

# **SUSTAINABLE PATHWAYS II**

## **Auckland Region Mediated Modelling**

*Post-report supporting Action Research and Integrated Assessment*

Marjan van den Belt, Ecological Economics Research NZ, Massey University

Vicky Forgie, Ecological Economics Research NZ, Massey University

Hendrik Stouten, Ecological Economics Research NZ, Massey University

Regan Solomon, Auckland Council

© van den Belt, Forgie, Stouten, Solomon

Published by Ecological Economics Research New Zealand  
College of Humanities and Social Sciences  
Massey University  
Private Bag 11 222  
Palmerston North  
New Zealand

While the author has exercised all reasonable skill and care in researching and reporting this information, the authority accepts no responsibility for the opinions expressed, or the accuracy or completeness of the contents of this document. The author will not be liable in contract, tort, or otherwise howsoever, for any loss, damage or expense (whether direct, indirect or consequential) arising out of the provision for the information in the report or its use.

ISSN 2253-4911 (Online) 2012/1

## EXECUTIVE SUMMARY

The Sustainable Pathways 2 (SP2) project (MAUX0906) is funded by the New Zealand Ministry for Science and Innovation (MSI). It is a six-year 'action research' programme (2009 – 2015) with a value of NZ\$3.9M. The focus of the SP2 project is to provide processes and tools that allow the simulation of development pathways and visualisation of future change to New Zealand's urban environment. The synergetic modelling tools will support integrated decision-making and adaptive management.

This report is a post-assessment for the Auckland Region Mediated Modelling component of the SP2 project ([www.sp2.org.nz](http://www.sp2.org.nz)). The Mediated Modelling (MM) component provided an opportunity for 8 - 15<sup>1</sup> representative stakeholders to come together over a period of three workshops (8 Sept 2011, 24 Nov 2011, 15 March 2012) to interactively build a scoping model to link social, cultural, economic and environmental issues in one framework. As detailed in the pre-report (also available on [www.sp2.org.nz](http://www.sp2.org.nz)) the topic was left open. An extensive list of interests and potential scenarios was developed over the course of the three MM workshops but a definite topic not decided on. Instead, stakeholders built their understanding and mutual appreciation of the key stocks and flows (such as population density, ethnic grouping, land use, transport, education and health) and the dynamic interaction between these variables, based on a model of the overall 'attractiveness' of the region. The resultant scoping model has linkages and feedbacks that can be run over time to illustrate long-term intended and unintended consequences of decisions and is available via the [www.sp2.org.nz](http://www.sp2.org.nz) website.

As a focus of the SP2 project is adaptive management the changing context in which the SP2 project operates in the Auckland Region is outlined first in this report. The MM process undertaken is then described and this is followed by a content analysis which covers the model and scenarios produced. A discussion of the MM goals and outcomes precedes conclusions and proposed next steps.

The *contextual* analysis indicates that Auckland Region (AR) remains in flux and there is both a need and desire among stakeholders to be involved in integrated decision-making. However, *how* to achieve such integration *with* stakeholder involvement remains experimental. Contextual drivers dominate the next steps contemplated in this action research programme.

The MM *process*, without a clearly defined topic, was 'trialed' with three workshops. Past experience indicates that a series of 10 workshops is generally required for the substantial shift in thinking and commitment to action that the MM process can generate. Although this was not an ideal starting point, three days was the most time participants felt they could devote to the workshops. Two groups of participants were surveyed to evaluate the MM process in Auckland. Firstly, those who participated in all workshops and completed the pre-questionnaire. As the MM process in Auckland emphasised the importance of contact between workshops some of these stakeholders were able to develop sub-sector models to present at subsequent workshops. Notably, those involved in this manner rated the

---

<sup>1</sup> Attendance at the three workshops varied.

workshops and the potential for deploying the MM tool more favourably than those who were not involved between workshops.

The second group were those who withdrew, apologised or didn't attend the final workshop(s). The MM approach, time constraints, lack of a topic and lack of clear link to the Spatial Planning were the main reasons given for non-attendance.

The model developed is spatially homogeneous and its purpose is to increase understanding based on an attempt to integrate the perceptions and reference trends identified by invited stakeholders. The model is not intended to predict future outcomes. The *content* of the model allowed one scenario to be run: "What if projected population growth and associated ethnic diversity happens, how does this affect 'attractiveness' of Auckland?" Additional sub-scenarios or 'what-if' questions were formulated around: (1) climate change resulting in more Pacifica immigrating to the Auckland region, (2) immigration to/from the Auckland region for education, (3) immigration to/from the Auckland region due to its overall 'attractiveness', and (4) changes in birth rate, with the Maori birth rate used as an example. Additional scenarios run (representing stakeholders contributions) included 'what-if' (5) the priority of health care is moved from the elderly to young children (with a voiced wish to expand this to pre-natal care); (6) the Metropolitan Urban Area of Auckland expands; and (7) restoration efforts for natural capital increase or decrease.

The current model illustrates that increasing the population in Auckland initially increases 'attractiveness' but then a downturn occurs. This is the result of more pressure on health, education, employment and ecosystem services which combine together to make up 'attractiveness'. Pacifica immigrating to the Auckland region as a result of climate change, and Asian immigration to the Auckland region for education, has the year of decline starting approximately 10 years before that of the base run. A one percent increase in Maori birth rate results in the year of decline starting 8 years before that of the base run. More people moving to the Auckland region because of the 'attractiveness' of the Auckland region results in the year of decline starting 2 years before that of the base run. The model shows that increasing population with no comparable increase in investment in health and education reduces the 'attractiveness' of Auckland in the long term. Hence, the scenarios confirm the perception of the participants that increasing future populations for the Auckland region will have dramatic results if they are not well planned for.

MM aims to model the perceptions of the participants, supported with available data, ideally geared toward solutions and identification of sustainable pathways going forward. The SP2 team is grateful for the willingness of participants to be involved and hope they received value from it. Without these participants, an MM process could not have happened.

The next step for the MM component under the SP2 programme, as proposed by Auckland Council (AC), is to focus on 'Urban Intensification'. There is also the potential for a spinoff MM process on 'Freshwater' within the Auckland Council.

## Table of Contents

EXECUTIVE SUMMARY .....	II
1. BACKGROUND .....	1
2. COMPONENTS OF ACTION RESEARCH: CONTEXT, PROCESS AND CONTENT .....	3
2.1 Context .....	3
2.1.1. Unitary Plan .....	3
2.1.2. Long Term Plan (2012 – 2022) .....	4
2.1.3. Area Spatial Plans .....	4
2.1.4. Central Government Reform .....	5
2.1.5. Auckland Council Changes Impacting the SP2 Project .....	5
2.1.6. Integration of the Sustainable Pathways Project .....	6
2.2 Process .....	7
2.2.1 Stakeholder participation .....	7
2.2.2 Participant brief feedback after each workshop .....	9
2.2.3 Post-survey results from participants who attended the full MM series .....	10
2.2.4 Post-survey results from participants who did not attend the full MM series .....	16
2.2.5 Workshop Activities .....	19
2.2.6 Causal Loop Diagram Evolution .....	19
2.3 Content .....	22
2.3.1 Model description .....	22
2.3.2 Scenarios and simulation .....	23
3. DISCUSSION .....	35
3.1 Reflections .....	35
3.1.1 Scenarios .....	36
3.1.2 Addressing the questions raised in pre-report .....	36
3.1.1 Mediated Modelling and the Integrated Spatial Explorer (ISE) .....	39

3. CONCLUSION AND NEXT STEPS .....	39
4. ACKNOWLEDGEMENTS .....	42
Appendix A The workshops .....	43
Appendix B Development of 'Natural Capital Model Sector' as an example of 'in between workshop interaction with participants' .....	68
Appendix C Post-survey Analysis for Full Attendance.....	72
Appendix D Post-survey Analysis of Participants who did not complete workshops .....	87
Appendix E Auckland Regional Model Description.....	97
REFERENCES.....	124

# 1. BACKGROUND

The focus of the Sustainable Pathways 2 (SP2) project is developing processes and tools to support dynamic, integrated, spatially explicit, adaptive urban planning in New Zealand.

This report is a post-assessment for the Auckland Region Mediated Modelling component of the SP2 project. The Mediated Modelling (MM) component provided an opportunity for 8 - 15<sup>2</sup> (see table 1 under 2.1.1) representative stakeholders to come together over a period of three workshops (September 2011 – March 2012) to interactively build a scoping model to link social, cultural, economic and environmental issues in one framework, aiming to support the Spatial Planning activities in Auckland. Stakeholders identified and built their understanding and mutual appreciation of the key stocks and flows in the System Dynamics scoping model. The scoping model with linkages and feedbacks can be run over-time to illustrate long-term intended and unintended consequences of decisions. The model developed is not spatially explicit and its purpose is to increase understanding, not predict future outcomes. The intention is for the MM process to: (i) allow stakeholders to see the integrated 'big picture' and gain a greater understanding of the other stakeholder perceptions, (ii) construct a System Dynamics scoping model that can be used by stakeholders to explain possible outcomes from proposed actions, and (iii) inform the development of the more data intensive Integrated Scenarios Explorer (ISE) being constructed for both Auckland and Wellington as part of Objective 2 of the SP2 project.

This post-assessment report has been written to serve four functions. The first is as a requirement of 'action research' where researchers document facts/observations as part of an on-going cycle of: planning outcomes, undertaking actions, observing outcomes and reflecting on those outcomes. For the SP2 project, action research is regarded as a collaborative process where researchers work with stakeholders to critically reflect on both the research process and actions undertaken to achieve a cycle of improved outcomes. As Wadsworth (1997) states "Action research is not merely research which it is hoped will be followed by action! It is action which is *intentionally* researched and modified, leading to the next stage of action which is then again *intentionally* examined for further change and so on *as part of the research itself*." The action research component of the SP2 project contributes to the knowledge base required to integrate adaptive management processes into every-day decision-making.

The second function is to provide feedback to the participants on the process, the content of the modelling tool developed and the context in which this tool is evolving. In an ideal situation this report would provide support to participants to communicate the results from the MM process and model to their individual networks.

The third function of the post-assessment report is to provide information for a review of the SP2 project by a subset of the National Advisory Group for Integrated Planning (NAGIP) and international advisors. NAGIP was established to provide input and guidance for integrated modelling and models to support planning in New Zealand. A task for a subset of this advisory group is to review the pre- and post- assessments of the MM workshops to evaluate the action research and provide independent

---

<sup>2</sup> Attendance at the three workshops varied.

perspectives on how best to progress the SP2 project moving forward. The support tools developing under SP2 will ideally be valuable to other local government and central government agencies so a blueprint describing the provision of these support tools and ways to improve the efficiency of their development is an envisioned output by 2015.

Finally, this report provides a stepping stone to look at inter-linkages between the MM component and the spatially dynamic component of the SP2 programme.

In this report the changing *context* in which the SP2 project operates in the Auckland Region is first outlined. The MM *process* undertaken is then described and this is followed by a *content* analysis which covers the model and scenarios produced. A discussion of the MM goals and outcomes precedes conclusions and next steps.

## **2. COMPONENTS OF ACTION RESEARCH: CONTEXT, PROCESS AND CONTENT**

### **2.1 Context**

This analysis describes the context within which the SP2 project has been operating over the last year and is likely to be operating over the next years. The Royal Commission on Auckland governance delivered recommendations after a two year inquiry into the functionality of local government arrangements in Auckland. The Government responded by passing two Acts: the Local Government (Tamaki Makaurau Reorganisation) Act, and the Local Government (Auckland Council) Act. The outcome of this legislative process was the amalgamation of the eight territorial local authorities into the Auckland Council. As part of the Local Government (Auckland Council) Amendment Act 2010, the Auckland Council is required to develop a 'Spatial Plan'. The Act states that the Auckland Council must prepare and adopt a spatial plan for Auckland, with its purpose to contribute to Auckland's social, economic, environmental and cultural well-being through a comprehensive and effective long-term (20 to 30 year) strategy for Auckland's growth and development.

The Auckland Council adopted the Spatial Plan in March 2012 following consultation with the public. The Council's focus is now shifting to plan implementation, in particular, an amended regulatory framework through the Unitary Plan to enable the future land use vision to be achieved. Other implementation processes currently underway are covered by a range of statutory and non-statutory planning documents, include the Long Term Plan 2012 – 2022 (LTP), Asset Management Plans, Local Board Plans, and Area Spatial Plans. More detail on these and other approaches is outlined below.<sup>3</sup>

#### **2.1.1. Unitary Plan**

The mayoral vision is for Auckland to become the world's most livable city. The Unitary Plan will be the principal regulatory tool to implement the vision. A political working party and council officers will produce a draft Unitary Plan by December 2012, for notification and public consultation in early 2013.

The council has adopted the following key principles for the Auckland Unitary Plan:

- outcomes focused
- simple
- bold
- innovative
- user-friendly
- regulation in proportion to the scale of potential impact

---

<sup>3</sup> Note the plan is a plan for the region. Therefore implementation is contingent on others.

The Unitary Plan will be a combined plan replacing existing regional and district plans. The staged process for its development is set out below. Current district plans and regional policies and plans will remain operative until the Unitary Plan is adopted.

Stage one May - December 2011	Direction setting and big policy issues
Stage two January - June 2012	Next level of policy issues
Stage three July – December 2012	Finer grain detail and localised issues. Draft plan completed.

Under the Resource Management Act the Unitary Plan must be reviewed at least every 10 years. In reality the council will look to update the plan to keep it relevant before then.

### ***2.1.2. Long Term Plan (2012 – 2022)***

The Long-term Plan (LTP) outlines what Council plans to do, its priority projects and activities, and how it plans to pay for it over the next 10 years (2012-2022). The LTP seeks to turn the aspirations of the 30-year Spatial Plan into action through outlining the projects and services the Council will deliver as part of its role to ensure Auckland becomes the world's most livable city.

### ***2.1.3. Area Spatial Plans***

Auckland Council is embarking on a programme to develop 21 Area Plans. Area Plans are based on the same geographic areas as Local Boards. These plans:

- help to implement the directions and outcomes of the Auckland Plan at a local level
- reflect local aspirations such as those included in Local Board Plans (where these are consistent with the direction set by the Auckland Plan)
- provide strategic direction to progressively inform the policies and rules of the new Unitary Plan which will eventually replace the existing regional and district plans of the former councils
- inform future versions of the Long-Term Plan (which determines council spending over a 10-year period). This will enable the council to prioritise and budget for projects to achieve area plan goals

Area Plans will analyse local issues, challenges and opportunities and when complete provide a long-term (30-year) vision for:

- implementing the Auckland Plan at a local level
- identifying the timing of development projects and infrastructure needs
- how we use land to live, work and play
- the size, role and function of town centres
- key transport routes and improvements

- recognition of heritage, landscape, landmarks, and natural features
- social and cultural facilities
- public open space
- local business and employment opportunities

Area Plans are not required by legislation but are an important part of the new planning framework for Auckland. They effectively translate the macro scale vision as described in the Spatial Plan into a different spatial frame of reference. Area Plans will be implemented through:

- the Unitary Plan
- new council policies
- Council investment (through the Long Term Plan)
- advocacy to other organisations (eg. central government) - seeking to influence the investment and activity of these organisations to support Area Plan aspirations
- asset management plans

Area Plans will be implemented not only by Auckland Council, but also through partnerships and alignment with other organisations and delivery partners. They will be delivered over a 4-year programme, from 2012 to 2016 and the sequence of release of Area Plans has been confirmed by the Council's Auckland Plan Committee.

#### ***2.1.4. Central Government Reform***

*The Government recently announced* an eight point reform programme to improve the legislative framework for New Zealand's 78 territorial and regional councils. These reforms propose to clarify councils' roles, deliver stronger governance, improve efficiency and fiscal management. The specifics of the '*Better Local Government*' work programme relevant to the SP2 project are:

1. The Local Government Act 2002 will be amended to replace references to the 'social, economic, environmental and cultural well-being of communities' (the four well-beings) with a new purpose for councils of 'providing good quality local infrastructure, public services and regulatory functions at the least possible cost to households and business.'
2. The Local Government Act 2002 will be amended to provide, by way of regulation, fiscal responsibility requirements in respect of income and expenditure, and prudent debt levels to be developed in consultation with Local Government New Zealand.

#### ***2.1.5. Auckland Council Changes Impacting the SP2 Project***

Council representation on the SP2 project has changed frequently. This has had the advantage of allowing more staff within Auckland Council to become familiar with the SP2 project but has also impacted negatively on continuity. The original leader of objective 3 was Dr Catherine Murray. She was replaced with Geoff Cooper, Chief Economist in the Economic Development unit of Auckland Council.

Regan Solomon, Team Leader: Land Use, Built Environment and Infrastructure Research is now the project lead for objective three.

### ***2.1.6. Integration of the Sustainable Pathways Project***

The SP2 project provides Auckland Council with planning tools that assist it to explore the socio-economic, cultural and environmental trade-offs associated with policy options. The tools aim to foster a Systems Thinking / System Dynamics modelling approach to decision support and assist with spatial planning. With the first Spatial Plan now completed, the SP2 project can contribute to future updates by testing selected changes to the region as proposed in updates to the Spatial Plan.

The SP2 project has three objectives. Objectives one and two involve the development of two computer-based modelling tools which can be used to simulate projected changes over a 30-year time frame. Objective three involves embedding these tools within the Auckland Council for day-to-day use. Objective 1 is the construction of the mediated model, which provides a process of bringing stakeholders together and explores a core issue from a system dynamics perspective. The second objective is the Integrated Scenarios Explorer (ISE) model that models future land use change based on assumptions about the relationships between Land Use, Economics and Environment. The development of the ISE model for Auckland is informed by the Mediated Modelling; key elements and drivers are captured through processes of mediation. The integration of outputs from objective 1 into objective 2 allows for learning, consensus-building and participation in scoping for the linkages between social, cultural, economic and environmental considerations pertinent to the Auckland region.

A function of the Mediated Modelling (MM) workshops was to provide an opportunity for representatives of key organisations in the Auckland region to see how their organisation's role linked to that of other organizations and was best positioned to deliver positive outcomes for the people of Auckland. The MM workshops also provided an opportunity for participants to evaluate the capacity building required to use modelling tools in their organisations to foster adaptive management.

The three MM workshops have developed the "Auckland story" detailed in this report in the form of a simulation model. This model has been built to reflect the perspective of the participants involved. As this project goes to 2015, at a later date the story will be revisited to see how accurate it was and how participants and their organisations have updated the story; told in the form of running scenarios with the evolving scoping model of which the first iteration is presented in this report.

## 2.2 Process

The MM process described here follows on from the 'Pre-report supporting Action Research and Integrated Assessment' for Auckland. It outlines the workshops, activities in-between workshops and follow-up questionnaires.

### 2.2.1 Stakeholder participation

Stakeholders were predominantly from the public sector. Participant attendance fluctuated over the course of the 3 workshops. The attendance for each of the workshops is presented in Table 1.

*Table 1: Auckland MM workshop attendance*

Name	Organisation	8 Sep 2011	24 Nov 2011	15 Mar 2012
Hamish Glenn	NZCID	✓	✓	✓ Apologies after 10.30
Peter Alexander	Auckland International Airport	✓	✓	Withdrawn
John Davies	Auckland Transport	✓	✓	✓
Hamish Bunn	Ministry of Transport	✓	✓	Did not attend
John Karl	Ministry of Education	✓	✓	✓
Maria Wood (1) Theresa Webb (3)	Ministry of Education	✓	Did not attend	✓
Bernadine Vester	City of Manukau Education Trust	✓	✓	Did not attend (On leave)
Megan Carbine	Auckland Council, Environment	✓	✓	✓
Marianne Scott	Auckland Public Health Service	✓	✓	Did not attend
Belinda Chin (1) Sonja Tepavac (3)	Office of Ethnic Affairs, DIA	✓	Did not attend	✓

Vui Mark Gosche	Ministry of Pacific Island Affairs, DIA	✓	No response	Did not attend
Peter Atkinson	Employers & Manufacturers Association (Nth) Inc	✓	✓	Did not attend
Susan Warren	City of Manukau Education Trust	Did not attend	✓	Did not attend
Chris Wong	Ministry of Health	✓	Did not attend	Apology
Roz Sorensen	Ministry of Health	✓	✓	✓
Marjan van den Belt	Ecological Economics Research New Zealand	✓	✓	✓
Vicky Forgie	Ecological Economics Research New Zealand	✓	✓	✓
Hendrik Stouten	Ecological Economics Research New Zealand	✓	✓	✓
Geoff Cooper (1) Regan Solomon (2,3)	Auckland Council, Economic Development	✓	✓	✓
Garry McDonald	Market Economics	✓	✓	✓
Catherine Murray	Market Economics		✓	✓
Susan Fairgray	Auckland Council		✓	
Karen Creagh	Auckland Council		✓ am	✓

Of the 15 original participants, one participant formally withdrew from the project. Two 'slots' were handed over to others due to changes in employment positions. Eight stakeholders attended the final session or part of it. Four of these participants were surveyed after the workshops because they were the only ones who had completed a pre-survey and attended all 3 workshops; we consider this our primary questionnaire. There was no followed up with a scheduled phone call to discuss the open-ended questions as all were clearly answered. An additional (secondary) questionnaire was sent to nine participants who apologised, didn't attend or withdrew. Seven participants, who had incomplete

attendance, returned the secondary questionnaire. We remain unclear about the perception of two participants unaccounted for. In addition, we asked participants to provide brief feedback at the end of each workshop. This required rating their agreement or disagreement with statements on a 1 to 5 'Likert scale'. Following are the results and discussion gathered from each of the modes of feedback.

### 2.2.2 Participant brief feedback after each workshop

Brief, instant feedback was collected at the end of each workshop to help the project team improve the workshop process. There were, however, limits on the extent this was possible due to constraints such as no clear topic and a commitment of 3 instead of 10 workshops.

Feedback is summarised in Figures 1 and 2. The catering provided by Auckland Council was rated exceptionally good. Workshop 1 and 3 were held in the same room, but workshop 2 was held in a less desirable space. The response to 'eliciting scenarios' is puzzling since we didn't address this issue directly in Workshop 1, focused on this in Workshop 2 and ran scenarios during Workshop 3; the project team suspects that this pattern may be due to high expectations regarding scenario development, which were only partly met. The overall impression of the workshops was positive, but with a slight decrease overtime (4.25 to 4.0, where 4 refers to 'satisfied' and 5 to 'very satisfied'). The same pattern applies to facilitation. Time series trends were not well developed during the workshops due to time constraints.

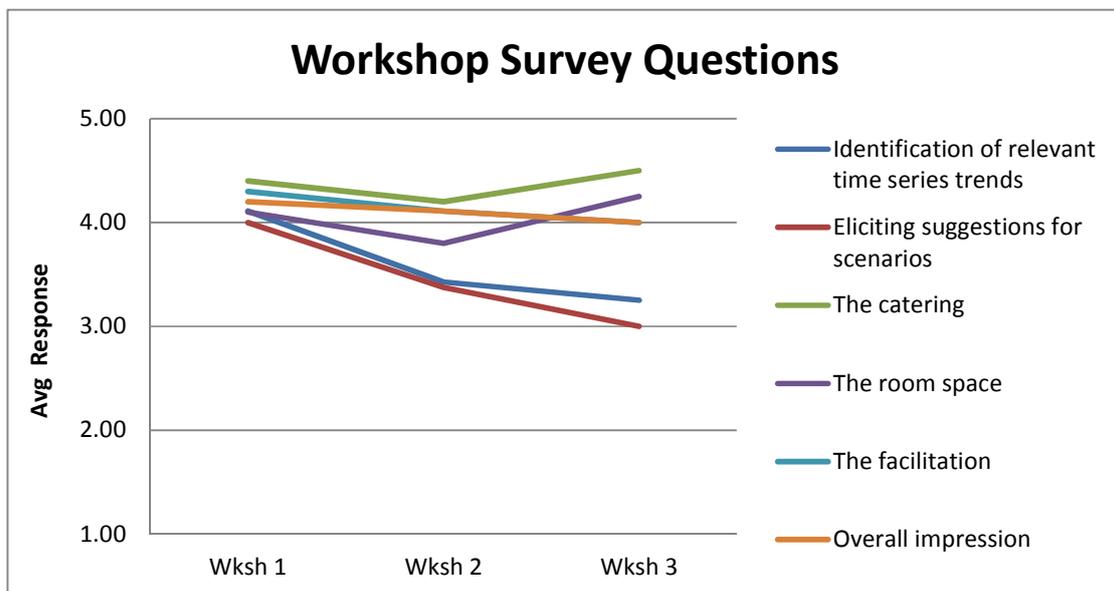


Figure 1: Workshop feedback on context and process

With regard to the Causal Loop Diagram (CLD) development, Storytelling capacity and the level of effectiveness of building onto the previous workshop, Figure 2 reflects feedback consistent with expectations; the CLD was indeed only presented and not updated at Workshop 3 and in addition, the final CLD reflected the causal loops in the model rather than the more ambitious (wish list) CLD

developed at Workshop 2; Storytelling around the model sectors started in Workshop 2 and continued in Workshop 3.

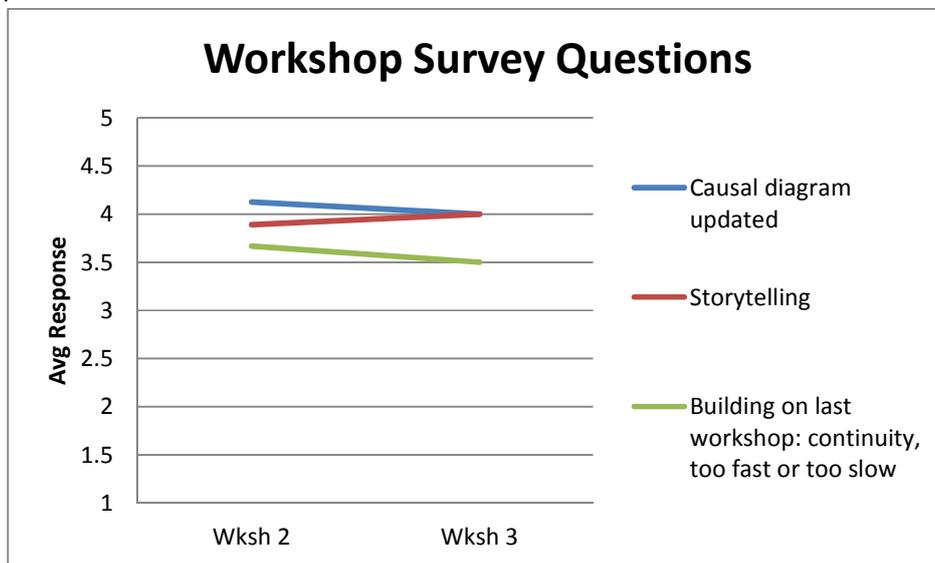


Figure 2: Workshop feedback on tools

### 2.2.3 Post-survey results from participants who attended the full MM series

Four participants attended the full MM workshop series and filled out both pre- and post surveys. The detailed results of each question are included in Appendix B. The scale from 1 to 5 represents a Likert scale where 1 = strongly disagree, 2 = disagree, 3 = neutral, 4 = agree and 5 = strongly agree.

As Figure 3 illustrates issues brought to the workshops by these participants were addressed and integrated during the workshops. The views of two of the four respondents were modified, which can be interpreted as learning occurred for them. All respondents expressed the view that their issue could benefit from an extended MM process.

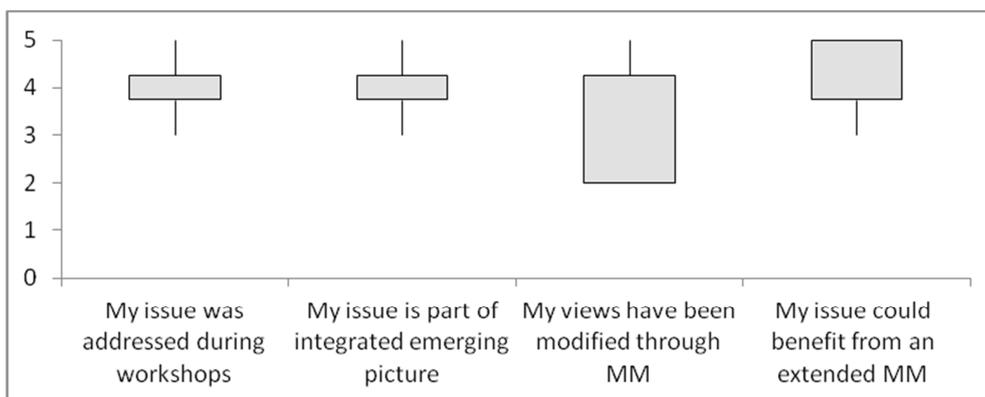
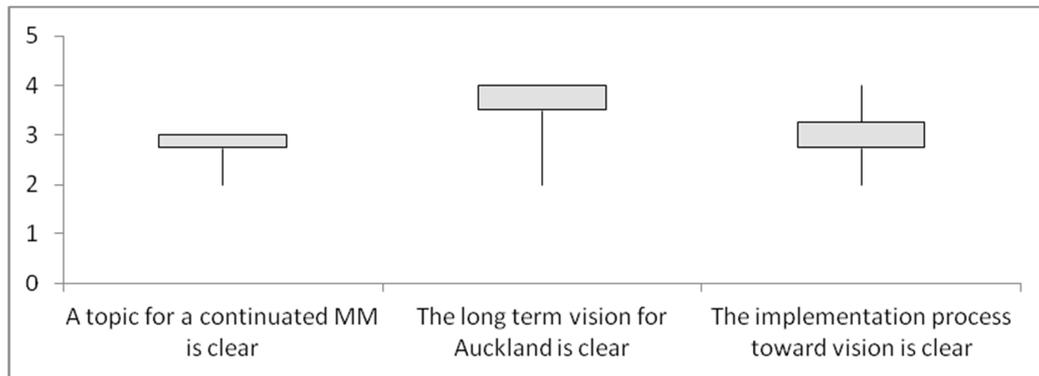


Figure 3: Appropriateness of issues addressed during MM workshops

With Q2, we aimed to understand the ‘creative tension’ between ‘where we are now’, ‘where we are going’ and ‘how we get there’. Figure 4 illustrates that the challenge of lack of a specific topic was not overcome during the MM workshops. The longer term vision is moderately clear to some, while the implementation pathway is less clear.



