the Wellington, Christchurch and Tauranga areas. This would allow the testing of the land use effects of transport infrastructure changes, road pricing and allow more comprehensive comparison of alternative planning policy packages.

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References

[1] My thanks to Andrew Murray for a discussion about methods he has seen applied in NZ
[2] Statistics New Zealand website
[3] Statistics New Zealand website