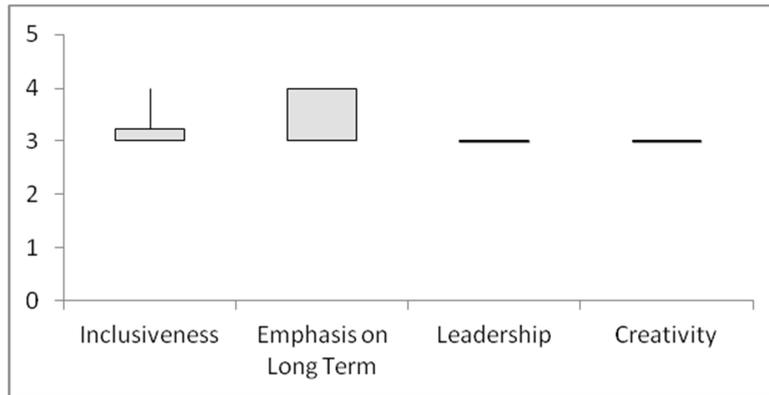
**Figure 4: Creative tension between now, future and how to get there**

Even though, it is acknowledged that the 4 well-beings are connected and difficult to separate, as in the pre-survey, the ‘full’ participants were asked to rank the 4 well-beings in order of importance to their constituency. They were then asked to reflect on how they felt the 4 well-beings ranked in importance in the discussions during the workshops. This revealed an out of alignment as summarised in Table 2 with economic and social interests dominating discussion.

**Table 2: Relative importance of 4 aspects of well-being**

Importance perceived by constituency	Importance given during the workshops
Environmental	Economic
Economic	Social
Social	Environmental
Cultural	Cultural

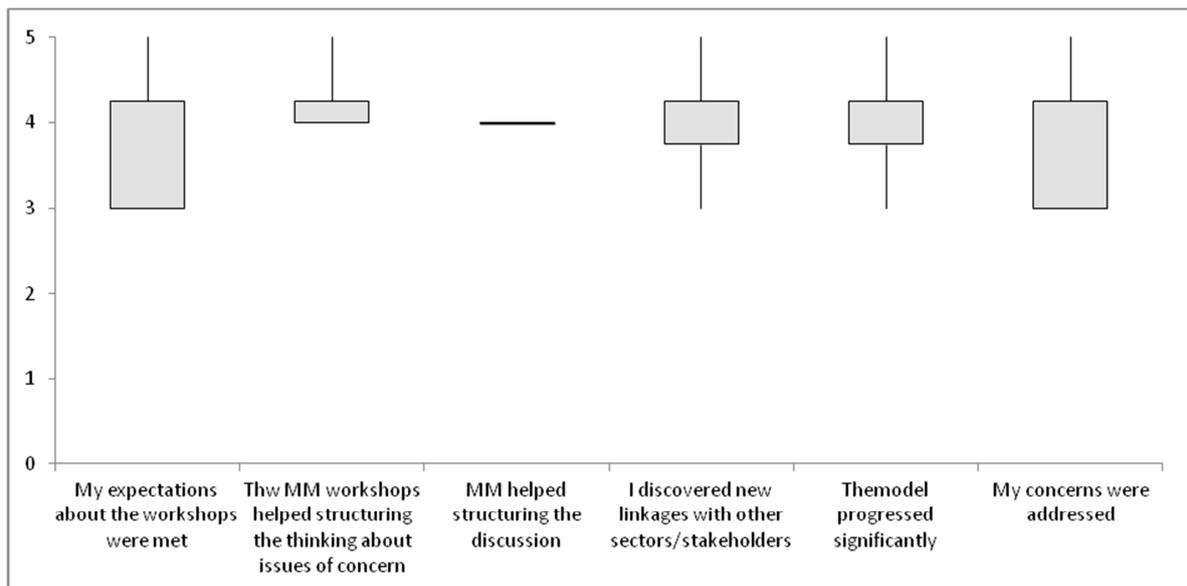
Participants were asked to reflect on how during the workshops the group rated on the level of inclusiveness of different perspectives, the extent emphasis was on long term issues, the leadership in terms of the likelihood that ideas developed in the group would be implemented and whether this group developed innovative ideas, i.e. creativity. Figure 5 shows a small appreciation of the inclusiveness and acknowledgement that emphasis was on strategic issues. However, there was no real sign of leadership or creativity observed.



**Figure 5: Rating of group characteristics during workshops**

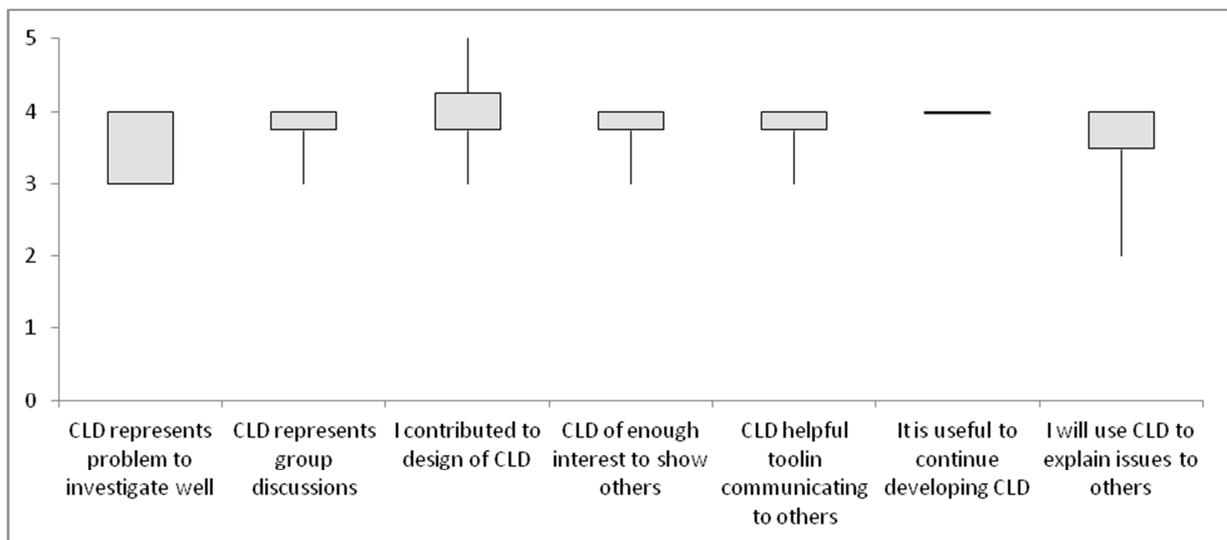
The response to Q6 “With how many participants do you intend to interact with on a regular basis in the future?” showed little evidence that participants developed new relationships that will be carried forward based on newly discovered common ground. All participants expected to interact regularly with 1-2 participants in the group.

Questions on the MM workshops (Figure 6) revealed that expectations were generally met. Neutral responses may also reflect the fact that few people had well-defined expectations about the MM process to begin with (see pre-report). The MM process was perceived as successful in structuring the thinking about complex issues as well as the dialogue during the workshops. Some new linkages were discovered and the model progressed moderately towards addressing participant specific concerns; the answers spread from neutral to very satisfied.



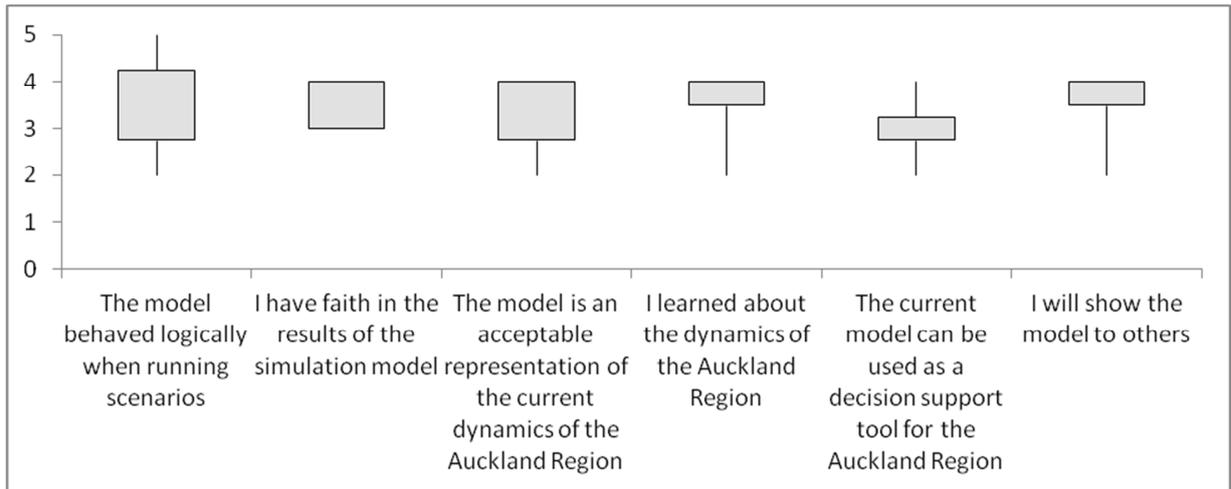
**Figure 6: Reflections on MM workshops**

A Causal Loop Diagram (CLD) was shown to participants in the workshops and again in the survey. Responses to the perceived value of the CLD are given in Figure 7. It was felt the CLD represented the problem the group wanted to investigate moderately well. Slightly more agreement was expressed that the CLD represented the discussion well and most respondents felt they had contributed to the design of the CLD. In principle, the CLD was considered a moderately helpful tool and of enough interest to show others. All agreed that it would be useful to continue development of the CLD. While three respondents expressed an intention to use the CLD to explain issues to others, one had no interest in doing this.



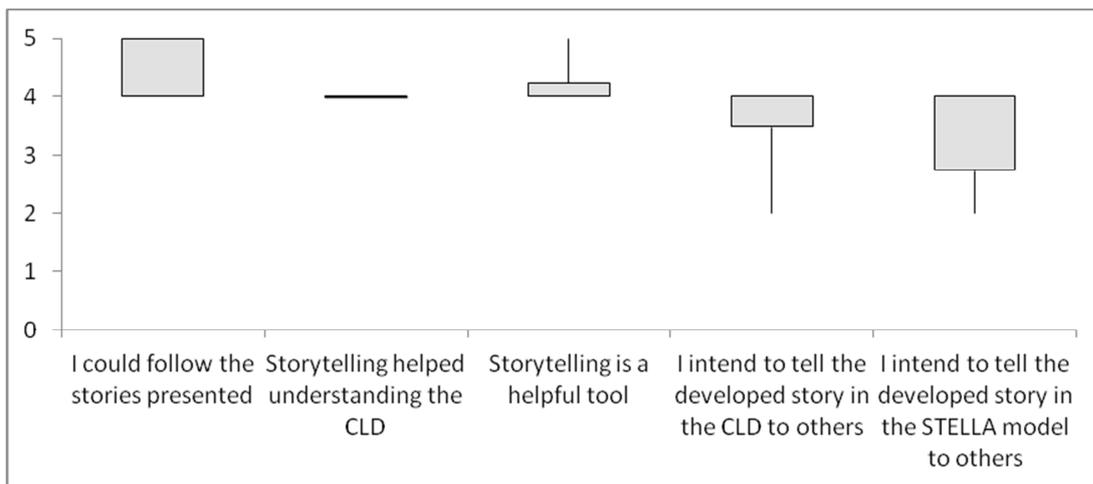
**Figure 7: Reflection on Causal Loop Diagram**

Figure 8 gives the respondents' assessment of the model developed over the course of three workshops. While respondents were fairly positive the model addresses issues raised in the workshops, they were divided on whether the model behaved logically when running scenarios and in their level of confidence in outputs. Responses ranged from 'disagree' to 'strongly agree'. A similar pattern was attributed to how representative the model is of the current dynamics of the AR. Three of the four respondents felt they had learned about the dynamics of the AR during the workshops but only one was of the view that the current model could be used for decision support. Three respondents intend to show this model to others, while one respondent does not have such intentions. None of the respondents had simulated the STELLA model at the time of the questionnaire, but three could see themselves using STELLA in the future.



**Figure 8: Reflection on the model**

With regard to the ‘story telling capacity’ of the CLD demonstrated in the workshops, Figure 9 shows that respondents were able to follow the stories presented during the workshops very well. There is an agreement that storytelling helped understand the CLD and it is considered a helpful tool. However, using story telling in combination with the CLD or the STELLA model to communicate the dynamics of the AR was not considered worthwhile by participants. This is consistent with the results from Figure 7 and Figure 8.



**Figure 9: Reflection on capacity of tools to support ‘story telling’**

When asked ‘What should be the purpose of the mediated modelling process going forward?’ the respondents offered the following suggestions:

- Supporting decisions where there are interdependencies between local and central government stakeholders.
- Enhance the learning.

- Clarifying CLD components. Include funding/investment in the model.
- MM could be used to support a cross-agency approach to planning Auckland's future, seeking to achieve best outcomes across the 4 well-beings. However, to do this the question(s) need to be part of a real planning process or at least mirroring a real issue so the correct people are involved and outcomes can be seen as a real option or series of options.

Reflecting on the three mediated modelling workshops, the **best** outcome for respondents was:

- Seeing the interrelationships and impacts resulting from decisions made by different stakeholders e.g. the impact of transport decision on employment in an area.
- The last workshop built on levels of understanding.
- Integration across disciplines. Viewpoints/issues of other groups was included.
- Cross-agency, cross-discipline discussions and learning. In a real situation, with a defined question and timeframe this could be a powerful process. The visual representation of linkages and flows could also be useful.

The **worst** outcome according the respondents was:

- The inability of the group to develop a question to do further work on.
- The first workshop took a while to get.
- CLD are not ideal for transport loops(s). The model was not really working properly after 3 sessions. Participant capabilities in terms of modelling need to be reinforced.
- Process suffered from lack of real purpose which meant people were not clear on what they were contributing to. Could explain low numbers at 3rd workshop.

At the end of the workshops the participant group did not agree on a question for further MM workshops to answer. The respondents volunteered the following topics:

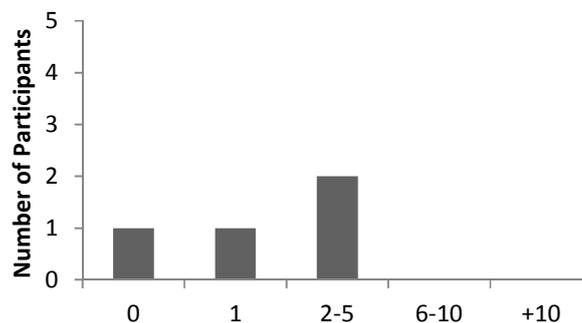
- The development of the Southern Initiative.
- Healthy housing.
- Effects of allocating different funding to each element in the model to see costs and benefits.
- Are the outcomes from the Auckland Plan going to differ when all aspects of liveability/'attractiveness' are considered together as in the MM model.

Suggestions for who to include in the subsequent workshops if the mediated modelling process continues were:

- AC, health, education, Super Ministry, Pacifika, Maori, Transport.
- Health, housing, social care agencies, energy companies.
- Same with more economic/business.

- Economic/industry sector, social development, environment, community representation.

The project website ([www.sp2.org.nz](http://www.sp2.org.nz)) was not visited regularly during the workshops by the respondents (Figure 10).



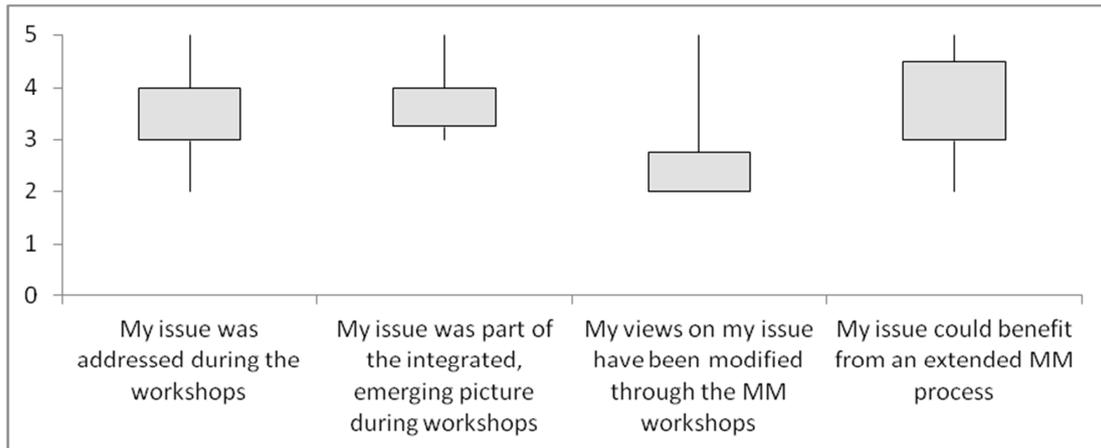
**Figure 10: SP2 website visitation**

All respondents expressed an interest in remaining involved in subsequent MM workshops and offered the following final thoughts, observations, suggestions, recommendations:

- Workshops are too laissez faire and need to be more controlled/managed regarding model building.
- MM is a useful approach but needs to be used for a real planning scenario so people can see how potential outcomes could be implemented.

#### **2.2.4 Post-survey results from participants who did not attend the full MM series**

Seven of the nine who attended some of the MM workshops returned the modified post survey sent to them. Half of these respondents thought their issue was addressed during the workshops. The other half was neutral and one did not believe their issue of concern was addressed at all (Figure 11). All were either positive or neutral that their issue was part of the integrated picture that emerged through the workshops. Most, though not all, had not modified their views as a result participation, i.e. little learning occurred for them. MM was not, however, regarded as a waste of time as a majority (4 respondents) thought that their specific issue could benefit from an extended MM process.



**Figure 11: Topic according to partial participants**

The following comments were provided to the question ‘Can you see a use for the Mediated Modelling process in the Auckland region going forward?’

- Yes, my observation was that some participants did not appear to think outside their narrow specialities.
- Yes.
- Very much so. Most important to continue the conversation with District Health Board representatives with decision making powers and not just analysts. Will maximise cross sector leverage and minimise ‘running interference’ due to ignorance about silo initiatives.
- No. The mediated modelling process does not adequately account for political reality nor the infinite complexity of social systems. The process essentially seeks to understand/demonstrate how everything interacts with everything else. At no point did I feel confident the model could successfully present this amount of information, even at a high level. Moreover, because the model does not attempt to provide any accurate detail on the extent to which one variable influences another (for example, we know that education and transport investment are both essential to economic performance, which one influences it more? On what time scale? Under which conditions?), the range of relationships identified through the MM process simply fuels political debate and does not resolve it. I cannot see any decision maker changing their fundamental view on an issue because of results emerging from MM. If no decision maker is going to change their mind from use of the model (and worse, employ it like modern cost-benefit analysis to speciously support a predetermined position), then the model is merely another piece of information to add to the infinite pile we already have. Money for MM would be better off spent on a keg party which will lead to social interaction which will improve connections between attendees which will facilitate knowledge transfer which will improve productivity which will lift Auckland’s economic performance.
- Yes, possibly.

- There is a fundamental issue with stakeholder accountability and some did not see the 'need' for them to consider the social and health issues in their thinking.

Some respondents offered their thoughts on what was the **best** outcome from the MM process they did attend:

- Realising the need for other agencies to work together is a very significant challenge.
- Discovering where other agencies were at for planning particularly where their work addressed the higher level determinants of health and health infrastructure planning.
- Seeing how the modelling system worked – interesting tool which conceivably could be useful.
- Gain further insight into issues for other sectors and points of commonality.

The **worst** outcome was offered as follows:

- No tangible outcomes.
- Lack of representation from the private sector. Apparent dominance of planning processes by transport, especially roading, land use and growing the regional economy with a view to turning health planning purely into a function of these three key issues.
- I found the process a bit frustrating, mainly because I had not been invited to the first session, so I was starting at a bit of a disadvantage, which meant that the work I did between sessions maybe wasn't exactly what was looked for.
- Unsure if the invested time would result in a positive outcome.

Two participants were interested in using STELLA in the future and one considered this was a possibility. Three participants could not see them or their organisation using STELLA. Two participants were keen to be involved in future workshops. Four participants did not want to stay involved though two of these were interested in receiving updates about future MM workshops. The following additional thoughts, observations, suggestions, recommendations were volunteered:

- I would have liked to complete my time with the group at these workshops, but due to the central government constraints these days, priorities are placed elsewhere. However, I do think that the modelling workshops are useful to get people thinking differently about the "same old" issues.
- The interagency work we are involved in already is at early stages but looking promising. You may need to check with the various council officers who are involved in this if some of your findings may be able to be utilised by them in the current work streams.
- A good initiative but didn't seem to integrate into the Auckland Plan process.
- Continue to engage with high level decision makers or none of this good work will be utilised in the way it should be. For health, engagement with DHB chief executives and Board chairs is critical.

- I think the modelling system is very interesting but I am still not entirely convinced that it offers much more than can be done in a simple diagram – except for situations where there is really strong data on the relationships between variables, so that the figures plugged in to the model are meaningful. I was sorry I didn't get to see the data side of the model in action – maybe that would have answered these concerns. I also think we lost an opportunity, maybe due to the timing of the process. If we had done this modelling a year earlier, it could have fed into the Auckland Plan development. It was frustrating to be going through this process, knowing that the Auckland Plan was being shaped, but not making explicit links between them.

### ***2.2.5 Workshop Activities***

Appendix A gives detailed summaries of the discussions that took place during the three workshops. The summary of Workshop 1 includes an action list for participants from Education, Health and the Environment who committed to contribute to the model building with follow up actions before the next workshop. The SP2 research team representative from Auckland Council also committed to follow up action but this did not happen as the role was handed over to a different representative. Such discontinuity is considered part of the adaptive management when reflecting on the MM process.

The follow up with representatives from Education, Health and Environment involved an iterative process by email where a model sector (in STELLA icons) was proposed with a narrative of what this model structure aimed to achieve and finished with specific questions or data requests. Appendix B provides the 'Natural Capital Model Sector' as an example. The Mediated Modeller used the 'storytelling' capability of STELLA to prepare each story which was then told at Workshop 2 by the respective participants to update everyone on this section of the model. The stakeholder/participant clicked on the 'space bar' to display the icons linking the story together. Text boxes appeared in order to tell the basics of the 'story'. The participant then elaborated with a narrative on the story presented in STELLA. This provided the starting point to improve the evolving model.

At the end of Workshop 1, all stakeholders were requested to submit scenarios before Workshop 2. Six scenarios were provided by stakeholders, but with such a short lead-time the research team was unable to reflect on the possible inter-linkages and provide feedback through the evolving model before Workshop 2. Elaborating on the proposed scenarios during Workshop 2 resulted in an even longer wish list for potential scenarios. These are listed as presented in the summary of Workshop 2 (Appendix A).

### ***2.2.6 Causal Loop Diagram Evolution***

When the topic is defined in advance, a preliminary systems dynamic model can be shown at the first MM workshop. As the topic was not agreed on prior to the Auckland workshops, instead a preliminary Causal Loop Diagram (CLD) was prepared linking the various topics participants were interested in (Figure 12).

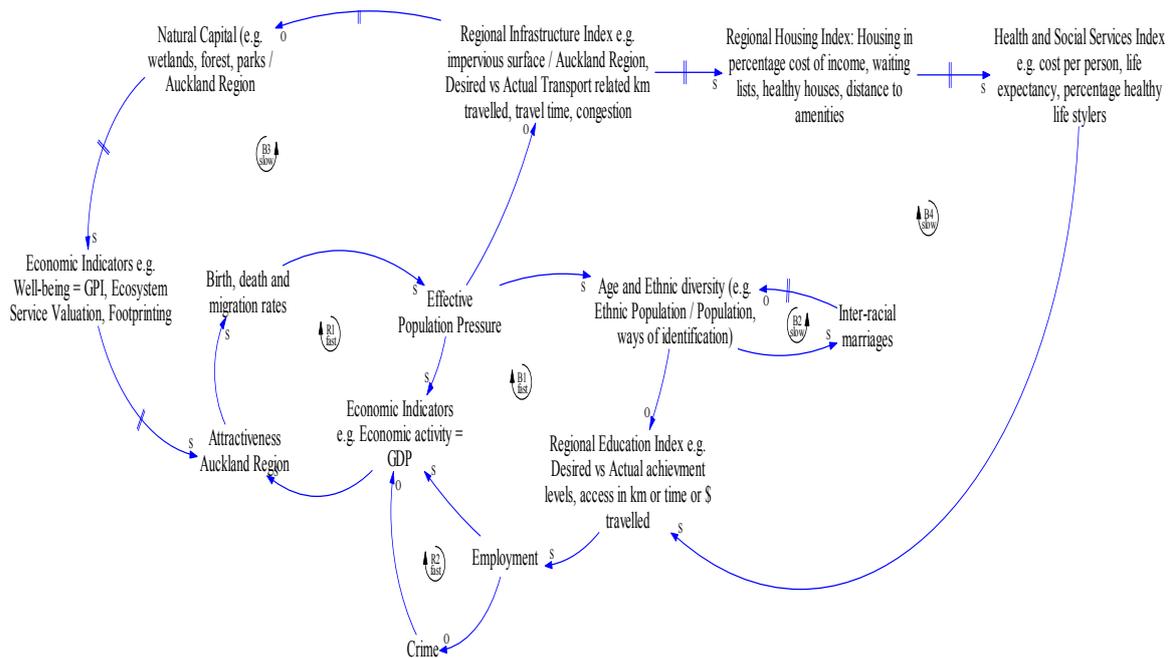
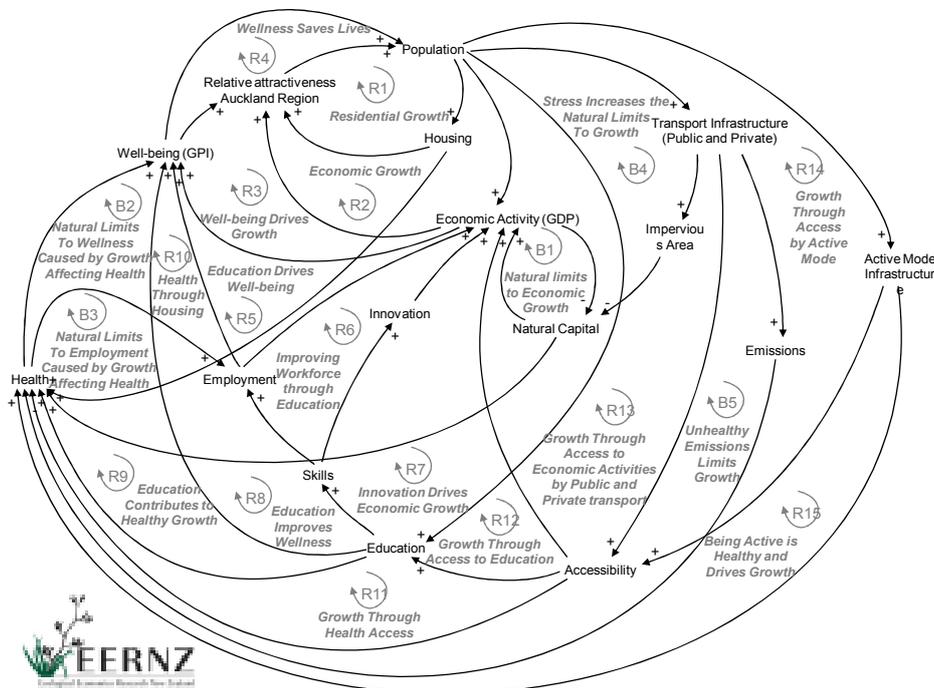


Figure 12: Preliminary Causal Loop Diagram of Auckland regional dynamics, presented at workshop1



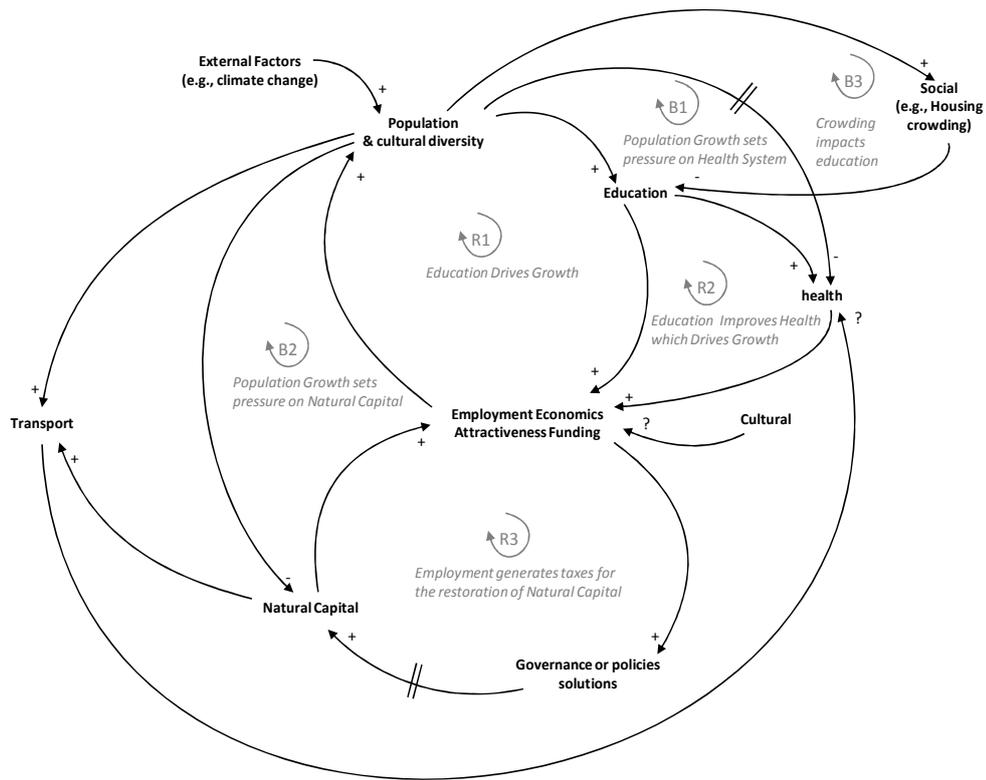
Note: +/- indicates moves in the same direction which can be either positive or negative.

Figure 13: Causal Loop Diagram of Auckland regional dynamics, presented at workshop 2

The causal loop diagram (CLD) was further developed over the course of the three workshops to reflect the complexity revealed in the dialogue

Figure 13 shows the CLD integrating the feedback of three participant sub-groups at workshop 2. This CLD reflects the 'wish list' of connections participants would like explored. The final CLD after the third workshop is given in Figure 14. When comparing the preliminary CLD with the final one, the following observation can be made:

- The primary reinforcing driver is population growth and economic activity.
- The balancing loops are represented by social, natural and other infrastructure such as transport, health and education. The balancing loops slow down economic growth. This was a concern distilled from participant pre-interviews.
- The final workshop focused more on 'attractiveness' rather than 'Economic Activity'. The infrastructure around Education, Health and Natural Capital, Housing and Transport all contribute to 'attractiveness'.
- The Cultural aspects were not addressed in part because representatives for this area did not participate consistently. However, the inclusion of ethnic/cultural diversity provided an important question for discussion; Does ethnicity matter for infrastructure provision? The answer seems to be not from a service provider's perspective if 'total numbers' are considered, but it does if equality and feedback loops are taken into account.



Note: +/- indicates moves in the same direction which can be either positive or negative.

Figure 14: Final Causal Loop Diagram of Auckland regional dynamics, presented at workshop 3

## 2.3 Content

The content segment of this report describes the model and the scenarios that were simulated at workshop 3 and which can be simulated on-line at this point. Two participating organisations were provided with a STELLA license to run the model and free run-only STELLA software can also be used. The model is accessible in Forio, which allows users to assess linkages and run scenarios on the web, without the need to download STELLA software.

### 2.3.1 Model description

Figure 15 shows the user-interface of the Auckland Mediated Model, gives a model overview, and the interconnections between model sectors. The details of these model sectors, relevant equations and calibrations with data used, are described in Appendix E.

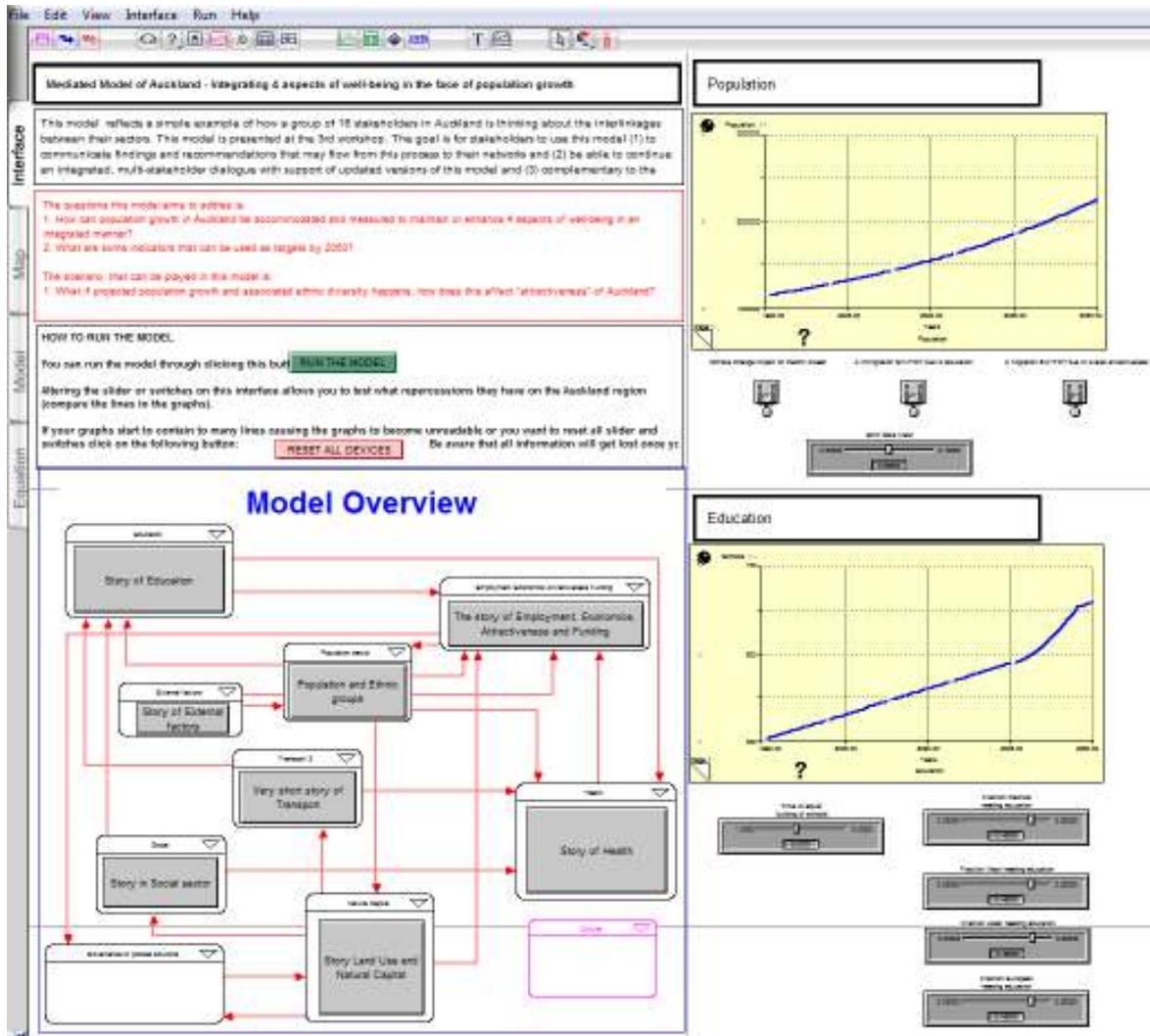


Figure 15: User-interface

Slide bars on the interface allow a user to simulate alternative scenarios and explore the impact by comparing various graphs. The graphs represent ‘what is happening’ from 1990 until 2050. The model is calibrated where data trends (sometimes only 2 data points) are available, such that the model “fits” data trends between 1990 and 2012. Assumptions are then made on how current trends project into the future. The goal is to support the understanding of how various trends interlink by simulating ‘what-if’ scenarios.

### 2.3.2 Scenarios and simulation

The interface of the current version of the simulation model allows for four decisions to be taken in light of the ‘what-if’ question: “What if projected population growth and associated ethnic diversity happens, how does this affect ‘attractiveness’ of Auckland?” Four sub-scenarios are formulated around: climate change impacting on the Pacific Ocean resulting in more Pacifica immigrating to the Auckland region

(switch on model interface); Asian immigration to the Auckland region driven by education quality (switch on model interface); immigration to the Auckland region due to its overall 'attractiveness' (switch on model interface); and a change in the birth rate of Maori (slider on model interface, initial value = 5 percent of the Maori population).

To test the impact of each of these scenarios, five runs were performed and the results are given in Figures 16 to 21 for the variables (i) Total population (ii) Pacifica population (iii) Maori population (iv) Asian population and (v) European population and everyone else (vi) Auckland 'attractiveness'. The first run ("line labeled 1") in each graph shows the base run where the model is run without parameter adjustments. The "line labeled 2" shows the impact of increased immigration of Pacifica due to climate change. The "line labeled 3" shows the impact of immigration to the Auckland region driven by quality of education. The "line labeled 4" shows the impact overall 'attractiveness' has on immigration to the Auckland region. The "line labeled 5" shows the impact an increased Maori birth rate has on the Auckland region.

#### *Climate change impacting on the Pacific Ocean resulting in more Pacifica immigrating to the Auckland region*

The climate change scenario is not based on researched projections but rather on the perceptions of knowledgeable participants of the potential impact. In the modelling the immigration of Pacifica clearly shows up in the population graph which in 2050 is 19% higher than the base run. The ratios for the different ethnic groups also alter. In the year 2050, Pacifica represents 36% instead of 24% (i.e., base run) of the total population (Figure 17). This increase in the representation of Pacifica in the total population results in a relative decrease for all other ethnic groups: (1) Maori went from 15% to 12% by 2050 (Figure 18), (2) Asians from 29% to 24% by 2050 (Figure 19) and (3) Europeans (and everybody else) from 32% to 27% by 2050 (Figure 20).

This population increase resulted in interesting changes to the 'attractiveness' of the Auckland region (see Figure 21). We observe that this scenario results in faster growing 'attractiveness' between 2010 and 2025 for the Auckland region compared to the baseline. However, 'attractiveness' then drops below that of the base run from year 2025 to end with a loss of 27% in 'attractiveness' by 2050. The reason for this behaviour is that the 'attractiveness' of the Auckland region first responds to a faster increase in employment level due to more people (mainly Pacifica). However, there is also an increase in the number of young people wanting education which is not met with extra investment. Crowding in schools ultimately leads to negative impacts on NCEA results which reduces the employability of school leavers. Hence, more unemployment reduces the 'attractiveness' of the Auckland region.

#### *Asian immigration to the Auckland region driven by education quality*

This run assumes that Asians are the ethnic group that immigrate to New Zealand for education. The switch causes the ratio of Asians in the total population to be higher than the base run at 40 percent

instead of 29 percent (see Figure 19). This has almost the same effect on the 'attractiveness' of the Auckland region as the previous run which is not surprisingly as the reasons for the behaviour of the 'attractiveness' are also the same. The only difference is that due to a higher Asian success rate in the educational system (especially under crowding circumstances) compared to Pacifika, the lag time for the impact on 'attractiveness' is slightly longer.

#### *Immigration to the Auckland region due to its overall 'attractiveness'*

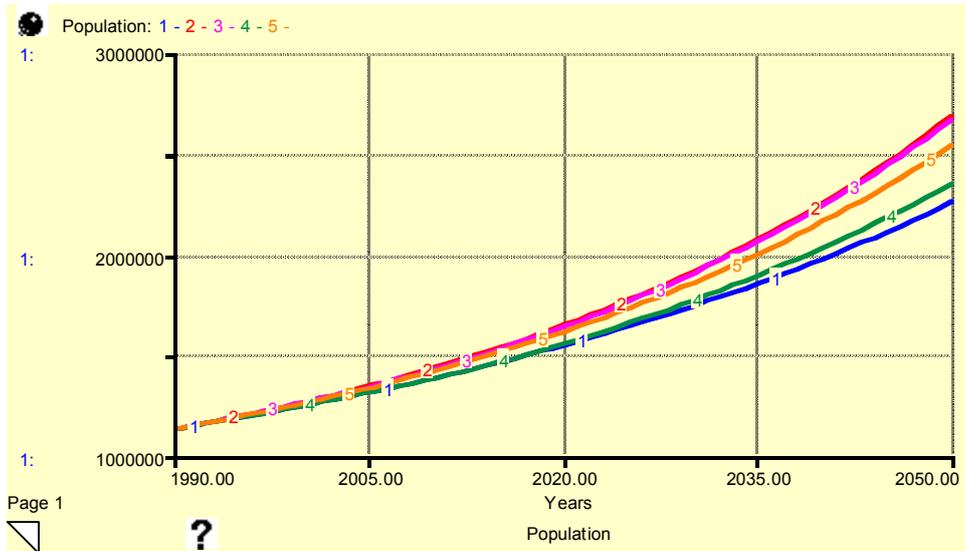
The run where immigration to the Auckland region based on the 'overall attractiveness' is activated (Figure 21) results in population pressure impacting on the factors that make up 'attractiveness' which are education, benefits derived from ecosystem services, employment and health. This in the longer term reduces the 'attractiveness' of the Auckland region as the factors that drew people to the region are no longer available.

#### *One percent change in the Maori birth rate*

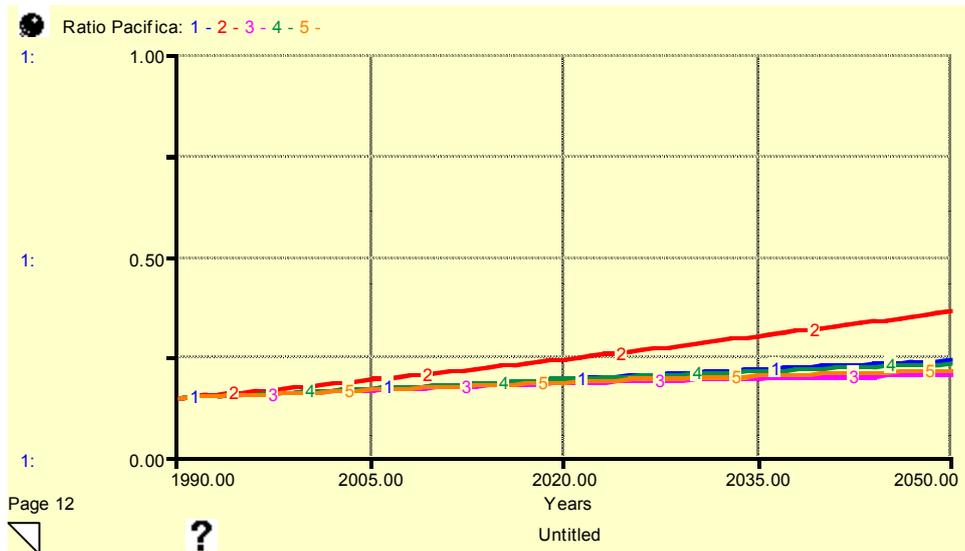
If the birth rate for Maori increases from 5% to 6% of the Maori population by 2050, Maori are a significantly larger ethnic group accounting for 24 percent of the total population compared with the base run of 15 percent (Figure 18). The effect this increase in population has on the 'attractiveness' of the Auckland region is again similar to the effect the increase in Asians and Pacifika have on the 'attractiveness' of the Auckland region.

#### *Summary of model simulations*

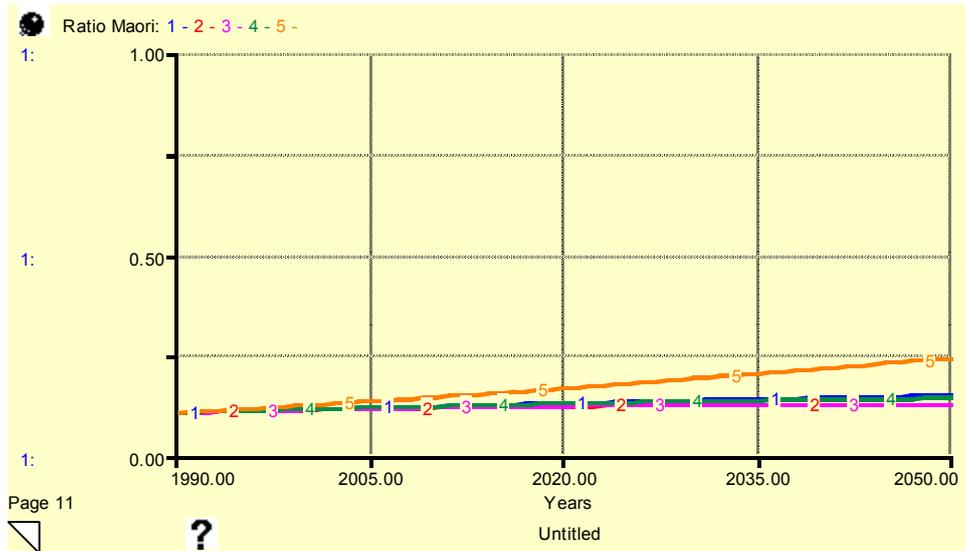
In sum, increasing the population in Auckland initially increases 'attractiveness' but then a downturn occurs. This is the result of more pressure on health, education, employment and ecosystem services which combine together to make up 'attractiveness'. Pacifika immigrating to the Auckland region as a result of climate change, and Asian immigration to the Auckland region for education, has the decline starting 10 years before that of the base run. A one percent increase in Maori birth rate results in the year of decline starting 8 years before that of the base run. More people moving to the Auckland region because of the 'attractiveness' of the Auckland region results in the year of decline starting 2 years before that of the base run. The model shows that increasing population with no comparable increase in investment in health and education reduces the 'attractiveness' of Auckland in the long term. Hence, the scenarios confirm the perception of the participants that increasing future populations for the Auckland region will have dramatic results if they are not well planned for!



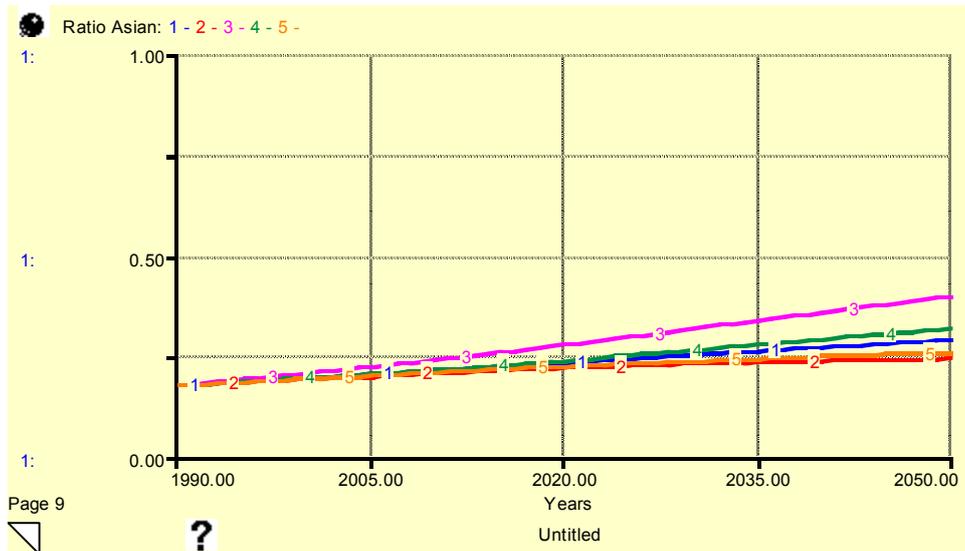
**Figure 16: Simulation results for population in the Auckland region for five different scenarios related to the question of “what if projected population growth and associated ethnic diversity happens, how does this affect ‘attractiveness’ of Auckland”. The runs are: (1) a base run, (2) climate change impacting on Pacifika, (3) immigration to the Auckland region for education, (4) immigration to the Auckland region because of its overall ‘attractiveness’, and (5) an increased Maori birth rate (6% instead of 5% of the Maori population).**



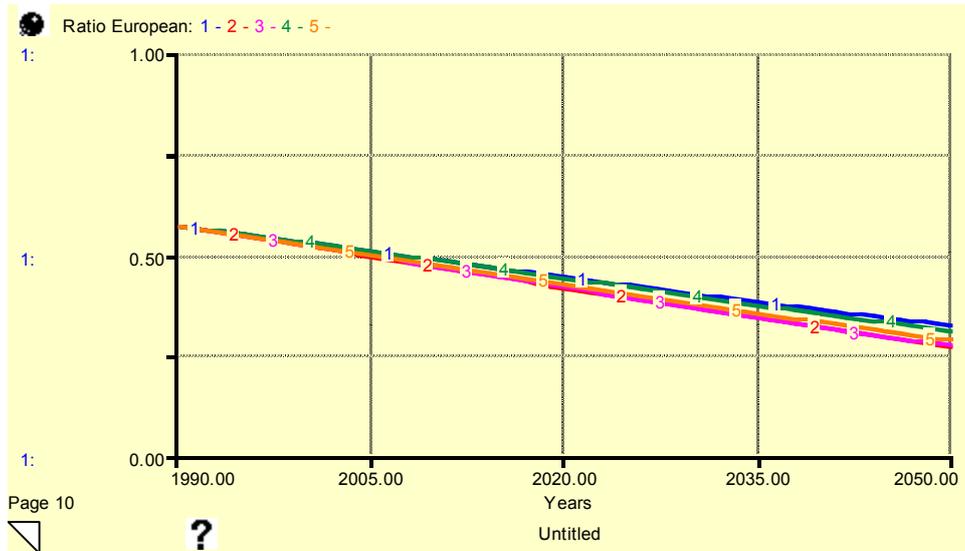
**Figure 17: Simulation results for the ratio of Pacifika in the Auckland region for five different scenarios related to the question of “what if projected population growth and associated ethnic diversity happens, how does this affect ‘attractiveness’ of Auckland”. The runs are: (1) base run, (2) climate change impacting on Pacifika, (3) immigration to the Auckland region for education, (4) immigration to the Auckland region because of its overall ‘attractiveness’, and (5) an increased Maori birth rate (6% instead of 5% of the Maori population).**



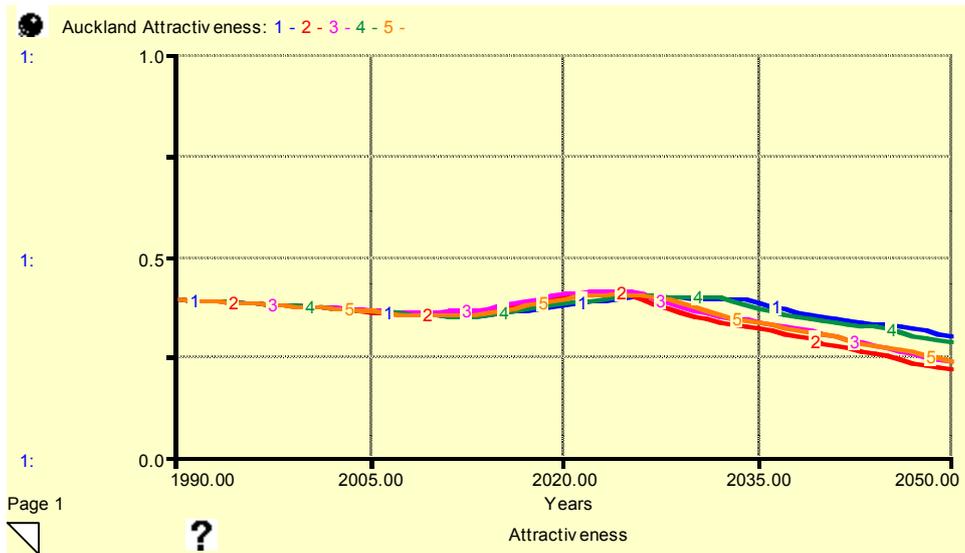
**Figure 18: Simulation results for the ratio of Maori in the Auckland region for five different scenarios related to the question of “what if projected population growth and associated ethnic diversity happens, how does this affect ‘attractiveness’ of Auckland”. The runs are: (1) base run, (2) climate change impacting on Pacifika, (3) immigration to the Auckland region for education, (4) immigration to the Auckland region because of its overall ‘attractiveness’, and (5) an increased Maori birth rate (6% instead of 5% of the Maori population).**



**Figure 19: Simulation results for the ratio of Asians in Auckland region for five different scenarios related to the question of “what if projected population growth and associated ethnic diversity happens, how does this affect ‘attractiveness’ of Auckland”. The runs are: (1) base run, (2) climate change impacting on Pacifika, (3) immigration to the Auckland region for education, (4) immigration to the Auckland region because of its overall ‘attractiveness’, and (5) an increased Maori birth rate (6% instead of 5% of the Maori population).**



**Figure 20: Simulation results for the ratio of Europeans (and everybody else) in the Auckland region for five different scenarios related to the question of “what if projected population growth and associated ethnic diversity happens, how does this affect ‘attractiveness’ of Auckland”. The runs are: (1) base run, (2) climate change impacting on Pacifika, (3) immigration to the Auckland region for education, (4) immigration to the Auckland region because of its overall ‘attractiveness’, and (5) an increased Maori birth rate (6% instead of 5% of the Maori population).**



**Figure 21: Simulation results for the ‘attractiveness’ of the Auckland region for five different scenarios related to the question of “what if projected population growth and associated ethnic diversity happens, how does this affect ‘attractiveness’ of Auckland”. The runs are: (1) base run, (2) climate change impacting on Pacifika, (3) immigration to the Auckland region for education, (4) immigration to the Auckland region because of its overall ‘attractiveness’, and (5) an increased Maori birth rate (6% instead of 5% of the Maori population).**

### Additional Scenarios

Three additional scenarios were contributed by stakeholders. These were 'what-if': priority for health care moves from the elderly to young children; the Auckland Metropolitan Urban Area is allowed to expand; and restoration efforts for natural capital increase or decrease. The following section describes these runs.

#### Priority for health care moves from the young to elderly

In the base run of the model it is assumed health care resources do not increase overtime. In the base run young people get enough health funding to remain healthy (Figure 22). The elderly are funded at a level that results in 85% being healthy in 1990 but this falls to 40% in 2050 as the number of elderly grows (Figure 23). A reallocation of resources in favour of the elderly causes approximately 15% of the young to become less healthy and 15% more of the elderly to become healthy. Hence, there is a one-on-one relationship in the model meaning that for every percentage of healthy elderly we gain there a percentage of healthy youngsters lost.

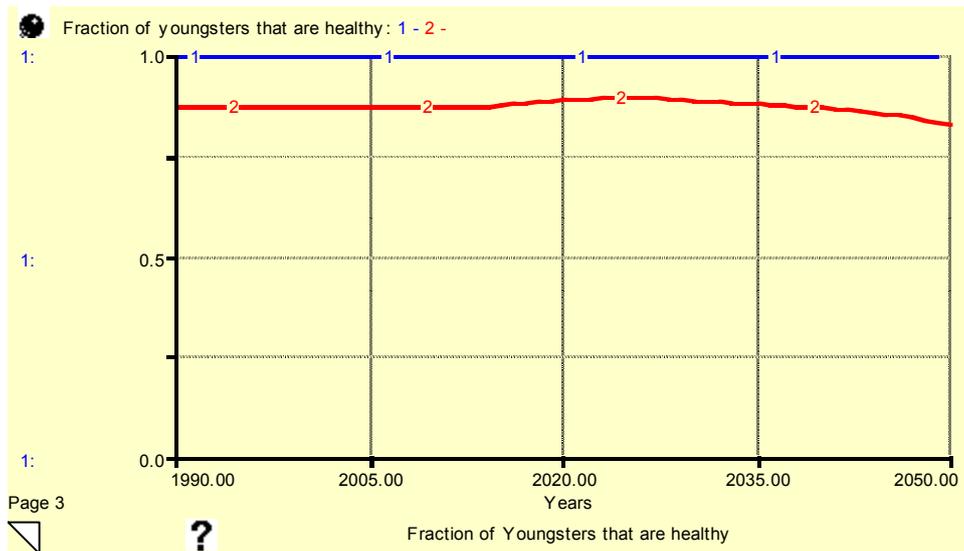
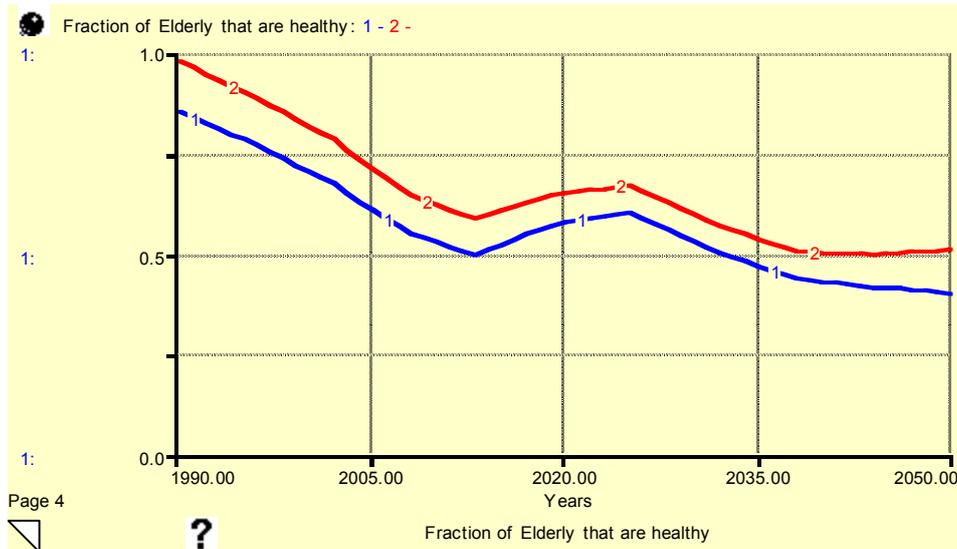


Figure 22: Fraction of youngsters that is healthy for (1) the baseline and (2) more health care to elderly



**Figure 23: Fraction of elderly that is healthy for (1) the baseline and (2) more health care to elderly**

The curve of the line is explained as follows:

- 1990-2010: Capacity cannot follow demand
- 2010-2030: Capacity has expanded and the elderly can now also benefit from under used capacity for youngsters
- 2030-2050: Under used capacity for youngsters disappears because more youngsters need more healthcare

### *Metropolitan Urban Area is allowed to expand*

From an environmental perspective land use is important and the model allows a simulation of a change in the zoning in the Auckland region. In the base run we have 563 km<sup>2</sup> zoned (Figure 24). If we expand this to 800km<sup>2</sup> the population trend does not change (Figure 25) but people instead spreading to benefit from the “new space” this has an interesting effect on the ‘attractiveness’ of the Auckland region due to its ecosystem services component. ‘Attractiveness’ lies slightly above the baseline from 2025 onwards and meets the baseline again in 2050 (Figure 26). The reason for this behaviour is that till 2025, the zoned limit of 563km<sup>2</sup> was not yet fully built on (Figure 24). After 2025, the city expands more than the baseline resulting in more urban area and also more open spaces in the city, which initially gives the city higher ‘attractiveness’ due to increased ecosystem services (Figure 27). However, with a time lag, stress on natural capital builds (Figure 28) and ecosystem services deteriorate.

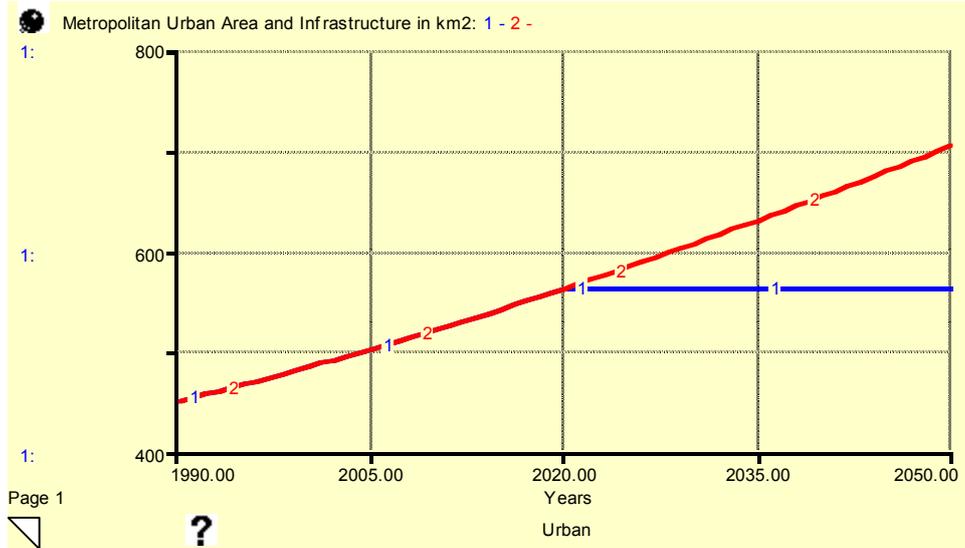


Figure 24: Metropolitan Urban Area Infrastructure when (1) 563 km<sup>2</sup> (= base run) and (2) 800 km<sup>2</sup> is being zoned

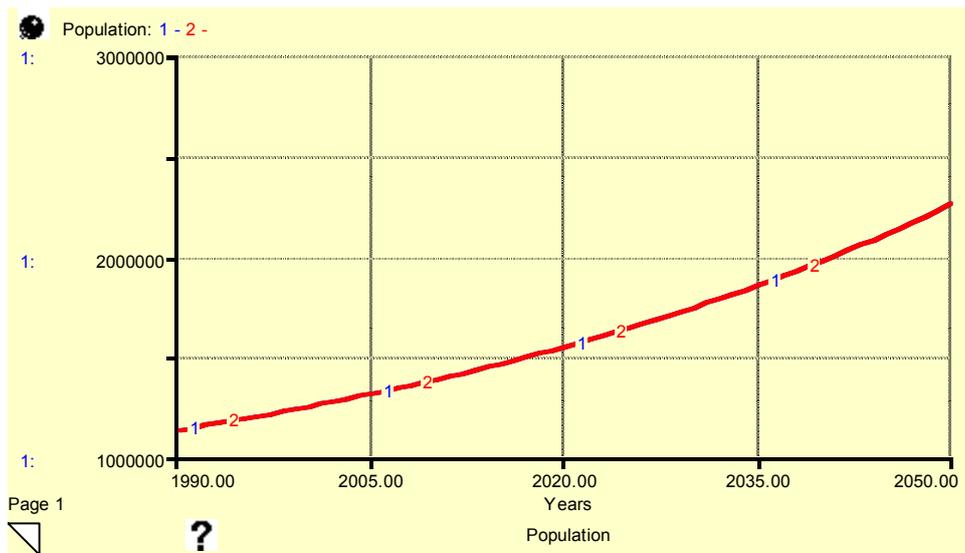


Figure 25: Population when (1) 563 km<sup>2</sup> (= base run) and (2) 800 km<sup>2</sup> is being zoned

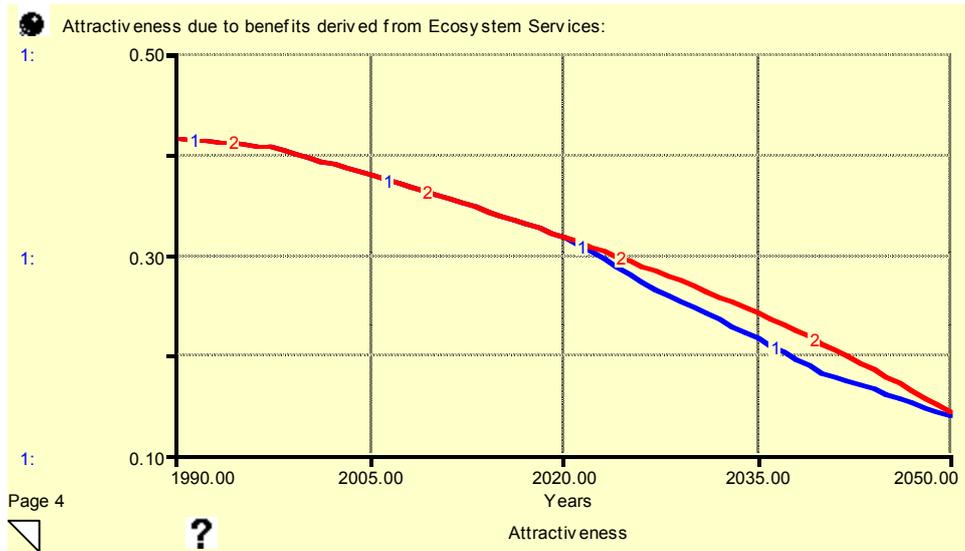


Figure 26: 'Attractiveness' of the Auckland region due to Ecosystem Services when (1) 563 km<sup>2</sup> (= base run) and (2) 800 km<sup>2</sup> is being zoned

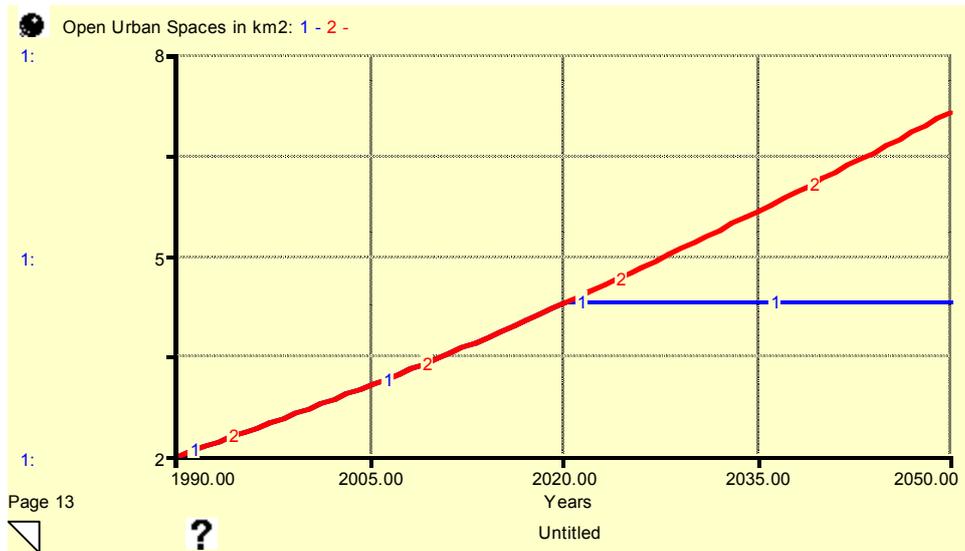


Figure 27: Open urban spaces when (1) 563 km<sup>2</sup> (= base run) and (2) 800 km<sup>2</sup> is being zoned

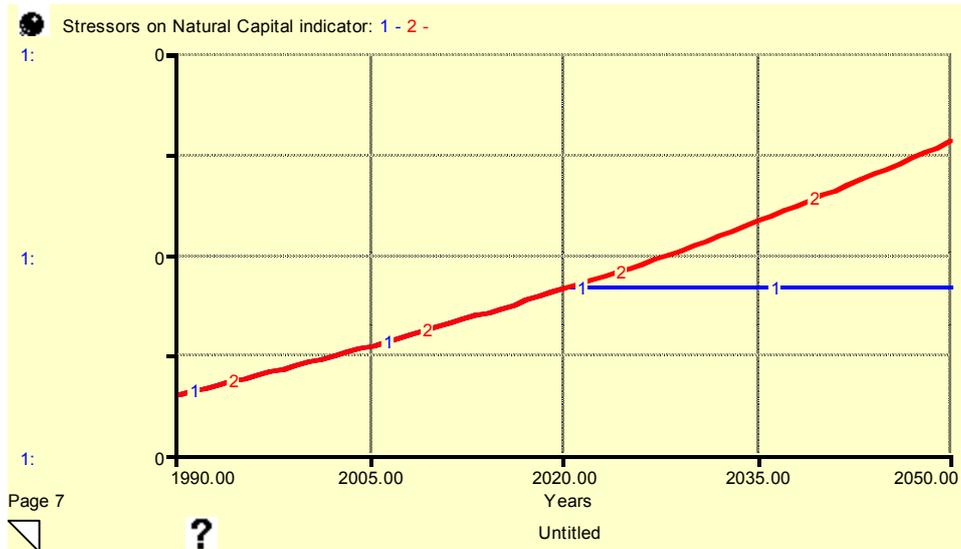


Figure 28: Stressors on natural capital when (1) 563 km<sup>2</sup> (= base run) and (2) 800 km<sup>2</sup> is being zoned

### Restoration efforts for natural capital increase or decrease

This run allowed changes to the restoration rate of natural capital from a 0.02 (baseline) to a maximum of 0.1 (scenario). The increase in terrestrial natural capital above the baseline (Figure 29) is from “other area in human production”; which rapidly disappears (Figure 30). Terrestrial natural capital can only grow to just below 900km<sup>2</sup> as there is no “other area in human production” left to convert. The conversion does not change the ‘attractiveness’ of the Auckland region in this model as ecosystem services are part of both land uses and contribute equally to ‘attractiveness’ (Figure 31).

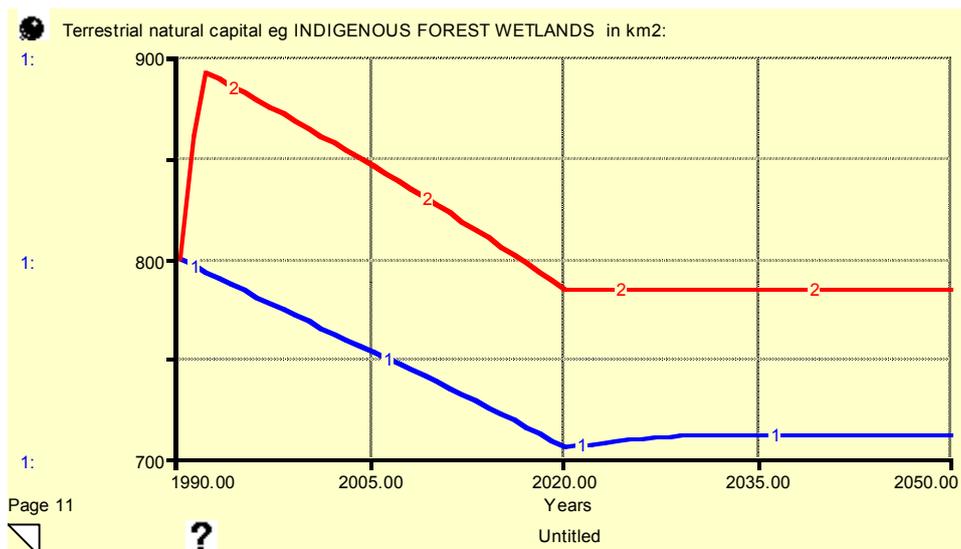


Figure 29: Terrestrial natural capital when the restoration rate of natural capital equals (1) 0.02 (baseline) and (2) 0.1

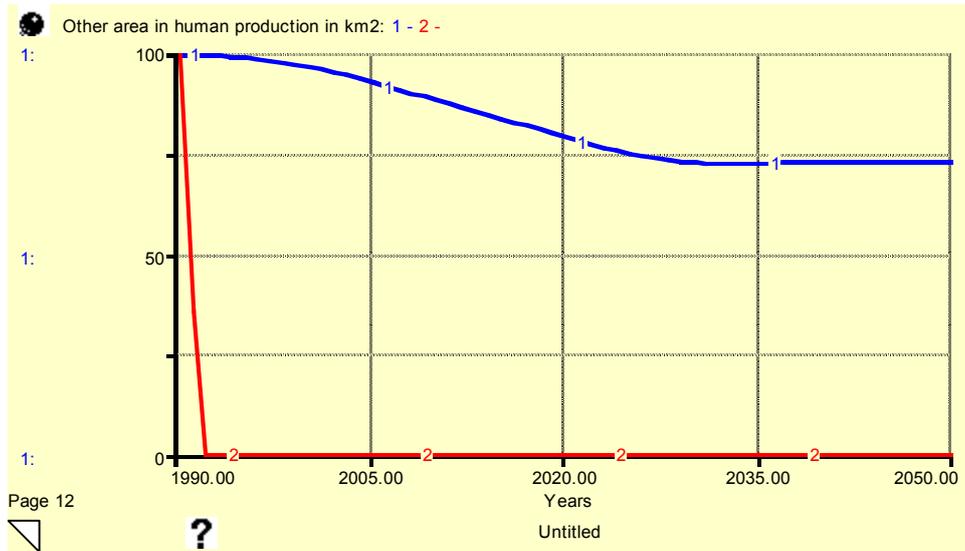


Figure 30: The results for the variable "Other area in human production" when the restoration rate of natural capital equals (1) 0.02 (baseline) and (2) 0.1

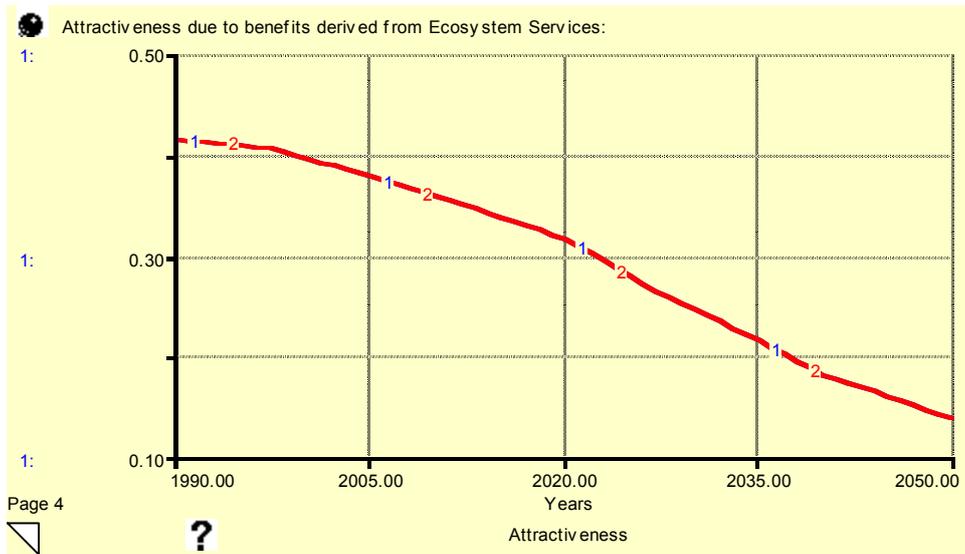


Figure 31: 'Attractiveness' of the Auckland region due to ecosystem services when the restoration rate of natural capital equals (1) 0.02 (baseline) and (2) 0.1

### 3. DISCUSSION

In the pre-assessment document what was meant by: (1) Adaptive Management, (2) Normative goal of Sustainability, (3) Scale and (4) Integration was made explicit to avoid misunderstanding. This section discusses these topics referring to the findings in the MM workshops.

**Adaptive Management (AM):** The AM cycle follows the path of envisioning, assessing, planning, implementing and monitoring. AM remains an integral part of the MM component and increasingly the SP2 programme. This report reflects AM starting from a lack of a clear topic. Participants engaged on the basis of long term **vision** for Auckland as ‘the world’s most livable city’. The Auckland Spatial Plan covered the **planning** phase. The MM component aimed to contribute to the assessing step, but we had a difficult time fitting in between ‘vision’ and ‘plan’ in the first iteration. However, the SP2 programme is firmly embedded in the research division (i.e. contributing to the assessment step of the AM cycle). No recommendations were formed at the end of the three MM workshops and the next ‘planning’ step for MM needs to be directed by AC and the SP2 Project Team. See also ‘next steps’. The ‘implementation’ step could be regarded as the on-line featuring of the scoping model and report. Based on the model and the evaluation of the surveys (monitoring), the planning of the next step will be aligned with the ‘vision’ for the SP2 project and the contextual drivers identified in this report.

**Sustainability:** The word ‘sustainability’ is seldom used anymore.

**Scale:** Regional dynamics were the focus on the Auckland region modelling, however, external impacts, such as climate change and immigration certainly entered the conversation. Purely local considerations, such as ‘where should the next school be build’ were regarded as ‘spatial issues’, not part of the MM component. The national-regional considerations were important for some participants. This is an interesting space, as such conversations can become increasingly politically motivated. For some participants (perhaps those who are not always included in the national-regional discussions) that worked and for some (perhaps those who already have established venues for such dialogues, the MM tool didn’t provide the support or rigor to warrant prioritisation of time. This isn’t unusual (van den Belt 2011).

**Integration:** The linkages in the model evolved to represent the interests and perspectives of the participants. The topics of Education, Health, Environment and Transport remained at the forefront, thereby adding social and ecological considerations. Cultural aspects were included through ethnicity, however, the stakeholders representing this space did not fully attend the workshops. As a result already at the bottom of the ranking of the 4 aspects of well-being, cultural considerations remain there.

#### 3.1 *Reflections*

The governing context in Auckland is under-going significant change. The project teams reflection on this is that this initially led to interest and energy from participants, who wished to explore if the MM approach could indeed provide a pathway into the integration process, both by virtue of (1) meetings of

people with different interests and perspectives who 'should' be interacting but in reality never do due to segmented obligations, and (2) a potential process to structure a complex dialogue.

- Generally, both time commitments and politics determine progress made in a MM process and this was true for the MM process executed in Auckland
- Although there was a conceptual link with Spatial Planning leading up to the MM process, when the process happened, the people involved in Spatial Planning were so over-burdened and focused on the draft plan, that direct participation did not materialise. This was a disappointment to some participants, who viewed this involvement as important for success.
- Many concrete political issues and debates, such as the Central Rail Link, were being considered outside the MM process. In some instances stakeholders in the MM process were debating the dynamic interlinkages of such issues, without mentioning the 'real' political debate.
- Without a concrete topic, and the involvement of the AR representative responsible for facilitating the stakeholder invitations (for reasons explained in the pre-report), the technical process of Systems Thinking, System Dynamics and Collaborative Learning became the main objective. A shift in focus moved AC towards getting a better understanding the AC internal integration processes before engaging with external stakeholder. See next steps.

### ***3.1.1 Scenarios***

The request for developing 'scenarios' resulted in late submissions (1-2 days before the 2<sup>nd</sup> workshop) which were then difficult to turn into high level integrated scenarios using the evolving model. This was when the two limitations/compromises of: (1) no clear topic, and (2) reduced commitment from 10 to 3 workshops became most apparent. It can be argued that the abbreviated MM process has allowed participants to understand enough of the MM tool to make an informed decision as to whether or not it is a useful tool, however, on the other hand a case can be put that the MM tool wasn't featured in its full capacity.

### ***3.1.2 Addressing the questions raised in pre-report***

Eight questions were posed in the AR pre-assessment report as a means to test the team's anticipated outcomes from the MM process and enable a comparison to be made with what actually happened. This section answers those questions drawing on the information in the post-workshop survey provided by respondents who attended all workshops. The responses to the questions are provided in Appendix C.

#### ***Question 1: Was the model used sufficiently in supporting the dialogue?***

During the workshops both Causal Loop Diagrams (CLDs) and a system dynamics model were used to support the dialogue. For the CLD, participants were either uncertain (i.e., neutral, 2 participants) or positive (i.e., agree, 2 participants) that the CLD was a good representation of the issues the group set

out to investigate. Three respondents were positive that it captured the discussion that took place (one neutral) and they had individually contributed to the CLD (one neutral, two agreed and one strongly agreed). Three agreed that the CLDs would be of interest to others (one neutral). Three agreed about the CLD value as a way of communicating problems in the AR to others (one neutral) and all thought that the CLD was worth developing further.

Interactive model building in STELLA happened on the afternoon of workshop 1 and the morning of workshop 2 only. The question arises whether this is a sufficient number of workshops to achieve the goals of a MM process, which generally takes about 10 workshops. With regard to the model building, three participants agreed and one participant strongly agreed that the Mediated Modelling helped structuring the thinking about issues of concern in the Auckland Region (Appendix C: Figure 53). All four interviewed agreed that MM helped structuring the discussion (Appendix C: Figure 54).

To follow the linkages within the CLD and the STELLA model, a story explaining the CLD was developed as a PowerPoint presentation which is available on the SP2 website. The advantage of using PowerPoint is that participants don't need to download STELLA to show other people, an additional step in the process. Downloading STELLA proved problematic due the firewalls in most organisations.

Storytelling provided a good means for all respondents to follow and understand the CLD. It was also seen as a helpful way for the respondents to communicate problems facing the AR to others (3 agreed, 1 strongly agreed). Storytelling was also used to demonstrate the updated model sectors.

However, mixed results were obtained with regard to willingness to actually communicate the developed story to others. One respondent was unwilling and 3 respondents intended to use the story telling capacity with others.

***Question 2: What is the significance of data availability and/or data translation?***

Data to run the simulation model was obtained primarily from StatsNZ and directly from participants. When data was unavailable for variables that needed to be quantified to run the model, "guesstimates" were made by the modelers in dialogue with the relevant participants. The Health, Education, Natural Capital and Transport sector were developed in consultation with the participants. The aim was for the participants to present the 'story' modelled.

Data translation was not an issue as stakeholders were generally very familiar with the type of data used. The linkages between sectors were apparent to participants and understood before the workshop so knowledge in this area was not significantly added to. Learning came from linking ethnic trends with Health and Education.

***Question 3: Was the model an appropriate vehicle to reach the conclusions or address the concerns of the participants?***

At the outset it was decided to keep the workshops general and not address a specific topic. Participants provided multiple varied scenarios as part of the workshop process and one was chosen by the modelling team to develop the simulation model. Based on the primary survey and critical assessment of the project team, the status of the model is that it is too under-developed to conclusively integrate and address concerns raised.

***Question 4: Did the reflection on the group's make-up change consistently?***

Not really. It was observed that Business and Industry should be participating more prominently but those stakeholders were the first to lose interest. There was a gap between the public and private sector on how the MM process was perceived. This could also be related to the lack of a topic as pointed out by the most critical (secondary survey) participant.

***Question 5: Did we lose or gain participants? Are the observed gaps in the stakeholder list persistent or changing?***

Of the fifteen initial participants at workshop 1, eleven attended workshop 2 and eight continued on to workshop 3. Four participants participated in all three workshops. One participant formally withdrew from the process. For the others, attendance at all the workshops was not possible due to other commitments.

Four of the eight participants in workshop 3 were surveyed. All expressed interest in actively participating in phase 2 of the MM process.

As participation in the group dropped off the gaps in stakeholder representation identified in the pre-workshop survey became more of an issue. This was because the drop off included participants representing Ethnic and Cultural organisations, which were under-represented to start with. Also, the Business sector under-represented from the start faded as we progressed. Those remaining provided a public sector perspective. This is taken into account as the next steps are considered.

***Question 6: Are participants (including those who were unfamiliar with STELLA) willing and able to demonstrate the model to others?***

None of the participants used STELLA to run the model after the workshops. Some participants tried to download the STELLA-software but their organisations IT systems fire-walled this. However, when asked, two participants could see a scenario where they themselves would use STELLA or their organisations would be interested in using STELLA in the future. Two organisations obtained Stella licenses so they could use the modelling software.

***Question 7: Does a significant portion (>50%) of the group want to continue the MM effort?***

All of those interviewed (4 respondents) wanted to continue the MM process. Two respondents to the secondary survey were keen to be part of further workshops and another two who did not have sufficient time asked to be kept informed with MM updates.

Respondents from both sets of surveys were generally of the view that their issue would benefit from a MM process. One respondent disagreed, three were neutral, three agreed and four strongly agreed (see Appendix C: Figure 41 and Appendix D: Figure 83). All 4 ‘full’ participants agreed that it could be useful to continue developing the CLD (Appendix C: Figure 63). One of the participants saw potential for the STELLA model to function as a decision support tool for the Auckland Region if the model is further developed. Hence, responses that improvements to the simulation are needed to generate insightful scenarios.

***Question 8: Is the website serving well as a communication tool?***

Since we didn’t set a benchmark for what constitutes “well” this question is hard to answer. Survey responses indicate usage of the website by the more active participants but the website was not used extensively. Only 2 participants visited 2-5 times, the remaining participants visited the website less than twice or even never.

***3.1.1 Mediated Modelling and the Integrated Spatial Explorer (ISE)***

The MM workshops have been run to provide stakeholder input into the development of the more data intensive ISE model. Based on the current scoping model/model description, a first round of recommendations will be provided to get the ISE inter-linkages workshops off to a good start. The MM participants received a presentation on the evolving spatially dynamic model for Auckland.

**3. CONCLUSION AND NEXT STEPS**

The fast tracking of the Auckland Spatial Planning process, a change to the requirement for Long Term Council Community Plans, governance restructuring, staff re-organisation and infrastructural projects of national importance attracting political attention were contextual circumstances that proved major hurdles for the MM process in Auckland. As a consequence of these influences a suitable topic for the MM process was not established at the outset. Following on from this the value derived from the workshop was more from demonstration of the MM process rather than its application. While some participants genuinely valued their MM experience, for others the lack of a topic of relevance and sufficient importance to warrant the time involved was a real issue. The three workshops did not provide consensus on a suitable topic for further MM workshops so AC is now considering focusing MM efforts internally rather than involving external stakeholders. The current challenge is to define a suitable ‘next step’ to bring context and process into alignment to produce more substantial content in the next iteration. Suggested topics are:

## **Topic 1: Urban intensification**

Background:

Auckland's spatial plan has been completed and launched. The plan retains a strong role for town centres as key growth locations. Under all policy prescriptions town centres are expected to increase significantly the density of residents and employees. A centre's ability to achieve the planning outcomes identified in the spatial plan is contingent on a number of local, regional and global factors. Local time and space specific variables such as the size and shape of existing land parcels coupled with external factors such as the availability of capital for construction will determine, either individually or in combination, the future outcomes within centres. The complexity in achieving these urban futures can be contrasted with the rather sanguine planning approaches, which produce normative spatial futures with an expectation that the agents responsible for producing these environments will act in accordance with planning desires. In short, the urban futures suggested by the Auckland plan are entirely contingent on the behaviours of a range of actors, some of whom may not share the values and goals embodied in planning (Couclelis, 2005) or the ability to act in a manner consistent with the plan.

A mediated modelling process could be conducted focussing on the role of centres in achieving the residential and employment outcomes outlined in the Auckland plan. The focus could be one of examining centres as a planning concept rather than specific centres in detail. The approach would seek to achieve the following objectives

1. Understand the range of agents, their motivations and influences on town centres.
2. Understand how their individual and collective decisions are likely to influence the future of these places.
3. Understand and model the interdependencies between agents and the effects of their individual decisions on other agents.
4. Understand the factors which fall within the 'circle of control' of Auckland Council and its council-controlled organisations.
5. Understand the factors within Auckland Council's influence and develop strategies and tactics that seek to maximise that influence.

## **Topic 2: Fresh water NPS**

Background:

A current and relevant policy topic that would benefit from a MM approach is the NPSFM work programme, and in particular the integrated management of whole of catchments. Integrated catchment management relies on a coordinated approach between the regulatory, service delivery and non-governmental sectors. It also requires effective collaboration and integration of effort within each of these sectors. Fenemor *et al.* (2011) list principles of *good water governance* as: participatory; transparent and accountable; integrative; efficient; adaptive and competent. Adaptive management models incorporate "collaborative learning, is responsive to changing pressures and values, and

anticipates and manages threats, opportunities and risks. It recognises that the system is complex and constantly in flux” (Fenemor *et al.*, 2011).

Feeney (2010) describes common and persisting barriers to effective and successful integrated management of catchments, which can be summarized as follows:

- challenges of integration at all levels, particularly including stakeholders, and the linking of policy to action, issues with solutions with regards to complex problems
- lack of capacity and resources to effective integration and stakeholder engagement leading to silos within and between organisations
- a lack of consistent approach including understanding the research needs, sharing of information and knowledge
- limited use of adaptive management models- lack of baselines, lack of clear objectives lack of provision to capture progress , lack of review
- the scale of catchments not coinciding with political boundaries
- long time-lags between investment and results making buy-in leading to insufficient funding
- institutional barriers – lack of an organisational learning
- inconsistency between Acts, Plans

Numerous teams across several departments within the council are planning, or already implementing, work that fit under the integrated management of catchments umbrella. Mediated modelling can advance the alignment and coordination of various pieces of work that are part of the same biophysical system.

This proposal suggests adopting a Mediated Modelling approach to explore integrated policy options through a collaborative process with teams across council and key stakeholder organisations that are involved with the management of water bodies on a catchment scale. The overarching objectives would include

1. Develop the first iteration of an agreed values framework for freshwater
2. Identification of current work progress and information gaps ; joint fact finding
3. Building capacity for integration of policy across land, freshwater and coast and aligning the policy requirements of NPSFM and the NZCPS
4. Develop integrated catchment management framework and processes
5. Building capacity for collaboration
6. Moving towards best practice adaptive management models for policy development implementation, monitoring and review.

### **Next Steps**

As this report is written, it was decided between AC and the SP2 project team to pursue the ‘Topic 1 Intensification’ proposal because it is closest linked with the intent of the SP2 programme. However, ‘Topic 2 Freshwater’ is likely to be pursued as a separate, AC driven project and as such, intends to maintain a synergetic relationship the SP2 under the mandate of ‘capacity building’.

## **4. ACKNOWLEDGEMENTS**

The Sustainable Pathways 2 project is funded by the New Zealand Ministry for Science and Innovation (MAUX0906). It is a great privilege to use 'action research' over 6 years and this report reflects a second step parallel to other objectives on-going under SP2, toward the envisioned outcomes in 2015. Many thanks to Auckland Council and the various staff who have supported the SP2 project in spite of major re-organisation of the Auckland Council; thanks for hosting the workshops and the catering exceeded our and the participant's expectations. Action research projects like SP2 cannot exist without participants and independent reviewers. We thank you for your time and effort. It is the sincere hope of the project team that we added value.

## **Appendix A      The workshops**

### **Sustainable Pathways 2 (SP2): Auckland Workshop 1 – September 8<sup>th</sup> 2011**

#### **Outline of the Day**

1. David Cleland welcomed participants. As pressure to complete the spatial plan for Auckland has limited the ability to run parallel processes for consultation there is interest in the Mediated Modelling (MM) workshops.
2. Participants introduced themselves.
3. The agenda and results from the pre workshop questionnaire were provided (these overheads are at: <http://www.sp2.org.nz/mediated-modelling-workshops/auckland-workshops/workshop-1-8th-september-2011/workshop-1-activities/>)
4. Systems thinking and system dynamics approaches were explained. Participants provided their input to the causal loop diagram (CLD) prepared for Auckland based on interview information.
5. Mediated Modelling and how it works was explained.
6. Using Stella to build a system dynamics model for the Auckland region got underway in the afternoon.

#### **Objective of the MM workshops**

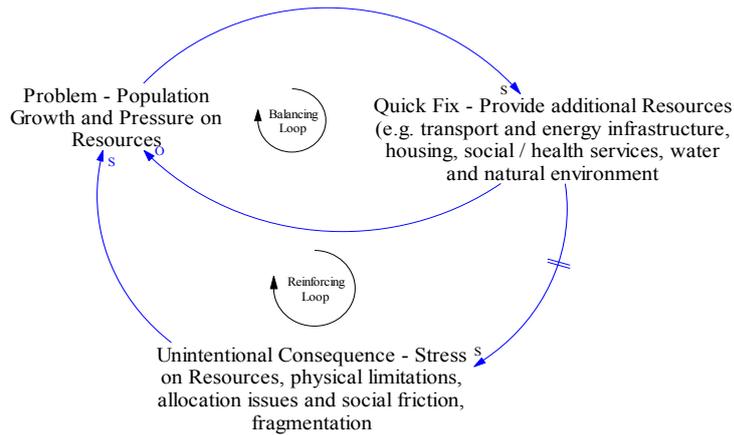
The MM workshops aim to foster a systems thinking / system dynamics approach to decision support for the Auckland region, and develop tools to assist with spatial planning. The workshops are also an opportunity for participants to evaluate what capacity building is required to use the tools provided in their organisations to foster adaptive management. SP2 has end-users (councils) as part of the project team. The three MM workshops will develop an “Auckland story” in the form of a simulation model from the perspective of the participants involved. As this project goes to 2015, at a later date we will revisit the story to see how accurate it was and how participants and their organisations have updated the story, told in the form of the model.

#### **The Systems Thinking, Causal Loop Diagram and Points of Debate**

Systems Thinking (ST) and its primary tool Causal Loop Diagrams (CLD) were introduced. Two important features in ST were highlighted: Feedback loop and Time lags. Some feedback loops are re-enforcing and some are balancing. The speed of feedback loops (=time lags) relative to each other provides the unintended consequences. The human mind can generally cope with a limited number of feedback loops and time lags and therefore requires the assistance of mapping and modelling to cope with additional complexity. Several archetypes in ST exist and “Fixes that Fail” was used to illustrate at the highest level

issues relevant to Auckland (Figure 32). Additional examples (transport, pandemic planning, business sales) were discussed.

### Causal diagram Mediated Modelling in Auckland: highest level “fixes that fail”

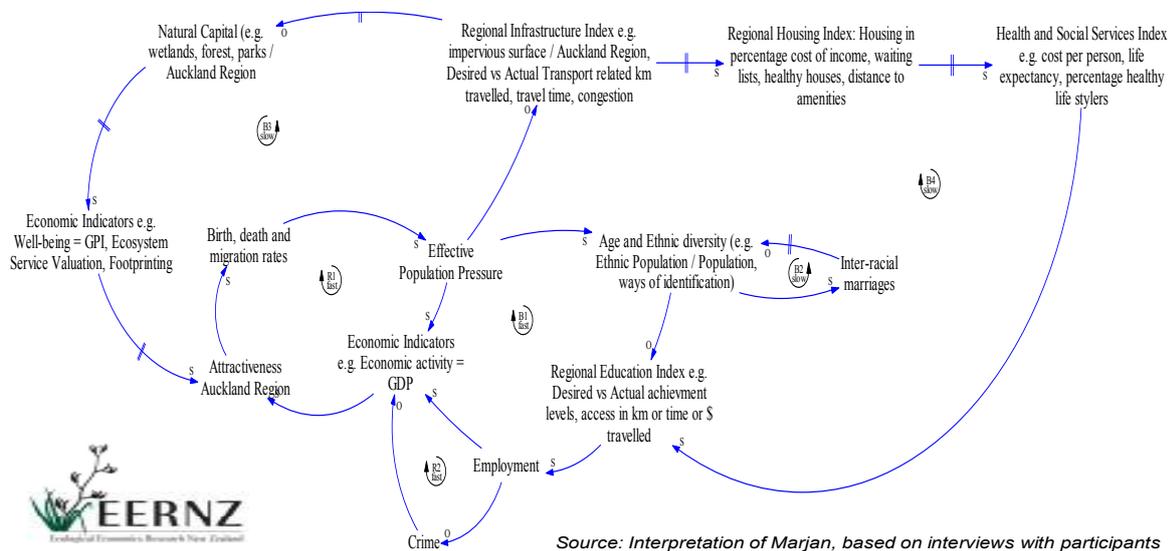


Source: Interpretation of Marjan, based on interviews with participants

**Figure 32: Fixes that Fail example for Auckland**

A more elaborate CLD of the issues relevant to Auckland was presented on three identical posters to allow participants to give feedback. The presented CLD, in Figure 33, is an interpretation based on the interviews before the workshop.

## Causal diagram Mediated Modelling in Auckland based on interviews



**Figure 33: CLD based on interviews**

### Group 1 Feedback on CLD (via Vicky)

- Inter-marriage is not a key issue of concern
- Many links are missing in the diagram; additional links needed between infrastructure, housing and Health/Social, Employment
- Mixes activities with indicators (2 different processes)
- The spatial plan 'spider diagram' has the key issues presented in the first web. Should these not be the things we are trying to link?
- External drivers/factors are omitted
- Production function (Capital, Innovation, skills, entrepreneurship) is missing.

### Group 2 (via Marjan)

- External factors to Auckland are considered to be: National Government funding, Foreign Direct Investments, Technology changes, Import/Export, Disasters, Climate Change.
- The CLD focuses on investments in public assets and misses aspects of productivity and investment in the private sector.
- Effective population pressure has a 10-15 year time lag to Infrastructure, as investments are anticipated and planned for in advance.

- Infrastructure could include “road safety” and provide a link back to Education, particularly “access in km”.
- ‘attractiveness’ of Auckland isn’t absolute, but relative to other regions.
- GDP should be indicated per capita or per worker.
- Health and Social Services impact Education, however, Education impacts Health and Social outcomes.
- Projections are that 60,000 additional kids will require schooling (in some form of delivery) and the growth rates differ per ethnic group.

### **Group 3 (via Hendrik)**

- Ethnic diversity is the primary driver of the causal loop, instead of effective population pressure. The type of population growth determines the indicators of Infrastructure, Housing and Wellness.
- Family and community dynamics should replace “inter-racial marriages”.
- Wellness is an indicator for “Health” and an indicator is available.
- Social Services is closer to Education rather than to Health
- Crime is too narrow and “Social Cohesion” is more relevant.
- Education should be regarded as the “type of education” which needs to be suitable; i.e. reducing the gap between jobs and education.
- With regard to Natural Capital, Auckland is dependent for energy and water supply on the Waikato (external factor).
- Direct (same direction) link from Natural Capital to Health/Wellness exists; If Natural Capital is reduced, then Health/Wellness is reduced.
- Wellness to employment requires a direct link.
- Allocation and opportunity costs between infrastructure, housing, wellness, natural capital and education are important.

### **SWOT on CLD**

- *Strengths*: Gives a picture of relationships. Moves people out of familiar territory and allows them to learn from other perspectives. Powerful communication tool if does not become too complex. Gives ‘discipline’ as forces to draw all influences and create a framework.
- *Weaknesses*: Reflects perspectives of those involved only (other views ie business are missing). There is a risk of becoming too detailed. The context the CLD applies to needs to be taken into account.
- *Opportunities*: A communication tool if not too complex. Complex models when completed are usually challenged at the CLD level so the points of debate on the CLD are of interest.
- *Threats*: If it is unclear what question is being answered it is difficult to ensure all model parameters are included. External drivers could change the system extensively.

## Links between Mediated Modelling (MM) Workshops and the Spatial Decision Support System (SDSS)

One of the goals of the MM workshops is to assess which additional links could/should be recommended for the Spatial Model, acknowledging there is a trade off between simplicity and accuracy. More data detail or structural complexity does not always equate with a better understanding. On the other hand, too much simplicity doesn't necessarily provide a pathway forward either.

Figure 34 shows the CLD based on the prototype of the SDSS model. The primary feedback loop is between Economy, Land Use and Transport. Much more spatial disaggregation is included in this data intense model than the MM model.

### Based on Spatial Model prototype: Causal diagram for Auckland

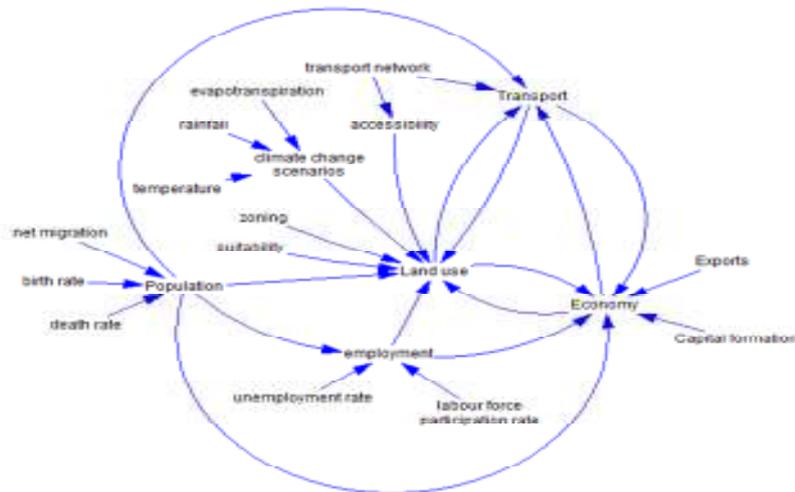


Figure 34: CLD based on Spatially Dynamic Model for Auckland.

**Table 1: Linking MM and SDSS**

<b>Mediated Modelling (MM)</b>	<b>Spatial Decision Support System (SDSS)</b>
The MM model being built as part of Objective 1 of the Sustainable Pathways 2 project is a systems dynamic model that uses participant knowledge to identify the key factors that need to be taken into account to link the 4 well-beings in the Auckland region.	The SDSS model being built as part of Objective 2 of the Sustainable Pathways 2 project is a large scale spatially explicit model (100m x 100m resolution) that links a number of existing models together. These include transport, population, economic, and landuse models.
The MM process aims to make some of the existing assumptions and links in the SDSS transparent and understandable, while assessing what linkages participants want to discuss for inclusion.	The existing models need to be linked together with feedback loops. Some feedback loops that determine the form of the city are currently missing, particularly with regard to social processes. Additional inclusions will be assessed in part based on MM.
The MM workshops provide the communication and understanding of what the SDSS model can do in a relatively non-technical way	The SDSS model is intended to be used in-house by council staff.
The MM model looks at changes over time and how interventions may have unintended consequences due to feedback loops and time lags.	The SDSS model is not an optimisation model but a scenario driven 'cause and effect' model. Can be used to simulate perspectives from different organisations/agents to see what land use outcomes may look like overtime taking into account feedback loops.

The aim of the SP2 program is to identify when to use what tool and how the tools (MM and SDSS) should evolve based on their strengths and opportunities while recognizing weaknesses. The endeavour is to provide a compatible package for Councils to use.

The software used for the CLD is Vensim and this software can be downloaded free of charge from <http://www.vensim.com/freedownload.html> Choose Vensim PLE and the type of computer you have.

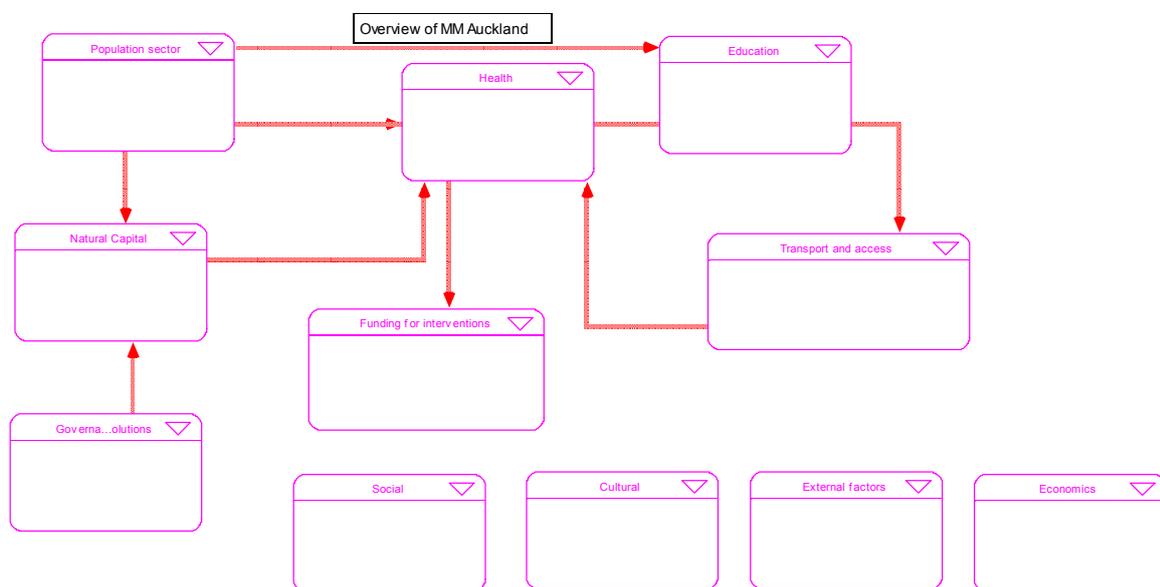
### **Systems Dynamics (SD) and Stella Modelling**

- SD modelling provides a way of simplifying and understanding a complex issue. It is not a quick fix but a way of adding efficiencies for solving problems.

- Provides a way of looking at anticipated and unforeseen consequences. Allows us to examine what happens and what levers can make a change.
- The people component is important for prioritising and transparency.
- Speed of loops (ie delays in system) can be incorporated.
- Alternatives can be considered. What makes sense for one purpose may not suit another. A compact central city form may be good for infrastructure efficiency by not resilience (eg Christchurch).
- SD approach can be powerful if it brings groups together and at the end they can all tell the same story with their own piece part of it.
- It is not the 4 wellbeings that are important but the movement in the indicators that sit the next level down.

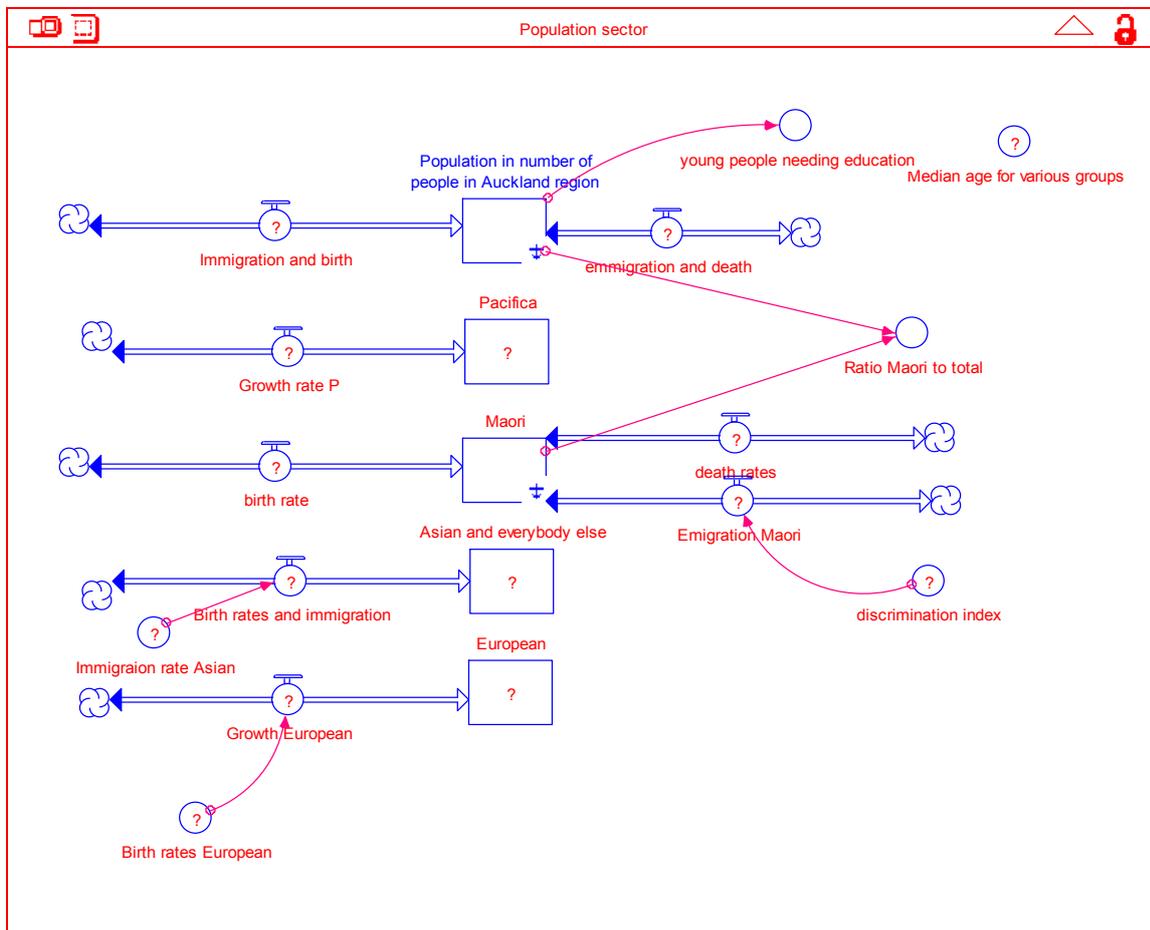
### Stella Modelling Session

During the afternoon, the participants were encouraged to discuss the various elements in the CLD and observations were reflected in STELLA language. Figure 35 shows the high level diagram of sectors included after the afternoon session and which sectors are currently connected (or not) by a red arrow.



**Figure 35: Overview of STELLA sectors after day 1**

Figure 36 provides an example of Stella modelling. This population module reflects participants desire to include the various ethnic groups and associated birth/death and migration rates.



**Figure 36: Provides an example of Stella modelling. This population module reflects participants desire to include the various ethnic groups and associated birth/death and migration rates.**

Points made by participants on the modules included in the afternoon session:

*Population:* Growth and ethnic mix is driving change. Internal migration patterns within NZ are not known. Paul Spoonley at Massey University might have data re external immigration. Pacifika data is important as this ethnic grouping accounts for 25% of the births in region.

*Natural capital:* Natural capital encompasses the free goods and services provided by nature. As these things are not part of the market system no value is placed on them. However, they do relate to economics as if the service is no longer provided and has to be replaced (eg water purification, flood protection) there is a cost. When we talk about Auckland for the models are we referring to the 'total' area or 'urban impervious' area?

*Governance/Policy/Solutions:* Where in the system is it possible to intervene?

*Funding:* What are the possible funding sources for solutions/interventions? Infrastructure investment can be private or public. Up to 2007 there was considerable private investment (eg shopping malls) in Auckland. Post 2007 more public initiatives (eg roading).

*Education:* 600,000 additional people will mean at least 60,000 extra students at compulsory education level. An equivalent amount of money will be required for pre-school and tertiary. What makes good education? Is it cost, distance to travel, delivery (eg broadband). Demographics impact on education. Needs to be on a spatial basis. Improved Pacific achievement can be a proxy. Social rate of time preference (ie social discount rate) needs to be considered.

*Health:* Demographics impact on health. Needs to be on a spatial basis. Investment decisions will have an opportunity cost. The relationship between education and health is strong. Child poverty rates are a major concern. MSD has data. A third of the NZ health dollar is spent on end-of-life treatment. Transport an issue for attendance at clinics.

*Transport:* Transport efficiency is measured in travel time (# of minutes) in morning peak hour traffic – a congestion measure. Another measure is ‘mobility’ which is speed taken to travel a kilometre (can also be used for walking, cycling etc). There are no measures for access to public transport (PT) other than closeness to big facilities; private car access is .7 per person. PT (4% of trips) focuses on journeys to CBD. There are links from transport to health-travelling to health system, emissions, exercise from walking/cycling). Links from transport to education – inability young to travel hampers youth employment/training. Links from transport to economy - 6% of growth in container shipping going through Ports of Auckland, trade-off between roads and expenditure in other areas.

Trends show improvement in minutes of delay per km. In peak times currently have half minute per km extra travel time. Present planning process assumes future generations have same car preference as today. Hard to see how can get away from cars as even if had enormous PT growth could at most get to 30%. With increased population the demand for private car travel will increase further.

Only 20% of car trips are work related. Therefore, having mixed use urban design or retraining so people can work where they live is only going to make a 20% difference. Agglomeration economics show there are co-location advantages for industries located in close proximity.

*Economics:* Public social discount rate (7%) is different from the private rate (8%). Are these the rates we should be using? Productivity needs to be included.

Additional modules needed: Housing, Social (could include housing), Cultural, and External Factors

## Summary

The goal is for the model developed to be used to look at options such as: If you don't get the impact till later is it worth doing? What is the cost of intervention now compared to doing nothing? If we model only what currently takes place is this extrapolated into the future and self-fulfilling?

Stella software can be accessed as a free run only version from <http://www.iseesystems.com/software/Player/iseePlayer.aspx>. This allows you to run the model but not save changes. A trial version is available free for 1 month. The SP2 research programme goal is for participants to be able to use Stella so anyone interested in using Stella please contact us.

### Action Points:

1. Megan Carbine to provide data on the 'urban' area and what it comprises. Also data for the total Auckland region.
2. Megan Carbine to provide definition of impervious area and current regulations.
3. Education participants: provide key attributes of good education and trends in education.
4. Health participants: provide key attributes of good health and trends in health. MM team will work with health people between workshops to see if we can model what investment in maternal and peri-natal health impacts would be on the system. Provide reduced-activity-days and premature death data from air pollution sources.
5. Geoff Cooper to check for agglomeration index suited to NZ and information on social rate of time preference discount rate.
6. Geoff Cooper to provide list of indicators used for the Auckland Plan.

### In preparation for 24 November:

Participants were asked to think about 'what if' scenarios in order to develop the model for the next Workshop on the 24<sup>th</sup> of November. We hope to receive your suggested scenarios by **4 November**. Instructions for scenarios:

Use three steps in defining your scenarios:

- Define a **problem**: e.g.: Health is decreasing among an Auckland population segment.
- Describe a **brief brainstorm** of possible **concepts** contributing to a solution for the problem: E.g.: exercise, food quantity, food quality, workload, commute, etc.
- OR draw a causal diagram interconnecting concepts.
- Finally, try to come up with interesting '**what-if**' scenarios related to these concepts that might offer a solution to the problem.
  - E.g. What if 30% of the people commute by bike and public transport instead of using the car by 2020?

In defining scenarios, be as specific as possible related to the time and timeframe, percentages of change, etc. as the aim is to simulate scenarios with the evolving model.

## **Sustainable Pathways 2 (SP2): Auckland Workshop 2 – November 24<sup>th</sup> 2011**

### **Summary of Discussion**

Comments from participants (and some feedback from project team) on the causal loop diagram (CLD) presented for the Auckland Region:

1. Shows that as population goes up the demand for housing increases. Population also drives demand thereby increasing economic growth and GDP (due to consumption of locally produced goods and services as well as other drivers). After 2041 the population of the Auckland Region is predicted to decline.
2. What is the definition of well-being?
3. The CLD should show the critical variable for inclusion in the model. Needs to keep simple at the same time as providing right feedback loops.
4. Formal and informal (eg on the job training, social networks) education contribute to well-being. The CLD has no direct links for alternative types of education.
5. Health is different from well-being as well-being covers cultural, income, social integration, work hours, employment plus many other factors.
6. Valuation of Assets – April 2012 Treasury will release National Asset Management Plan. Investment in education property is known but the actual value depends on the depreciation rate applied. It was agreed that an order of magnitude is all that is required for the modelling.
7. Modelling is to bring about synergies and identify who is looking at the same parts of the system from a different perspective? SP2 is an action research project so the participants here design what happens. SP2 is a 6 year project so we can come back to see what has changed and what is the same at a later date.
8. Agglomeration benefits link transport infrastructure to economic activity.
9. The dialogue, CLD and STELLA model from the Mediated Modelling (MM) workshops will inform the interlinkages for the Spatially Dynamic Support System (SDSS) model.
10. Cultural diversity impacts on health – the Stella model has incorporated this. Infrastructure is also utilised differently by different ethnicities, but this may be a level of (spatial) detail that the STELLA model should not attempt to handle other than narratives included in the documentation of the icons used in STELLA.
11. Age cohorts are required in the model by education and health. Current data is not collated by the education and health sectors using the same age cohorts.
12. External links are missing eg economic activity, international transport connections, broadband, free trade agreements. These are both internal and external aspects of the system. For example, even with available funding there may be insufficient skilled workers to build needed infrastructure. The Christchurch rebuild is an externality for Auckland.
13. Broadband should not be in infrastructure 'box' with transport as these are different processes. Broadband is a missing link. Important for health and education as well as

business and transport. Broadband can be a “case study” for the emerging model as it starts to capture the underlying structure integrating the basic 4 aspects of well-being.

14. Accessibility can apply to many things e.g. with broadband can do checks without hospital visits.
15. The CLD is about understanding the broad relationships which provide a high level overview. There is not always ONE equation to explain the entire breath of the relationships to include. It was advised to use a different thickness of line on the print out to show degree of “certainty” (this should be defined). We will refer to this as “quantifiable relationships”
16. “Soft’ (qualitative) relationships include social networking. We don’t have information on soft relationships but we know they are important. Not everything can be quantified. Softer mental health etc side might be missing from some loops.
17. Cause and effect relationships have been identified as important in health.
18. Transport links directly with economic activity as well as linking through accessibility.
19. Built infrastructure goes directly to GDP as well as jobs. Retail activity clustering drives economic growth which is not in the CLD. There is a multiplier effect from retail into economic activity. Different groups have different multiplier effects. The SP2 team needs to report back on whether the STELLA model should include this level of detail. The SDSS model has economic activity at the 48 sector level.
20. Disparity/inequality is an issue. Don’t have positive effects to well-being from economic activity if there is significant inequality.

## Scenarios

Participants discussed the scenarios (listed below) sent in to the SP2 team prior to the workshop. The discussion revealed some participants were unclear about what the scenarios were trying to achieve.

The objective of the scenarios is to guide model development going forward by selecting one or two scenarios that relate to the CLD and MM for the next workshop. The Auckland Plan spider diagram shows the key aspects of the four well-beings and the indicators developed. Our goal is to link some of the variables in a dynamic system. The goal is to change the way people think about a problem and identify cross-links and integration.

Scenarios force us to think about how long things take and delays in the system. From running the scenarios using the model we will be able to see what levers are available for broad intervention and at what level this occurs (central or local government, regional/national). The scenarios provide concrete inputs for model development (slide bars that set some driving parameters at different levels) and are a way of evaluating which indicators are relevant to examine as output variables and how they change over time. These output indicators will be displayed in the graphs which display changes between 1990 and 2050.

The goal for March is a scoping model that looks at some linkages and makes these explicit. Such a model can accommodate different ideas by using sliders. Identifying unintended consequences is one of the modelling objectives.

By March it is possible to prepare one model that can be used for scenario modelling. The goal is to develop a model to accommodate item 2 (scoping for breadth of high level interconnections between 4 aspects of well-being. Items 1 and 3 are added because the thinking of some participants will be there. This isn't "wrong" and such thinking will be accommodated to the extent possible, eg item 3 "spatial scenarios" will be forwarded to the spatial modelling component of SP2:

1. Depth – covering a small area (eg transport) in detail. There is a lot of time involved in making such a model quantitative.
2. Breadth – not detailed but with linkages across the different activities.
3. Spatial – providing information for the SDSS (final delivery will be post March).

*Submitted Scenarios by some participants in preparation of 2<sup>nd</sup> MM workshop.*

#### *Health scenarios*

2 scenarios were provided - one for older people and one for young people.

*For young people* the health of the mother when pregnant has the biggest impact on the child. No amount of money spent after birth can change this. Therefore, access to targeted health care and information is important at the antenatal stage. The material has to be targeted as cultures absorb information differently. For young people measures can be: Deprivation, over-crowding, diabetes in pregnancy, early childhood education, antenatal care, early intervention, maternal mental health.

*For older people* the goal is a healthy and productive population. There is a significant growth in the number of older people which will impact on health dynamics. It must be remembered that elderly people have positive as well as negative attributes and the needs of the future aged will not be the same as the current aged. Older people have ability and skills, provide child care and support communities. There are intangible benefits from having older people in community that are ignored.

Integration into the community is key to keeping older people healthy. Social networks and support are important. Housing needs to be warm to protect against respiratory disease and be affordable.

Ethnicity defines "older people". For Maori with a shorter life expectancy old can be less than 65.

Transport is an enabler and a way to maintain mobility. The issue is often availability after hours. Accessibility is defined as transport within 30 minutes of walking. For the elderly transport is not just trains and buses but also things like footpaths wide enough for mobility scooters . For buildings accessibility is built into legislation whereas for transport infrastructure change is made when there is new construction or alterations.

The challenge for a high level model is health factors are different for different age groups. (This also applies for education). Health currently does not integrate with urban planning. There are links for example the elderly preference is not rest home care and aged people complexes but integration in the community with accessible health services. Increasing goal is seen to be to keep away from big hospital campuses.

The CDL submitted is included in the PowerPoint presentation for this workshop on the SP2 website.

### *Education*

Education is linked to health as prevention and enabling through education is a way to stop people getting unhealthy. Fruit/lunch in schools can influence health (people are hungry scenario an actual policy up for debate).

There is a growth in school age kids in Auckland. Also more use of broadband and studio schools. School enrolment schemes can impact on transport.

The CDL submitted is included in the PowerPoint presentation for this workshop on the SP2 website.

Broadband – The broadband scenario is a “success to the successful” systems thinking archetype. Those utilising technology will benefit and those lagging behind will continue to do so unless there is intervention and deliberate effort to upskill them.

Whether broadband will effect transport is questionable. People are working from home. Census data had more people working from home than taking public transport. However, to date every technology to reduce face-to-face interaction has ended up in more not less interaction. People travel more and meet more as a result of technology. While the pattern might change the volume is not reducing. Broadband may create sprawl effects where people live further out and commute less regularly but further.

### *Pasifika Women*

This scenario links education, skills and economic activity. Looking at a system using the CLD allows the softer effects that we don't tend to look at as well as the economic costs and other spin offs to be included. There are social links into health. A question is if we change something is the net effect measurable in the future?

### *Economic Growth*

When forecasting economic growth the prerequisites that allow growth have to be in place. There needs to enablers such as available land in the right zone and basic infrastructure. Economic growth is also linked to natural capital, education and broadband. It is possible to have 'intellectual exports' that minimise the use of natural capital but these still require biophysical inputs.

### *Natural Capital*

Impervious surfaces that give run-off provide an indicator of lost natural capital. Metropolitan Urban Land (MUL) which is the ratio of impervious land/ total land is a measure. A compact city changes the impervious land ratio. Run-off caused by land clearing of bush/forest and conversion to agriculture is not taken into account with MUL. Stormwater ponds take out sediment rather than other pollutants which have the effect of concentrating toxins. Shellfish can be used as a proxy for marine ecosystem health. It is not recommended shellfish be eaten in the urban Auckland area due to contamination from wastewater overflows. Pollution time-lag effects are different from over harvesting and more difficult to

manage. The Ecosystem Service (ES) value of the marine environment is regarded as on average 3x the land value. To improve the marine environment riparian planting to reduce run-off is needed but there is a time-lag. Replanting takes approximately 15 years for any impact to be noticed. In the Waitemata Harbour there are thousands of tonnes of sediment washed up and down on every tide which would still need to be dealt with if siltation stopped today.

A dairy farm is classed as natural capital but the ecosystem services (ES) provided is food rather than other ES functions. Fencing off of streams and planting can increase the ES of a farm. Plantation forest is also considered natural capital, with one dimensional (fewer) ES and associated values.

### *Transport*

Transport is a complex picture by itself as illustrated by the Sterman Transport Model CLD handed out.

Car use (vkt) not the number of cars is what is relevant as travelling cars make the emissions and cause congestion. AC is concerned with cars on road – so travel mode is important. Have some survey data for kms travelled for industry. AC uses mode of travel as a proxy for quality of environment, average distance from school, quality of sidewalks. Have mode of travel data for schools signed up to 'walking schools' project which is about 25% of Auckland schools. Mode of travel can also be a sociological thing if majority of students get dropped off because of safety.

Education – uses average distance (kms) to school as the measure as the interest is students having local schools to attend. In Auckland 30-40% of kids go out of zone for education. A projected loss of 1700 school age children from the central Auckland area where popular schools are will increase travelling. Better local schools might influence transport. Community involvement in schools is impacted by travel but this can be compensated for if the old girl/boy network is very strong. Access to tertiary/post school education also requires transport.

Health – is impacted when kids are in cars and not walking. Traffic volumes lead to crashes which impacts health. Emissions (which there are set targets for) result in respiratory problems and climate change. Transport also provides accessibility to health services.

Economy – there is a link between kms travelled in cars and GDP up to a point. After saturation point increased vkt increase is driven by population growth. There are links between transport infrastructure and changes in landuse. If there is good spatial efficiency then the economy should be more efficient. Spatial efficiency could be used as an index/indicator. Not sure exactly how could measure – travel costs or GDP/ha?

Public transport – is rail separate from public transport because it is a key feature of the Auckland Plan?

## **Factors impacting on the modelling**

### *Policy Factors*

Time lags have major effects on system dynamics models. If the model is truly dynamic there will be oscillations over time. Politicians think changes take place straight away but the change process usually

takes 20 years. The modelling can show where stressors connect to several leverage points and change can get the biggest impact.

The Draft Auckland Plan incorporates model results for scenarios. A suggested option is to discuss these scenarios to decide what we want to work on.

Weighting is policy element. The model will provide an indication of what outcomes can be changed at the local government scale in Auckland (rather than central government controlled or internationally driven).

The depreciation rate is important for long term investment decisions. The central government capital depreciation rate is 2.5% over a 40 year period. The public works discount rate is 8%. There is a review currently underway. Different entities (local and central) are responsible for infrastructure planning and construction. For example State highways (24% of vkt) and local roads have different criteria for funding and construction. Health funding is also split. As indicators would not change it was agreed we did not need to make this split in the model.

#### *Population*

Auckland population demographics are different from rest of NZ as there is a growth bubble for both young and old people. The model needs to break population down into age cohorts in a way that makes sense across all sectors. Currently we have 0-16 (dependent children), 17-64 (working age); 65+ dependent elderly. The Health sector differs with the first cohort ranging from -9 months to 15 years. Immigration trends are from projections from Statistics NZ. Prof Paul Spoonley (Massey University) has offered to provide ethnic data.

#### *Calibration*

If model does not predict the present based on past history do you go back and change the model? Answer: it is possible to run regression analysis to see what curve is like. We are interested in what happens in the future so end-users need to agree with the relationships built into the model. These relationships can be more important than the data. As an example, if you have a range of values associated with a flow and you change the slider and it has no effect this indicates it may not be important. Systems dynamics modelling can include factors that don't have measures. In MM, an agreement among the participants about the direction of the relationship is relevant. This allows the perceived determinants of relationships to be included rather than just what can be measured. Sliders allow data ranges to be used. End-users need to have faith in the model to make the outputs of value.

#### *Spatially Dynamic Support System (SDSS) (N.B. Now renamed to Integrated Spatial Explorer)*

Some of the issues discussed are better suited to the SDSS model e.g. land use for industry. The SDSS model will add connectivity at a spatial scale and urban form. The MM can only handle relative amounts such as is 5% or 80% of land required rather than exactly where such land is located.

## Scenarios developed at the workshop

- a) How does transport investment impact on land use (a spatial what if)
- b) If \$500m of public money, \$1 billion of private sector money, and an unknown amount of end-users money is spent on broadband what impact will this have? Outputs wanted in graphs could be:
  - i. Take up by households
  - ii. Computer ownership
  - iii. Percentage working from home
  - iv. Weightless exports
  - v. Peak period travel
  - vi. Measure for access to health information
  - vii. Take up of education
  - viii. Physical activity levels, mental health
  - ix. Digital literacy
- c) If target for all school leavers is NCEA level 2 what policy levers do you need to adjust to achieve? Outputs wanted in graphs could be:
  - i. Numbers in schools
  - ii. Level of achievement
  - iii. Education level of mother
- d) What if population density is uniform everywhere across the AR. What will the density effect be on schools, accessibility, health etc (a spatial what if)
- e) What if no one could drive on a Sunday? Estimated to reduce kms by 10%
- f) What if people could sleep in offices at night?

## Action Points

1. Transport data will be provided by HB and JD
2. SP2 will work with the education scenario to make it a CLD
3. SP2 will finalise the two scenarios and send through to participants for confirmation. These will be used for the preparation for the March workshop.
4. CLD and story telling presented at the workshop is on the website at <http://www.sp2.org.nz/mediated-modelling-workshops/auckland-workshops/workshop-2-24th-november-2011/?stage=Live>
5. Stella free download link is: <http://www.iseesystems.com/software/Player/iseePlayer.aspx>. Anyone who would like to have their own copy to contact SP2

## Summary of Auckland Mediated Modelling Workshop 3 Discussion 15 March, 2012

### Causal Loop Diagram (CLD) of the Integrated Auckland

The links on the CLD are the main drivers that were discussed in workshops 1 and 2. Links have been reduced to the minimum to achieve maximum understanding. Governance and policy solutions are not detailed. In discussion prior to workshop 3 it was decided not to go into detail with transport as it is so

localised and specific in nature. The transport module has been reduced to link through “active mode” to health and “access mode” for health and education.

## **Model Scenarios**

The base case scenario, calibrated to fit historic data, assumes that all rates of change in the past continue into the future. Scenarios are then run with adjustments to the rates of change so that the implications of these can be compared with the base case. You can flip through the various pages of the graphs on the interface for comparison between scenarios. The graphs on the interface can also be exported to excel to view all graphs simultaneously. The scenarios are not intended as ‘predictive’ to tell you what the future will be, but rather a way to explore “what if?” questions.

A number of scenarios were suggested in Workshop 2 (see Workshop 2 notes). The one that has been developed is: “What if projected population growth and associated ethnic diversity happens, how does this affect “‘attractiveness’” of Auckland?” (Note ‘attractiveness’ has been defined as a composite of aspects of Health, Education, Transport, Economics and Natural Capital.)

### The story of Education was presented in STELLA

1. Educated Maori are going overseas (1 in 5). If education success rates change for Maori and Pacifica, is the future immigration profile is expected to be different? Currently Asian students pull the average pass rate up for students in New Zealand.
2. If Asians are here mainly for education, will they add to population growth if there is no employment? While some Asians return back to their home country after their education in NZ as they have qualifications for better jobs, other opt to immigrate to New Zealand. For migrant groups the issue is not just ‘attractiveness’ of Auckland but also the relative ‘attractiveness’ of where they come from. The model takes this into account with the “External Factors” box which can be adjusted to show ‘attractiveness’ relative to other places.
3. Underemployment is not accounted for because not everything can be included at the level the model is at.
4. By 2041 it is expected there will be 60,000 extra students in the 6 to 16 year cohort. There is a time lag with building schools. Currently the Ministry of Education takes this into account with future planning. The model represents the assumption that if school leavers don’t have level 2 NCEA they won’t get a job in future. The MM model allows for different education requirements for different ethnic groups.
5. Projections for increased homeschooling/mediaschooling are not significant as with most parents working it is assumed kids will be sent to schools. There are 540 schools currently in the AC area and plans to add another 120.
6. Schools could be business as usual (with similar requirements for land use) or take a different form such as high rise with fields on roof or using council fields. Another option is to timetable two sets of students per day. This may work for the CBD but was not successful in

Christchurch. Students tended to go to the Mall and not to school. Might work better where less traumatised students are involved.

7. There is a link between school size and outcome of education in the model. Crowding is linked to school and education outcomes for Pacifica & Maori especially. In the model there is unexplained NCEA results. It is not known exactly what the impact of a 500 pupil school having 800 students would be. Changes would be needed such as green space converted to all weather surfaces due to intensive use. Currently, the education system can use enrolment zones for size management.
8. Transport is an issue – young children finishing early have to wait round for older siblings.

#### The Story of Land Use and Natural Capital presented in STELLA.

1. The model combines land use and natural capital. As metropolitan areas expand more natural capital is consumed and more open urban space is created. Impacts of natural capital loss is assumed to take 7 years to see. Restoration of natural capital can take 15 years or more to become effective.
2. We have a supply of ecosystem services that we are dependent on and demand for ecosystem services increases the more people there are. Natural capital decline is often not visible. For example, seagrass is a highly valued because it is important for spawning, food, attenuation of waves etc. but no one sees the decline.
3. Often recreational demand competes with provision of other ecosystem services (eg driving vehicles on dunes). As ecosystems disappear, awareness of their value may increase. The risk is people do not value ecosystems until they are lost.
4. An added complexity is that future generations may have lower expectations, based on what they are used to. This is opposite to the situation for education and health where people have high aspirations for future generations. The same applies to transport where people make changes to improve their situation such as moving to a new house or buying a cell phone so they can work in the traffic.
5. The MM model can scope out trends of land use (and other) relationships, but not depict them spatially. The Multi-scale Integrated Model of Ecosystem Services (MIMES) is an option if spatial detail is required. MIMES can also work with different timescales (eg hydrology daily and restoration yearly). The MM scoping model can be the first step for moving onto MIMES.

#### The Story of Transport presented in STELLA.

The story of Transport became very short in the final model, although a more elaborate Transport structure was briefly presented to show *why* this departure was chosen.

There is a snobbishness associated with using public transport after a certain income level. Rail/ ferry are more acceptable as there is more private space. Rail to the North Shore would give a different commuter profile. Cars take the bulk of the transport investment but people won't move out of cars if they can afford not to. Bogata is an example of where people were forced out of cars and 2 years of

public unrest resulted but there is now better transport and social systems. Portland is another example of huge commitment to public transport and active mode.

#### The Story of the Social Sector presented in STELLA.

The story of the social links in the model was told through STELLA. This elicited the following observations:

Housing and education are social links. The current model has 4 ethnic links for transport. The social trade-off of poor transport systems is less leisure and family time. School children use public transport and were affected by the bus strike more than anticipated. Transport access (availability and cost) for Pacifica getting to school and employment is an issue. A bi-lingual school might not be local. Poor people travel long distances because they have no choice, the wealthy travel out of choice (eg to live by sea or on a lifestyle block).

#### The Story of the Health presented in STELLA.

1. The current statistics in the model are based on hospital visits and do not include doctor visits. To improve health statistics in the model EERNZ can send data requests to the Ministry of Health. Health is a limiting factor in the system as if children are not healthy they do not overtime add to the workforce. Employed parents are more likely to get their children the health care they require. The health of the pregnant mothers' impacts on child health so this needs to link into the system. There is a link between health and education as unhealthy children are away from school and education suffers. Education can also increase the demands on the health system as educated people are more aware of what they are entitled to and have greater expectations.
2. There are other factors in addition to health and education that influence participation rates in the labour force. For example 3<sup>rd</sup> generation dependency. The key is to have something representative as the model cannot cover all the detail.
3. If the Health sector managed wellness (demand) instead of healthcare (supply) would it be possible to lower the requirement to supply healthcare?
4. The link between active transport mode and health is to manage wellness rather than poor health. Active mode is also important for the elderly to maintain employment and social activity, thereby keeping them out of the health system.

#### The Story of the Economic Sector presented in STELLA.

It would be good to have an investment amount for Auckland and look at ways it can be spent. This can only be done in a ball park way with budgets to get broad funding ranges as getting actual \$ amounts as inputs is difficult. An alternative approach is to take a \$ amount and look at the benefits from that spending.

## **Ethnic Groups**

The question was asked whether there was any actual advantage from having 4 ethnicities in the model as this added complexity by a factor of four in the model building effort. For many actions cost is the same regardless of ethnicity and using income level instead might be more relevant. Any outcome could be apportioned by ratio if an ethnic breakdown is needed.

The advantages of including ethnicity suggested were: (i) can allocate budget differently (ii) have different birth rates (iii) more targeted direction of services (iv) can evaluate impact of policy on different groups.

The purpose for which the model is to be used is an important criterion when it comes to ethnicity. For transport ethnicity may not be important whereas for health and education it is critical, although the questions whether ethnicity should be relevant for transport should be asked.

The model as it stands follows the dialogue in the workshops. To support the dialogue it was legitimate to have 4 ethnicities.

## **Comments on the Model Presented**

The model reiterates relationships and interlinkages that are usually not reflected on and allows participants to understand each other's "silo". However, the model needs to provide more than formalising linkages and relationships already known. At the moment the model is 'unbalanced' with both economics and transport needing more work.

It would be good if you could tweak the model so you could see the big picture and then look at the detail if relevant. People want to know numbers even if they are just approximate to give scale and associated behaviour. It was agreed that for many factors such as natural capital and ethnicity there are no actual numbers.

The MM model scopes for relationships, a process that needs to be done with the right people to increase understanding. The goal is to improve this process and not be limited by lack of hard numbers. It was agreed that lack of information does not stop decisions being made at present.

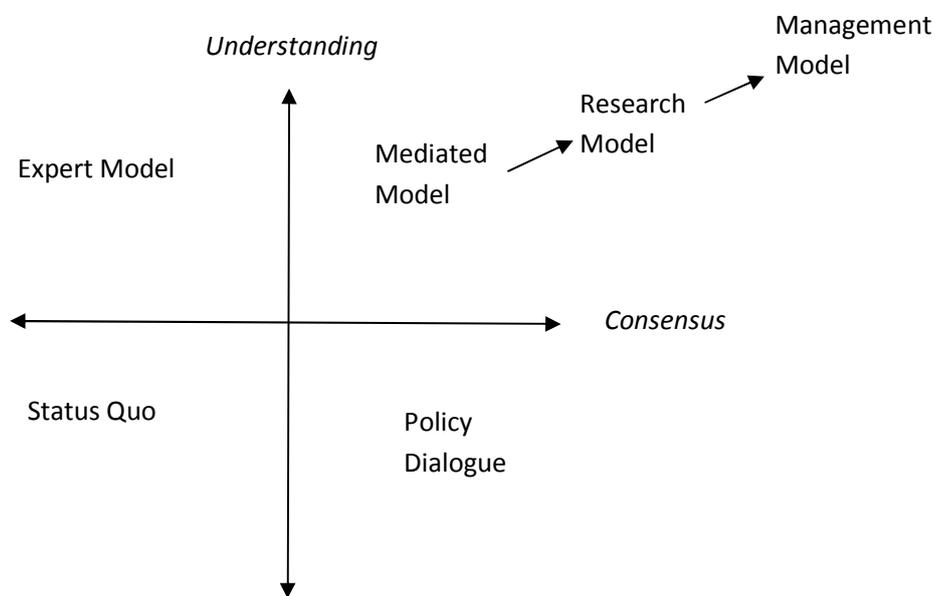
There are many issues such as the National Policy Statement on Freshwater that can be approached from a systems perspective. The MM model while not spatial is useful to look at such issues and how the underlying structure changes overtime. To use the MM model to answer a specific question, it was felt the question needed to be more focused. The topic as per ***"What if projected population growth and associated ethnic diversity happens, how does this affect "attractiveness" of Auckland?"*** was seen as too wide to do justice to building a model. The value of the workshops and current model has been the learning and demonstration of how to structure dialogue to get something concrete.

The process of developing the model through dialogue was useful but most participants would not be comfortable taking the current model to the next policy level due to lack of robustness. To sell the

model to decision-making in a policy environment it would need to be tighter. A dissenting opinion questioned how robust the decision-making process was at present. This person thought the current policy process was vague with no emphasis on learning about linkages and unintended consequences. “We don’t know what we don’t know.”

The model would be good value if it could justify allocation of funding to different activities. Marjan van den Belt emphasised that MM is not a Cost Benefit Analysis (CBA) type tool that can be used for comparing costs between development options, but different costs can be compared linked to understanding underlying systemic structures and assumptions made.

The MM model can help provide a test of internal consistency at AC. Any new proposal could have a CLD and a bit of a model with some data presented. The ultimate goal is people in different organisations use the modelling tools.



**Figure 37: Model Progression**

In the Adaptive Management (AM) cycle of “Envisioning -> Assessing -> Planning -> Implementing -> Monitoring” the step from Monitoring back to Envisioning is not often made so the outcomes of actions are rarely evaluated. The MM process can be used to foster AM capacity.

The participants were polled on “where in Figure 37 their interest is?” Two indicated they are after the robustness of an “Expert Model”; most fit in “Policy Dialogue” but are keen to explore the “Mediated Model” quadrant. One participant was interested in a way to draw expert modellers and data people into the dialoguing space so could see the “Mediated Model” quadrant as a way to meet in the middle.

## Going Forward

1. Who to involve if MM continues depends on the question to be answered. Participants could meet monthly and work on a specific part of the model. The 4 people left at the end of the workshop were interested in staying involved. After a year it would be realistic for these people to be able to run scenarios independently.
2. The current scoping model linking the 4 well-beings provides the broad picture. If you narrow down to a specific question it is still good to have this to come back to.
3. For the moment the objective for Auckland Council is to see if the tools are useful rather than address a specific problem. Long term it would be beneficial to have planners and staff think in terms of systems to improve decision-making. Auckland Council would also like to embed acceptance of the SDSS with stakeholders.
4. Using technical data people to build the model would not achieve the objectives of MM which is to understand linkages and foster dialogue. The onus is on participants to get robust data if it is needed to support the model.

## Possible Questions to Use Model For

The topic needs to be one where you can make a difference, progress tool development, is a challenge without a current (for or against) answer and not so small it gets lost in externalities. The model is best for exploring dynamic problems; issues that change over time and have one or several reference trends.. Results need to influence decision-makers, so who the audience is needs to be considered when deciding what the model can best be used for. The following suggestions were made:

1. If there is an increase in permeable surfaces what effect does this have on the marine environment?
2. What impacts will a 3 metre strip of beach have at Mangere? What effects does this have on 'attractiveness' of the area? (This was considered too local).
3. If the future urban plan for AC is xx what is the implications for health and education (This was answered as part of the Spatial Plan process by council staff and talking to Ministries)
4. Evaluation of policies and plans (eg rural/urban boundary setting)
5. What does success look like and use the model to backcast to see what needs to be done now to get there.
6. What would rationalising health facilities eg hospitals mean in terms of access? (This is a spatial question that the SDSS model is more suited for).
7. Healthy housing affordability in Auckland (a commissioned report has recently been released on this topic)
8. Life expectancy at birth by ethnicity
9. Liveability of Auckland City (which is same as 'attractiveness' so the model is part way there). Mapping the different levers that impact on liveability would be useful
10. Proximity to schools and how this affects NCEA results?
11. Public/Private split in terms of education, health, environment, hospitals, airports etc

12. Does Auckland plan for population growth or liveability? If planning for just population growth what does this mean for liveability?
13. If housing affordability continues to decrease what happens to liveability?
14. Sprawl vs compact – what does it mean for all aspects (health, transport, education, resilient city form assuming efficiency not only criteria). (A report on this had been done for the Spatial Plan so it was felt nothing could really be added.)
15. Scenarios could be expanded to show (1) how the dynamics of ecosystem services link (ii) how the dynamics of education link

### **Issues to be considered**

1. Does MM provide an extra something that we did not have before?
2. Does using the model make it easier for decision-makers to understand issues and for the less visible aspects to be brought to the table? The model is a tool to explore options to better understand the dynamics and implications.
3. The capability of the model at the micro-level is questionable. At the micro-level the model risks losing connections with the broader picture and requiring data that is often not there.
4. The modelling process needs to show change to achieve an outcome not just show linkages.
5. No one owns the model, it is a collaborative effort and the goal is for it to be used by everyone. The stakeholders involved are the agents of change for their organisations. It is accepted that not all participants want to run the model. The model is not the only point, system thinking and dialoguing are also important.
6. The current workshop process makes it easy for individuals and organisations to drop out.
7. The transport model is complex. It was difficult to include in the model so does this mean it is a big issue for everything? The Auckland transport model currently reflects council policy rather than forms it.
8. Getting data for transport and natural capital is difficult. It is possible to get response curves but not numbers.
9. Drilling down can be done within organisations. External links with organisations and interlinkages are the interest for the MM workshops.
10. If there are scenarios within scenarios can each scenario be modelled separately and then together to see the overall picture? This is a multi-scale, nested approach that may also provide a way to look at the regional issues and then impacts at the local level.

### **Presentation by Garry McDonald on the Spatial Dynamic Support System (SDSS) Model**

1. Land use in the SDSS model is based on GIS layers. A Principal Components Analysis (PCA) was done to determine the dominant land use for each 50x50m cell.
2. Land use classes in the SDSS are decided by the dominant activity of what is there at present. For example people working from home are classed 'residential'.
3. Animation runs can be captured and used again.
4. The SDSS model is used to test scenarios not make predictions about the future. Maps change overtime for each cell.

5. Spatial scenarios were proposed in Workshop 2. Additional scenarios suggested:
  - a. What happens with land use under different zoning.
  - b. Economic development agencies are interested in skills needed for the future. Are they going to be adequately supplied by an ageing population?
  - c. Growth in high density housing what does this mean socially? (The SDSS cant integrate health and education so would go back to the MM model for this)

## **Appendix B          Development of ‘Natural Capital Model Sector’ as an example of ‘in between workshop interaction with participants’**

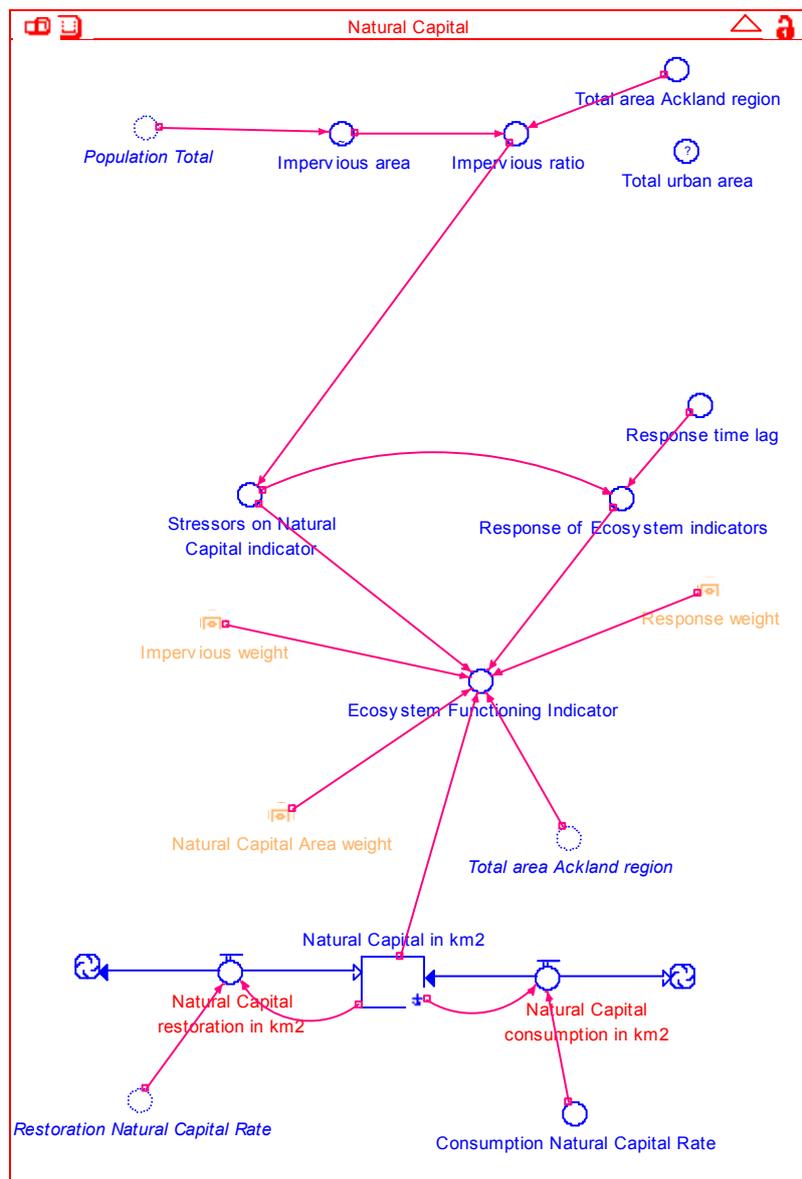
### **1. Natural Capital Model Sector (preparation with participant for workshop 2)**

Natural Capital (NC) is defined as the goods and services provided free of charge by the environment. In the Auckland region pressure on NC is driven by population increase. There is an assumed/justified (how?) relationship between population and impervious area, and this ratio is used as a proxy for stressors on Auckland’s ecosystems (Specify?). This ratio provides an estimate of the percent of impervious area in the Auckland Region (or Urban Area?).

This ratio is considered a Stressor on Natural Capital (other stressors can be added, if so desired). Stressors are assumed to show up as Responses of Ecosystems with a time lag (place holder 20 years?). In addition, there has to be a certain Natural Capital area (which changes over time due to conversions of Natural Area into Human Production Areas) or Restoration activities (which can be a Policy lever).

The combination of Natural Capital Area, Stressors and the Responses provide a rough indicator of Ecosystem Functioning (changing over time and changing fairly quickly once the Stressors cause Responses).

The Ecosystem Functioning Indicator can then be used in other parts of the model, such as Health or Economics. It may be compared with other regions to provide a benchmark.



Data supplied:

- Impervious area
- Pressure indicators

## **2. Natural Capital Model Sector (preparation with participant for workshop 3)**

Below is a diagram with a bit more spatial land cover: Terrestrial and Aquatic. The reason would be to emphasise that the urban area is embedded in and dependent on natural capital (similar to the 2<sup>nd</sup> workshop).

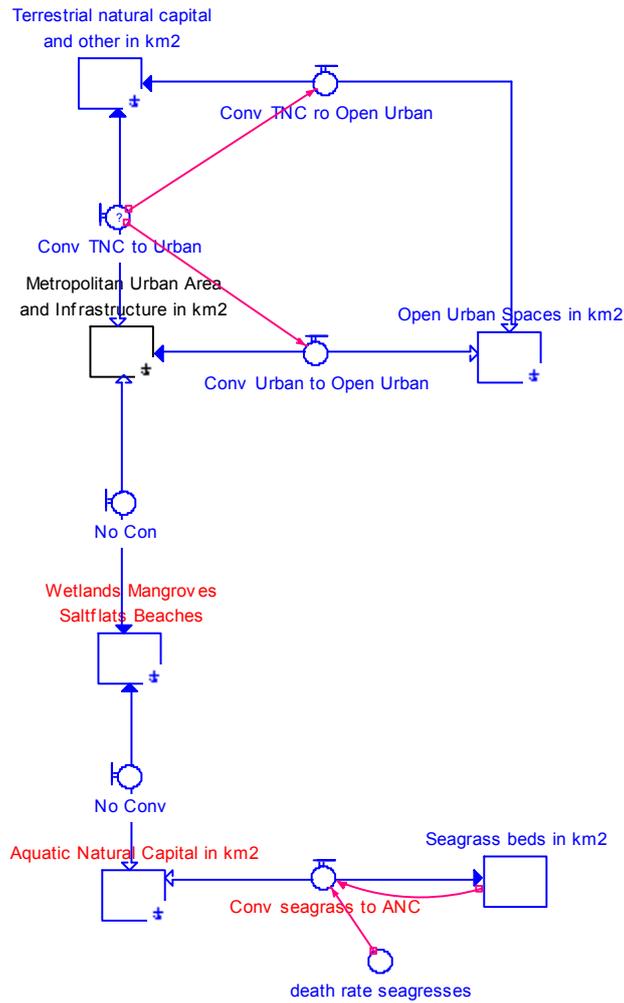
The intertidal zone wouldn't change: no conversion.

I roughed in seagrass beds, simply because those were an issue in Tauranga: highly valuable in providing ES and invisible to the eye. If you like the idea, we can keep it for that purpose, if you can quickly get your hands on trend data that show the faith of Auckland's seagrass beds, than I'm happy to put those in.

The terrestrial area is now conserved at 683 km<sup>2</sup> (pers. Comm., Garry McDonald) and divided in:

1. Terrestrial NC and Other – initial value in 1990 starting at 600km<sup>2</sup>
2. Metropolitan Urban area and Infrastructure –initial value in 1990 at 36km<sup>2</sup>
3. Open Urban Spaces - initial value in 1990 at 2km<sup>2</sup>

Population will then drive the Conversion TNC to Urban and when that happens, Open Spaces increase with a percentage being taken from both Urban or Natural Capital.



Questions:

1. Does that accommodate your request for Open Spaces and Natural Capital?

## Appendix C Post-survey Analysis for Full Attendance

### POST- QUESTIONNAIRE SUSTAINABLE PATHWAYS 2 – MEDIATED MODELLING AUCKLAND

Fourteen participants were surveyed and interviewed before the MM workshops began (pre-survey). Eight participants attended workshop 3, however, four of these people were not part of workshop 1 due to staff replacements. Four people attended all three workshops and these people completed a post-workshop mail survey. The survey results are presented in Appendix B.

The pre-survey was in part to establish a topic to explore using the MM approach. The post-survey sought to understand if individual participants thought their topic was sufficiently addressed, evaluate the use of MM, and establish the extent to which progress was made on their topic during the joint discussions.

The post-survey first summarised: 1) the issue of concern 2) the causes of that issue of concern, and 3) the implications of the issue of concern, as previously outlined by the participant in the Pre-survey.

1. After a reminder of their original issue of concern, the participants were asked to indicate their strength of agreement (on a five-point likert-scale from “strongly disagree” to “strongly agree”) for a number of statements related to their issue.

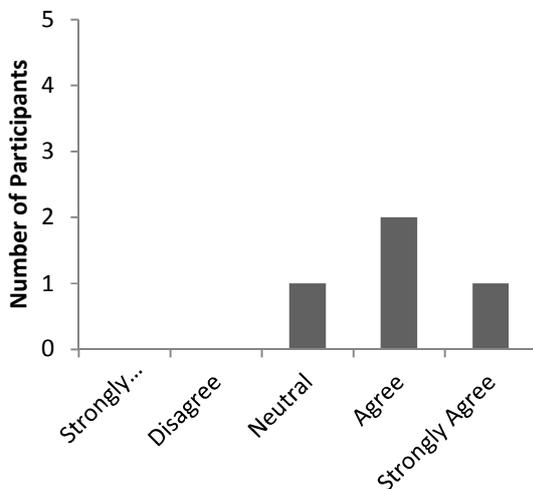


Figure 38: My issue was addressed during the workshops

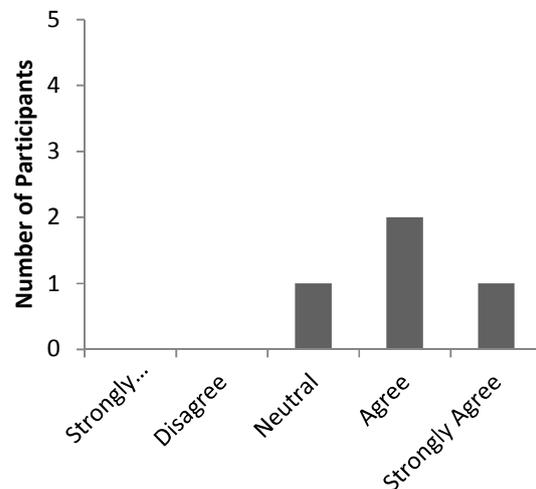
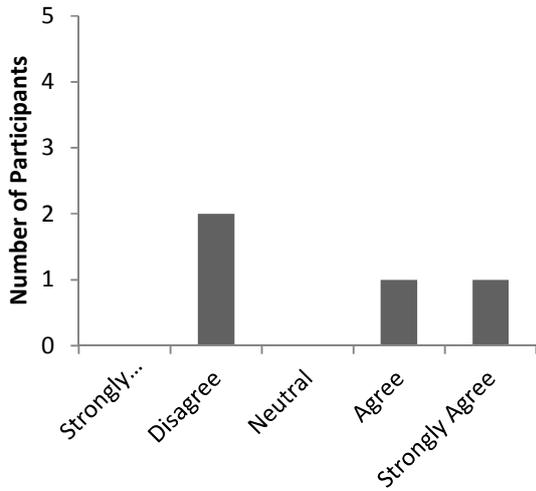
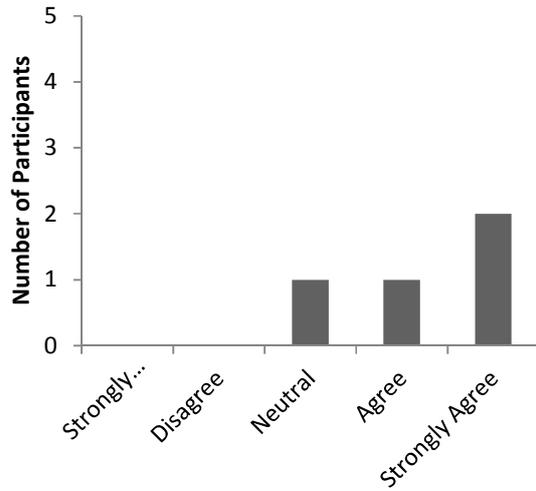


Figure 39: My issue was part of the integrated picture that has emerged through the workshops

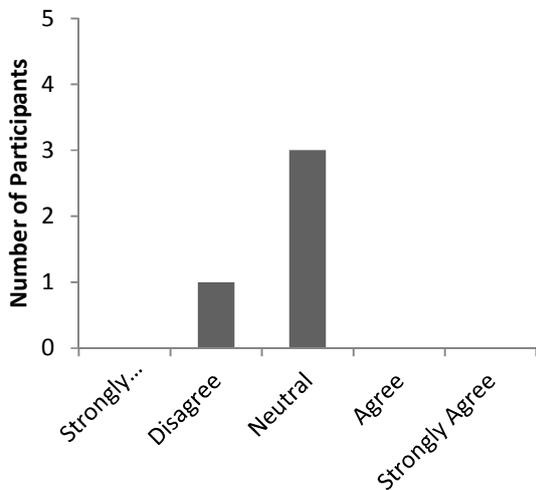


**Figure 40: My views on my issue have been modified through the mediated modelling workshops.**

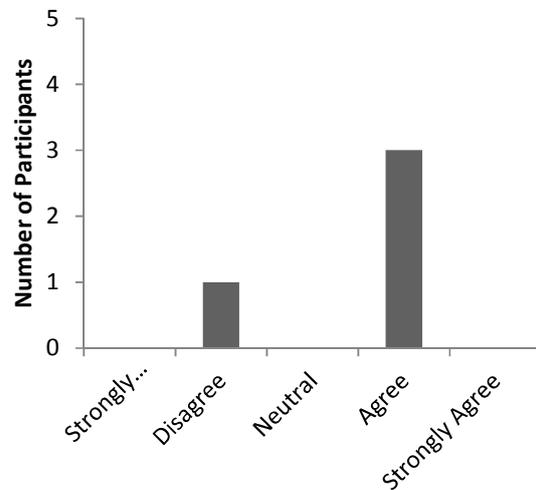


**Figure 41: My issue can benefit from an extended mediated modelling process.**

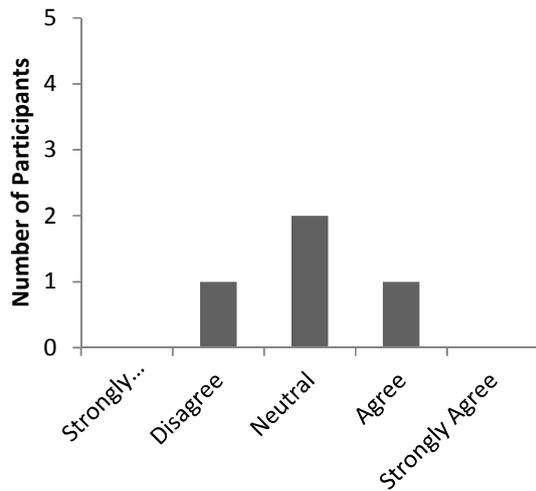
2. After the mediated modelling workshops and based on the actual participants do you perceive that within this group there is currently **consensus** on:



**Figure 42: An appropriate topic for the Auckland Region**

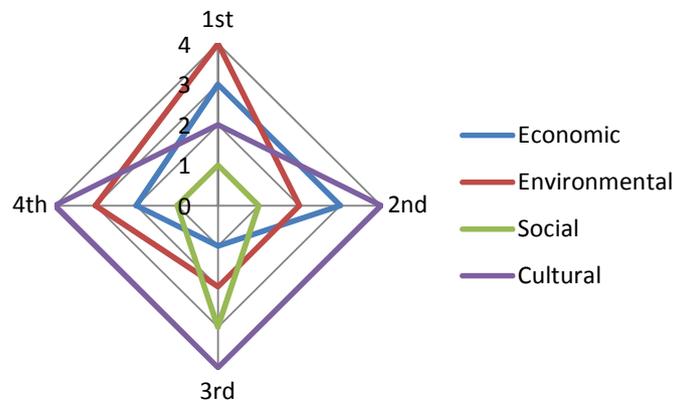


**Figure 43: The long term goal/vision for the Auckland Region.**



**Figure 44: The implementation process toward future goals/vision for the Auckland Region.**

- Reflecting on the discussion during the mediated modelling workshops, please rank the relative importance of the 4 aspects of well-being for the stakeholder group you represent. Rank in order of priority for your stakeholder group from 1(highest) to 4 (lowest):



**Figure 45: Reflecting on the discussion during the mediated modelling workshops, please rank the relative importance of the 4 aspects of well-being for the stakeholder group you represent. Rank in order of priority for your stakeholder group**

4. Please rank the relative importance by which each of the 4 aspects of well-being was discussed in the mediated modelling workshops. Rank in order of priority from 1(highest) to 4 (lowest):

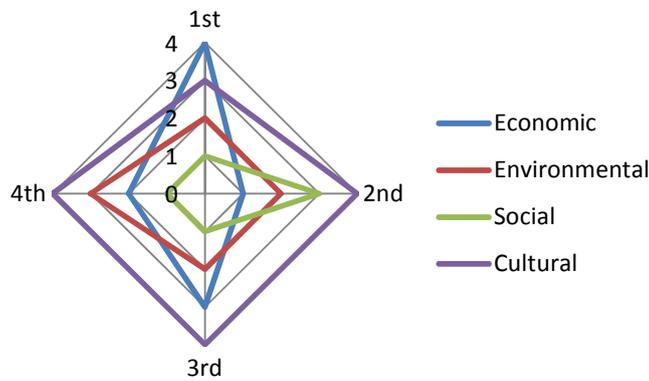


Figure 46: Please rank the relative importance by which each of the 4 aspects of well-being was discussed in the mediate modelling workshops

5. Reflecting on the **actual** workshop participants, how do you think the group rated overall in terms of the following criteria (Please mark you answer with an "x")?

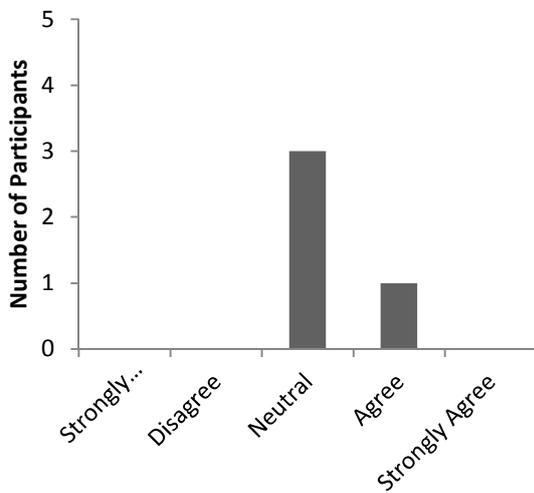


Figure 47: Inclusiveness: i.e. the level of inclusiveness of different perspectives

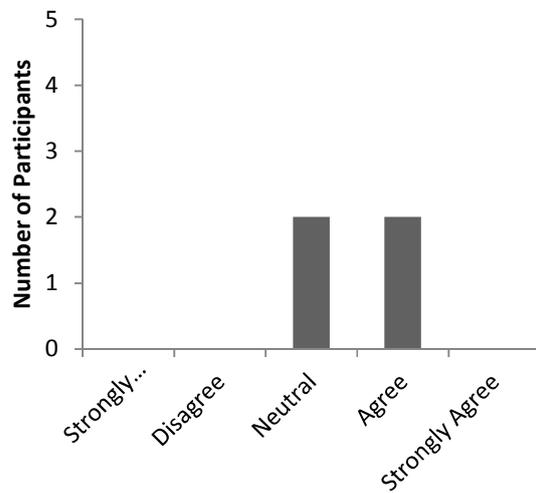
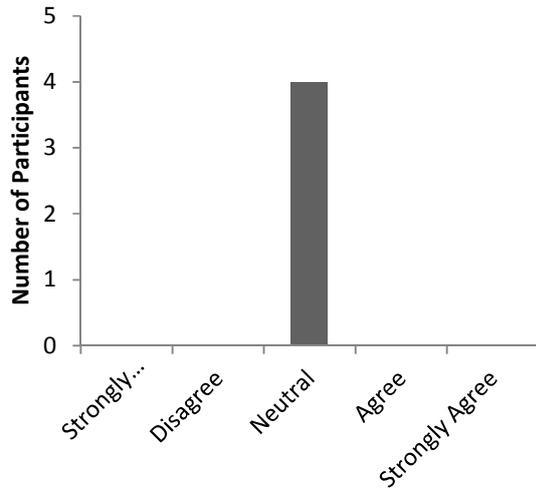
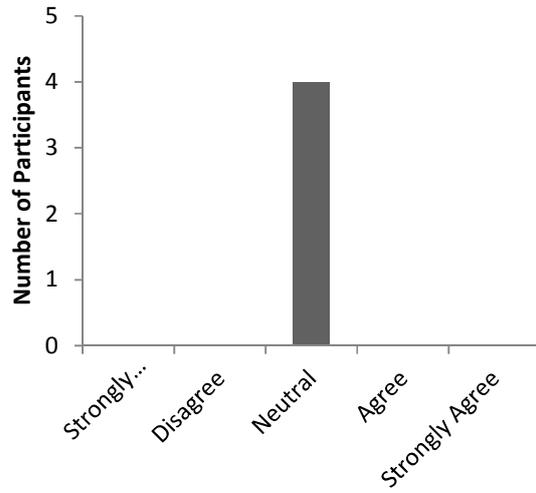


Figure 48: Long Term Time Preference: i.e. a strategic, long term emphasis

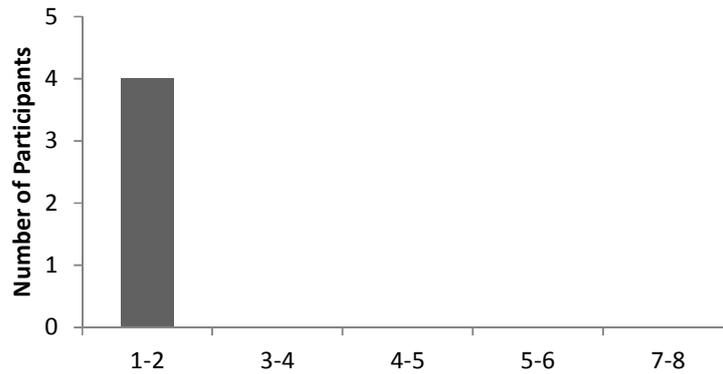


**Figure 49: Leadership: i.e. the ideas developed in this group will be implemented**



**Figure 50: Creativity: i.e. this group developed innovative ideas**

6. With how many of the participants do you intend to interact on a regular basis in the future?



**Figure 51: With how many of the participants do you intend to interact on a regular basis in the future?**

7. Please mark with an “x” the answer that best indicates your agreement or disagreement with each of the following statements related to the **mediated modelling process** in which you were involved.

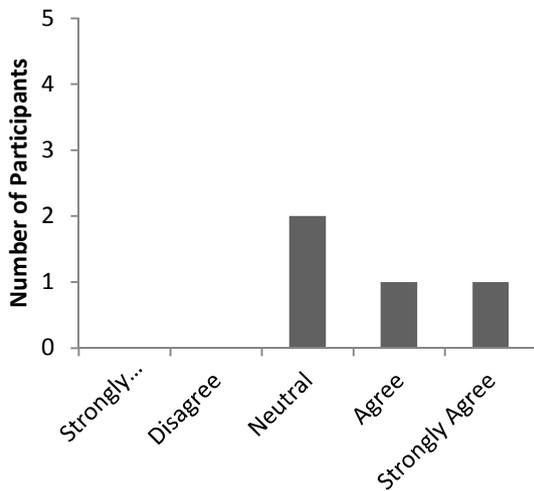


Figure 52: My expectations about the workshops were met

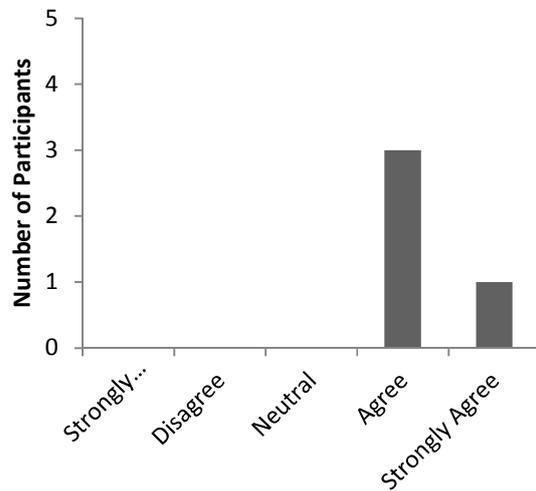


Figure 53: The mediated modelling workshops helped in structuring the thinking

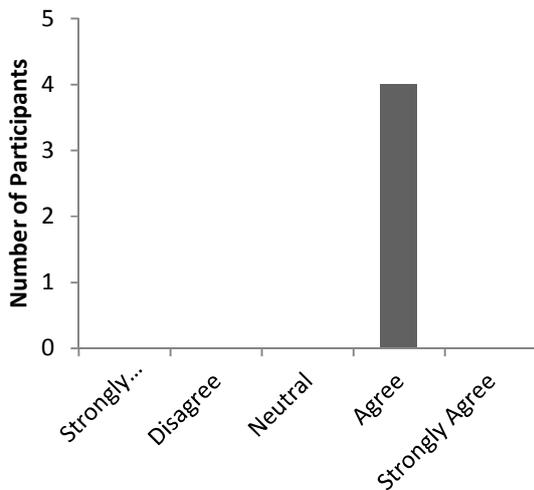


Figure 54: The mediated modelling workshops helped in structuring the discussion

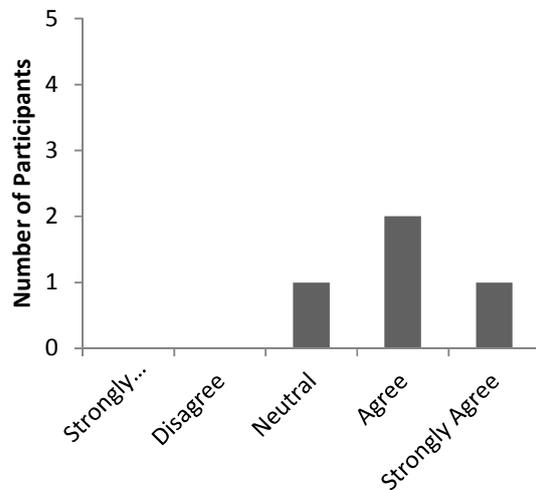
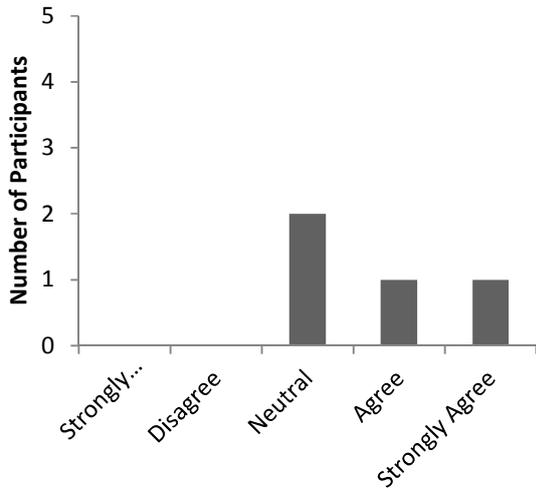
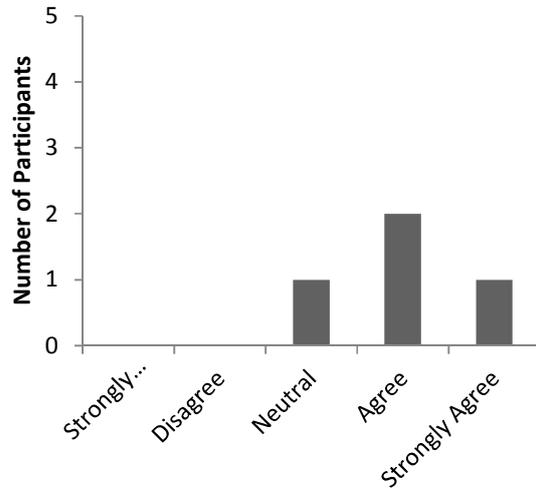


Figure 55: I discovered more linkages with other sectors and stakeholders than before the workshops

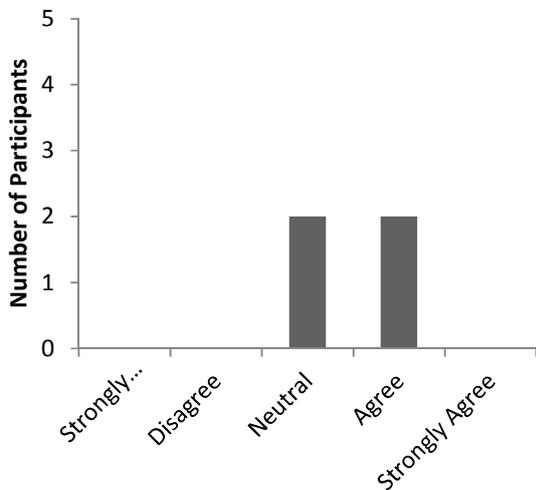


**Figure 56:** The model progressed significantly over the three workshops

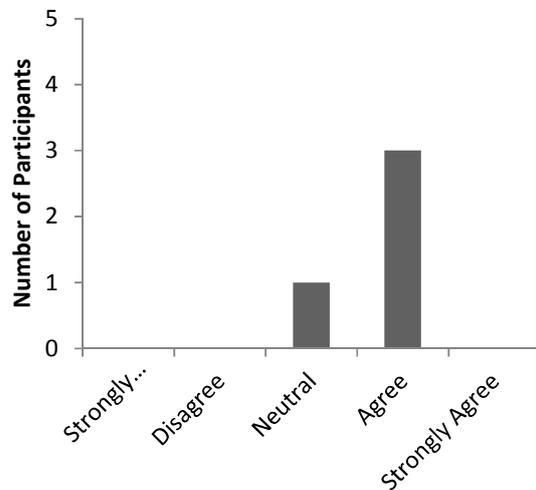


**Figure 57:** My concerns were addressed during the dialogue at mediated modelling workshops

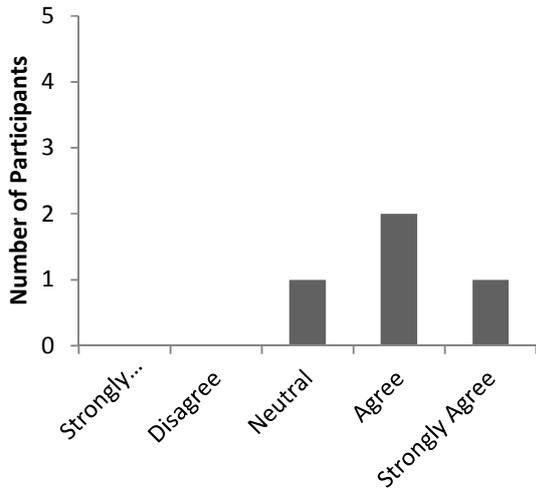
8. Please mark with an "x" the answer that best indicates how much you agree or disagree with each of the following statements related to the final version of the **causal loop diagram**.



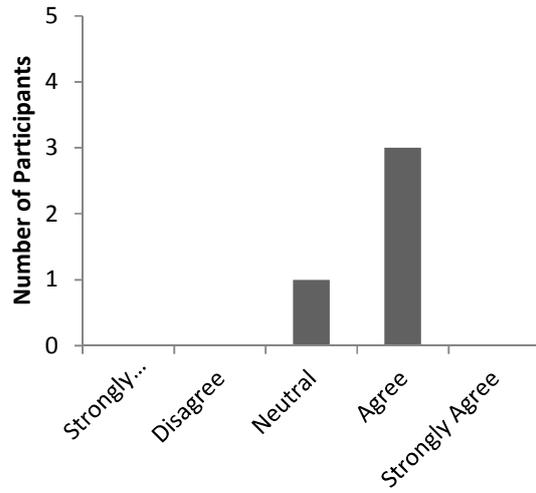
**Figure 58:** The causal loop diagram represents well the problem the group set out to investigate



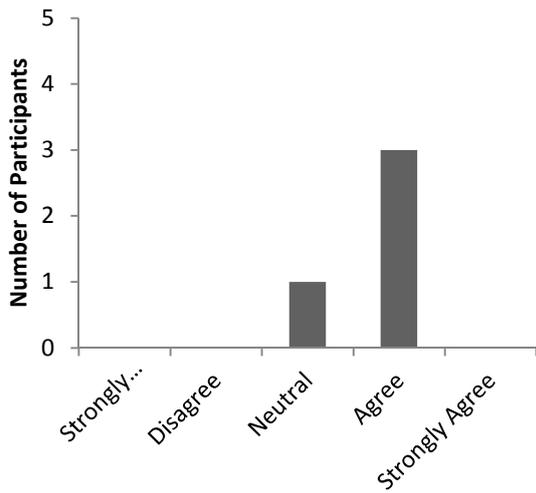
**Figure 59:** This causal loop diagram is a good representation of the group discussions



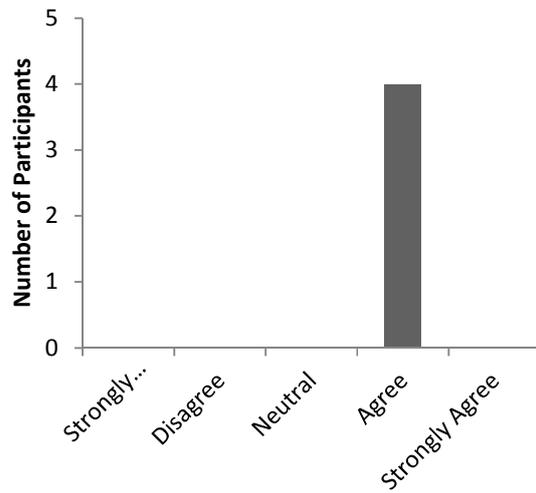
**Figure 60:** *I contributed to the design of this causal loop diagram.*



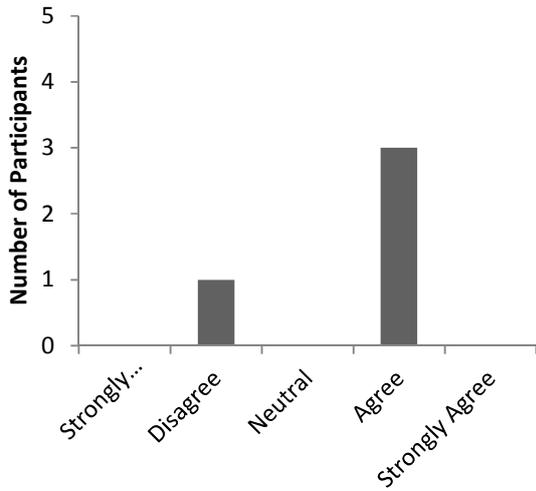
**Figure 61:** *This causal loop diagram is of enough interest to show to others*



**Figure 62:** *This causal loop diagram is a helpful tool for me in communicating problems facing the Auckland Region to others*

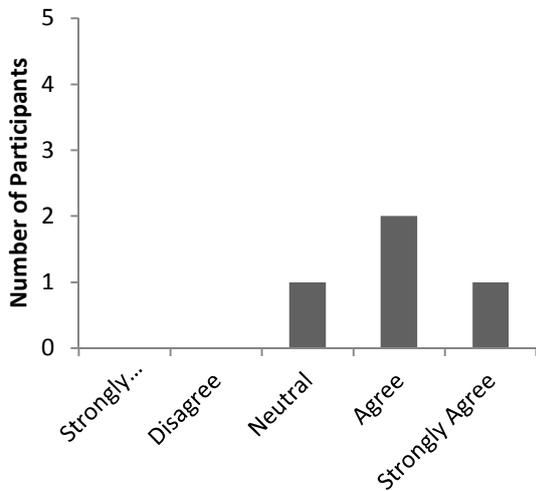


**Figure 63:** *It is useful to continue developing the causal loop diagram*

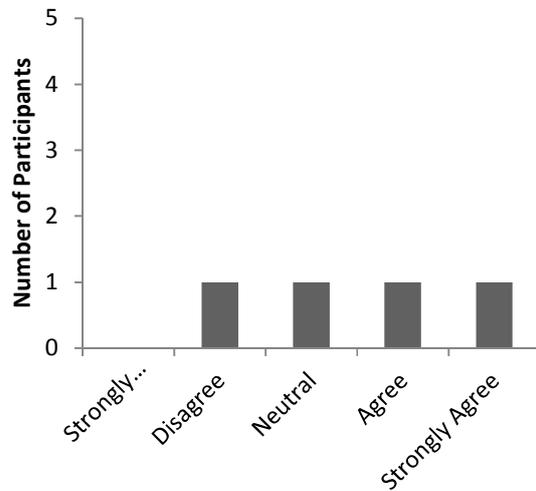


**Figure 64:** I will use this causal loop diagram to explain issues to others

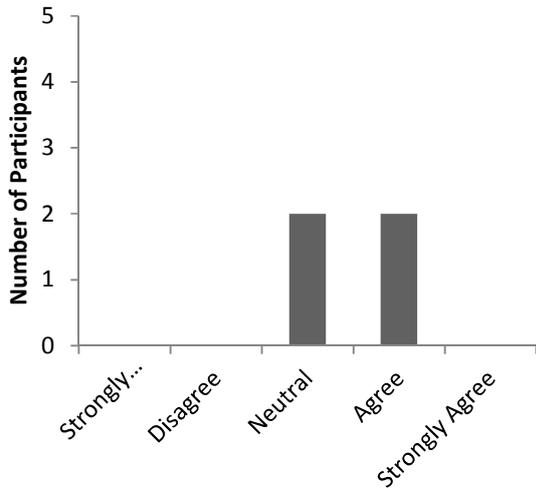
9. A **STELLA-model** was presented at the last workshop. Please mark with an “x” the answer that best indicates how much you agree or disagree with each of the following statements related to this Stella-model.



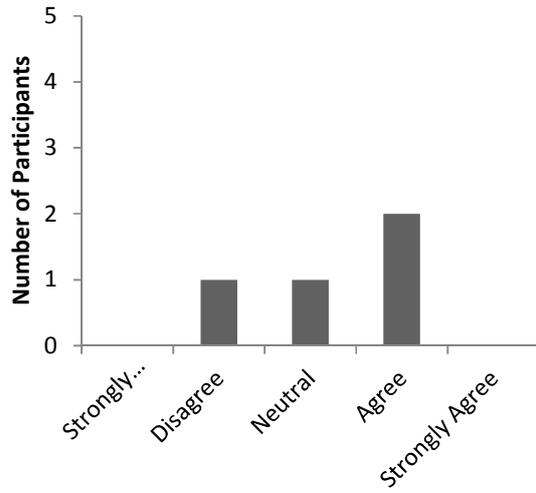
**Figure 65:** The model addresses the problems identified during the workshops



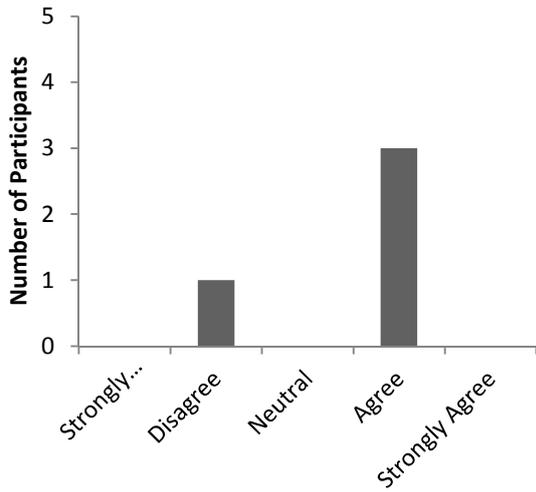
**Figure 66:** The model behaved logically when running scenarios



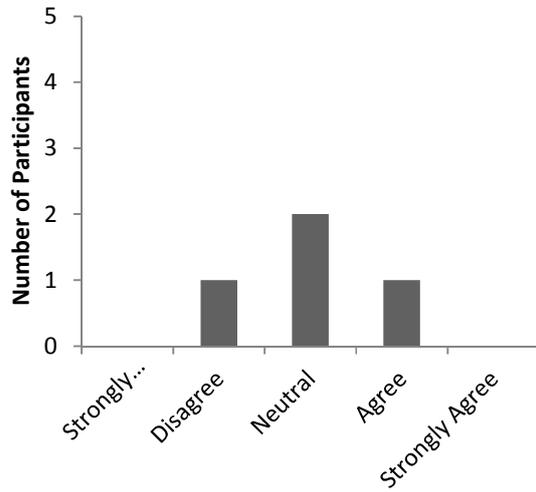
**Figure 67:** *I have faith in the results of the simulation model*



**Figure 68:** *The model is an acceptable representation of the current dynamics of the Auckland Region*



**Figure 69:** *I learned about the dynamics of the Auckland Region*



**Figure 70:** *The current model can be used as a decision support tool for the Auckland Region*

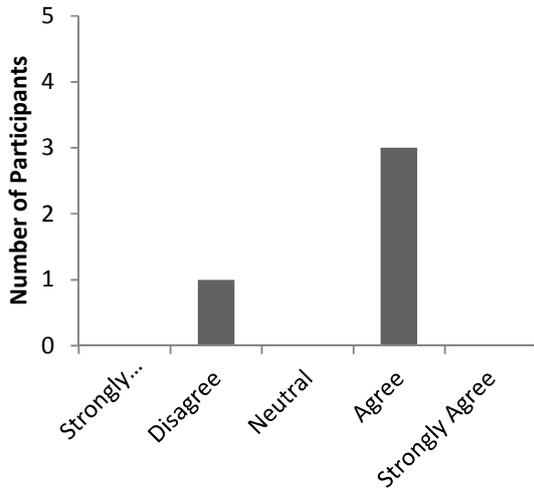


Figure 71: I will show this model to others

10. **Storytelling** was used in the last workshop to guide you through the final version of the causal loop diagram. Please mark with an “x” the answer that best indicates how much you agree or disagree with each of the following statements related to storytelling.

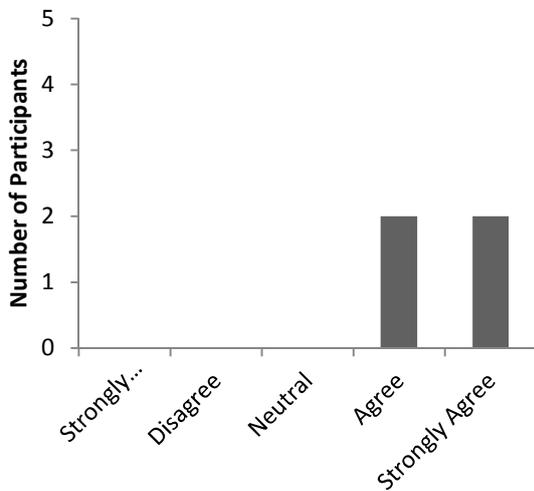


Figure 72: I could follow the stories that were presented to me during the workshops

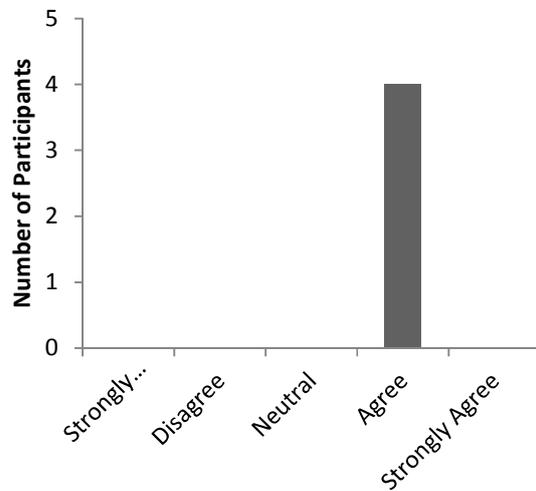
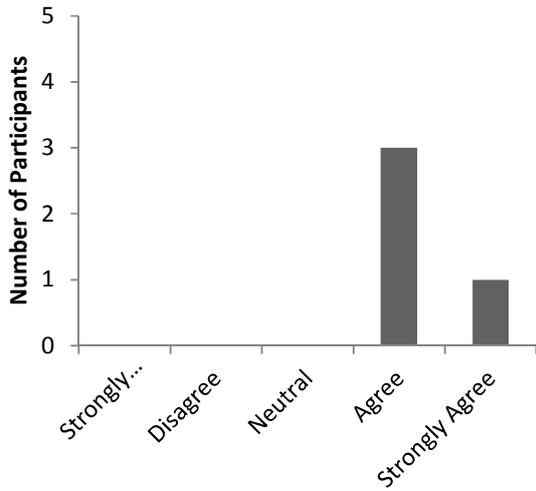
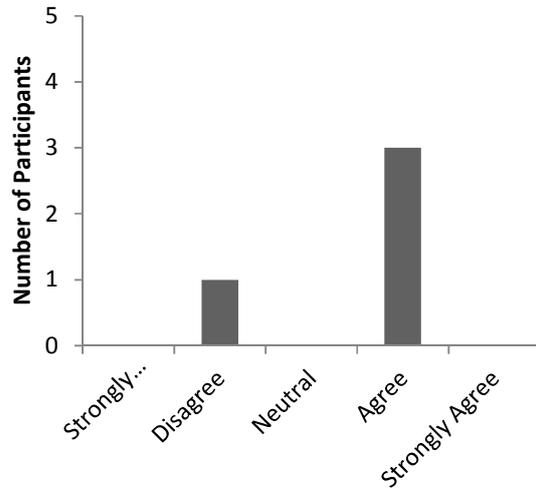


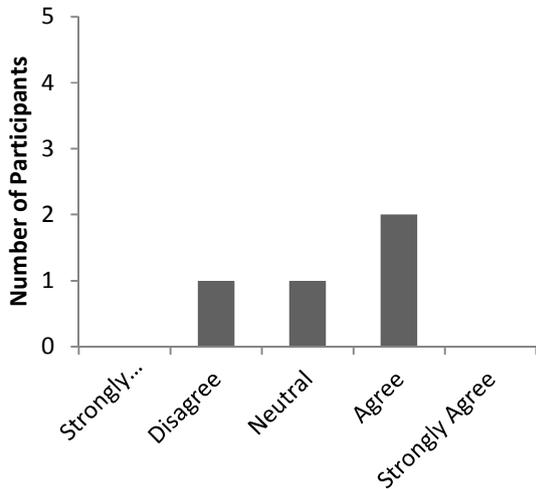
Figure 73: Storytelling helped me understand the causal loop diagram



**Figure 74:** *Storytelling is a helpful tool for me in communicating problems facing the Auckland Region to others*

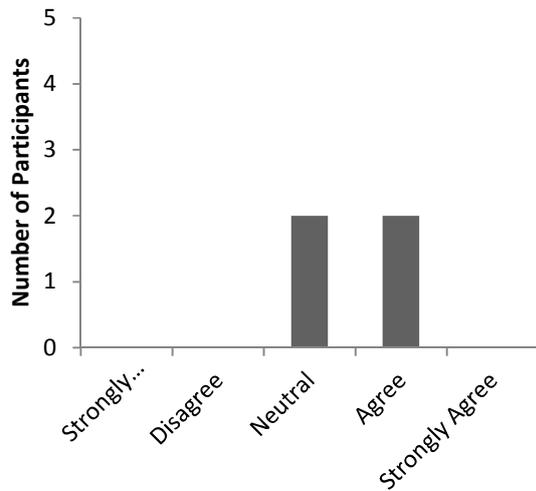


**Figure 75:** *I intend to tell the developed story in the CLD to others*

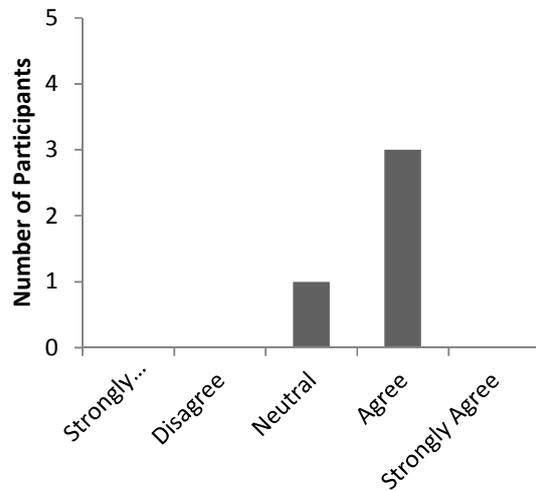


**Figure 76:** *I intend to tell the developed story in the Stella model to others*

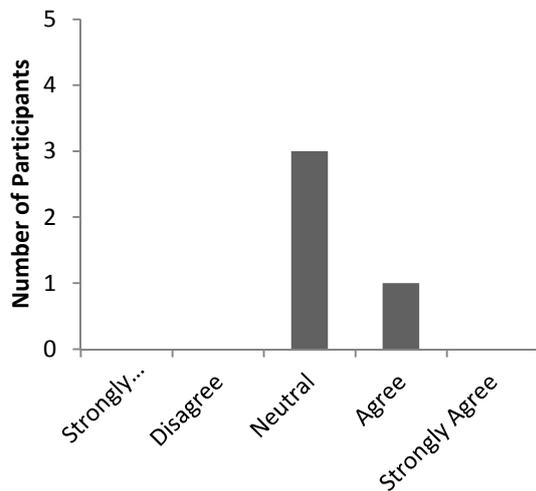
- The scenario **“What if projected population growth and associated ethnic diversity happens, how does this affect “attractiveness” of Auckland?”** was run through the STELLA-model. Please mark with an “x” the answer that best indicates how much you agree or disagree with each of the following statements related to this scenario.



**Figure 77: Running the scenario was insightful**



**Figure 78: Additional scenarios with the current model will be insightful**



**Figure 79: Improvement of the simulation model is required to generate insightful scenarios**

12. What should be the purpose of the mediated modelling process going forward?

- Supporting decisions where there are interdependencies between local and central government stakeholders
- Enhance the learning
- Clarify CLD components. Include funding/investment model
- MM could be used to support a cross-agency approach to planning Auckland's future, seeking to achieve best outcomes across the 4 well-beings. However to do this the question(s) need to be part of a real planning process or at least mirroring a real planning process or issue so correct people are involved and the outcome can be seen as a real option or series of options.

13. Reflecting on the three mediated modelling workshops, what was the best outcome for you?
- Seeing the interrelationships and impacts resulting from decisions made by different stakeholders eg impact of transport decision on employment in an area
  - The last workshop built on levels of understanding
  - Integration across disciplines. Viewpoints/issues of other groups included
  - Cross-agency, cross-discipline discussions and learning. In a real situation, with a defined question and timeframe this could be a powerful process. The visual representation of linkages and flows could also be useful.
14. Reflecting on the three mediated modelling workshops, what was the worst outcome for you?
- The inability of the group to develop a question to do further work on
  - The first workshop- took a while to get it
  - CLD not ideal for transport loop(s). Model was not really working properly after 3 sessions. Participant capabilities in terms of modelling need to be reinforced
  - The process suffered from lack of a real purpose at the start, which meant people were not clear on what they were contributing to and this may have contributed to the low numbers by the 3rd workshop
15. At the end of the workshops the participant did not agree on a question for further MM workshops to answer. What is your preferred topic?
- The development of the Southern Initiative
  - Healthy housing
  - Effects of allocating different funds to each element
  - Interesting to see if the outcomes for AP different from that from MM when all aspects of liveability/'attractiveness' considered together. The topic needs to be somewhere between focussed (e.g. impervious surface affect on marine environment is too focused and should be a numeric model) and broad. Scenario testing of proposed plan changes would be good. If we used the same definition/metric of liveability as AP could run planned approaches through MM and see if liveability really increases?
16. If we continue this mediated modelling process toward a dynamic GPI (Genuine progress indicator) or follow your suggestion, whom should be included in the subsequent workshops?
- Auckland Council, Health, Education, Super Ministry, Pacifica, Maori, Transport
  - Health, Housing, Social care agencies, Energy companies
  - Same, more economic/business input
  - Better representation from economic/industry sector, social development, environment. Might also be useful to have some

community representation, if focused on particular area could use local board.

17. Have you used STELLA (= the modelling software used in this project) to run the developed simulation model outside the Mediated Modelling workshops (Please mark your answer with an "x")?

*None of the participants used STELLA to run the model.*

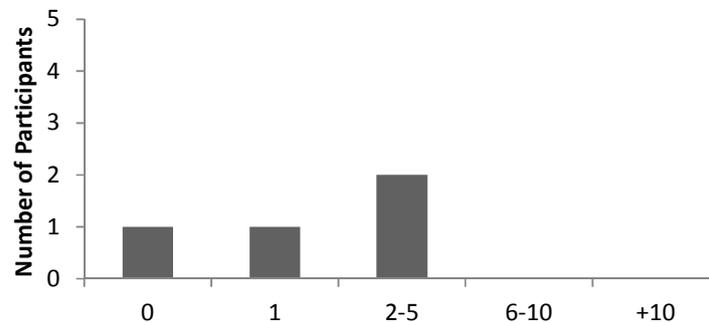
18. Is there any scenario under which you can see yourself use STELLA?

*Three participants can see a scenario where they themselves would use STELLA. One did not see this happening.*

19. Would your organisation (but not you) be interested in using STELLA in the future?

*Two participants thought that, if not themselves, their organisations would be interested in using STELLA in the future. One thought this was a possibility. The other participant could not see their organisation using STELLA.*

20. How many times have you visited the project website ([www.sp2.org.nz](http://www.sp2.org.nz)) during the workshops?



**Figure 80: How many times have you visited the project website**

21. Do you want to stay involved in the mediated modelling workshops?

*All four participants wanted to stay involved.*

22. Any other thoughts, observations, suggestions, recommendations?

- Consider workshops too laissez faire and need to be more controlled/managed regarding model building
- MM useful approach but needs to be used for real planning scenario so people can see potential outcome could be implemented.

## Appendix D Post-survey Analysis of Participants who did not complete workshops

Fourteen participants were surveyed and interviewed before the MM workshops began (pre-survey). Four people attended all three workshops and these people completed a post-workshop mail survey the results of which are presented in Appendix B. As the SP2 project is ‘action research’ we strive to learn about what does not work for participants as well as what does. Two participants withdrew because of employment changes so it was no longer relevant for them to be involved. The remaining eight participants who started but did not complete the workshops were surveyed with a request for their honest feedback on the MM process. This Appendix presents the collated data from the seven surveys returned.

1. After asking about their original issue of concern the participants were asked to indicate their strength of agreement (on a five-point likert-scale from “strongly disagree” to “strongly agree”) to the following statements related to how their issue of concern was treated during the workshops.

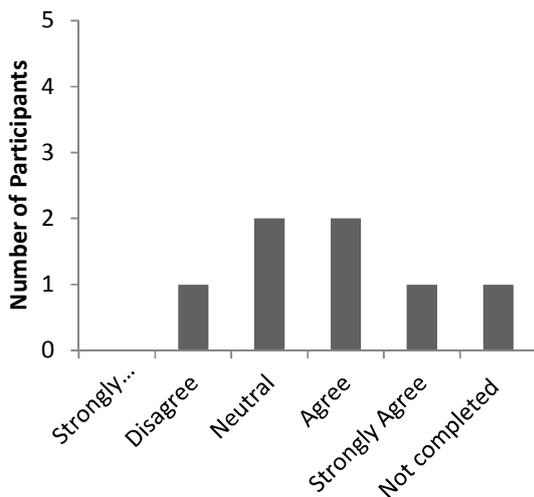


Figure 81: My issue was addressed during the workshops

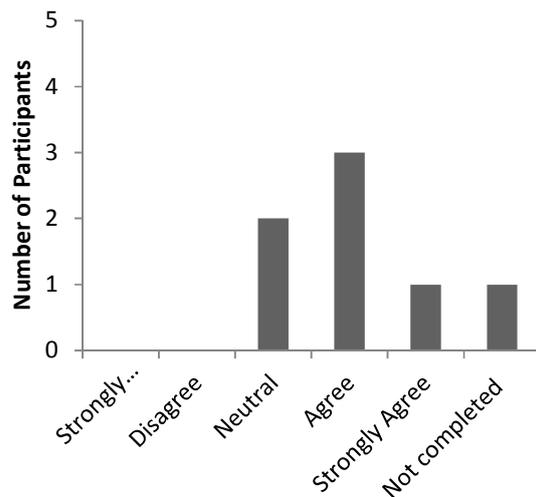
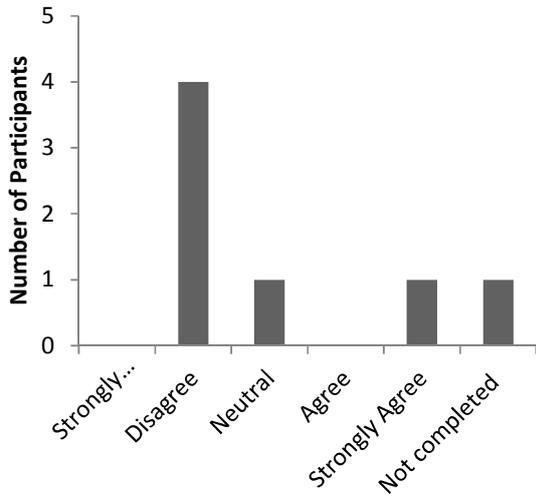
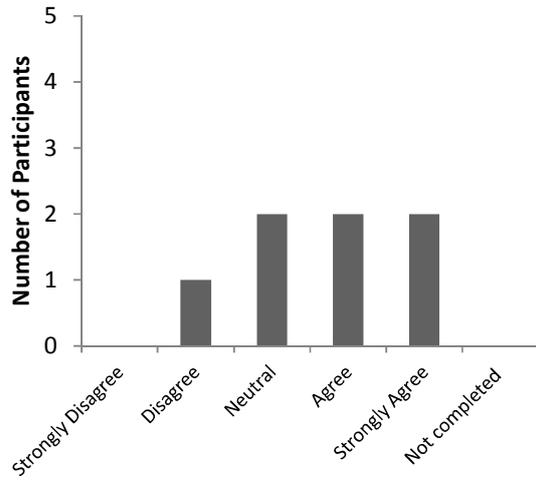


Figure 82: My issue was part of the integrated picture that has emerged through the workshops

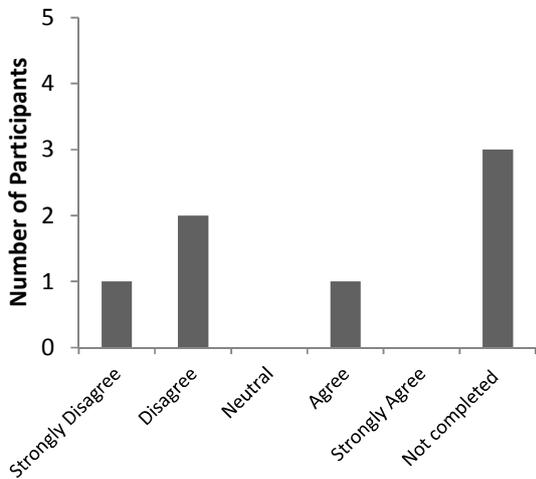


**Figure 83:** My views on my issue have been modified through the mediated modelling workshops.

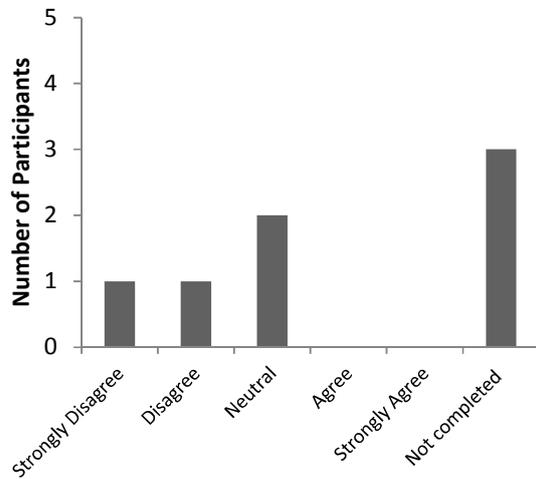


**Figure 84:** My issue can benefit from an extended mediated modelling process.

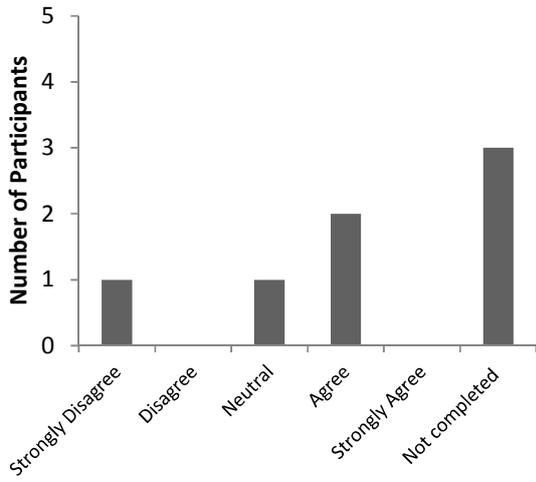
- Participants were asked to indicate their strength of agreement (on a five-point likert-scale from “strongly disagree” to “strongly agree”) with the following statements about why they choose not to continue to participate in the MM workshops:



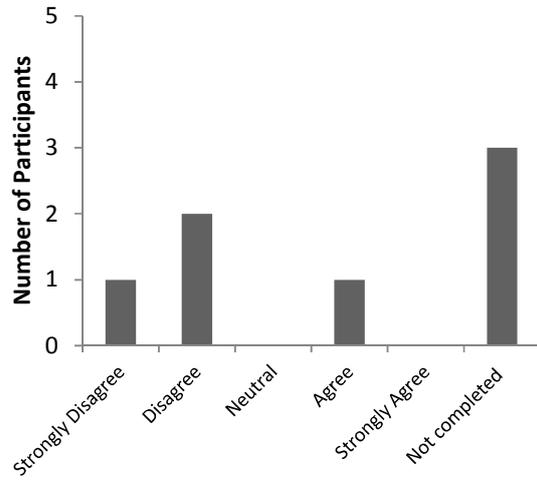
**Figure 85:** Did not see the process going anywhere useful



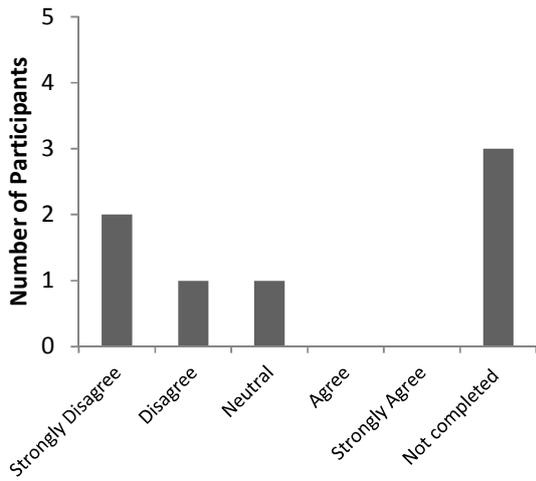
**Figure 86:** Do not have confidence in the model outcomes



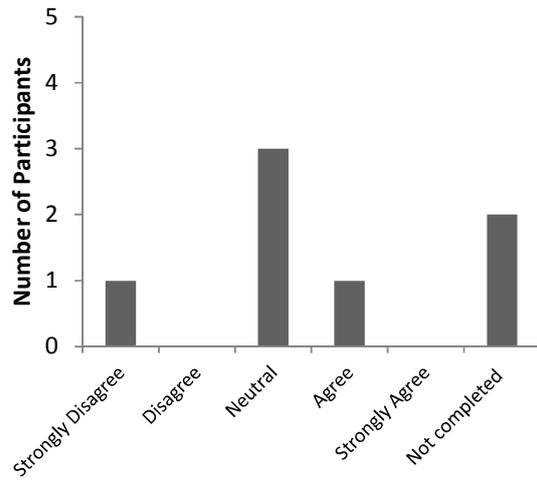
**Figure 87: The topic was too broad**



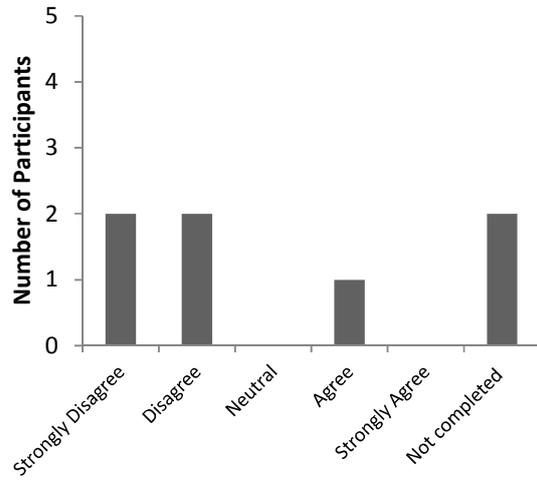
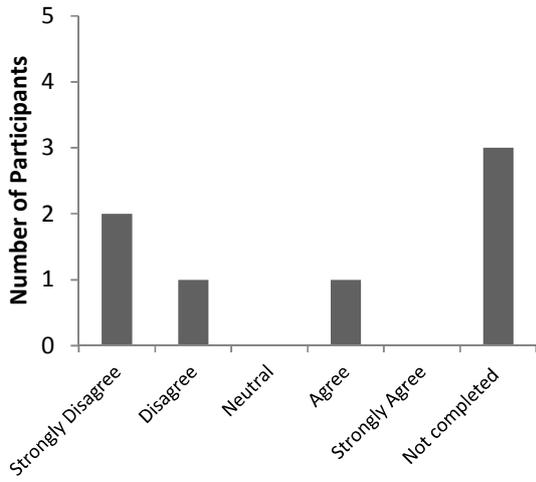
**Figure 88: The topic was not relevant to me**



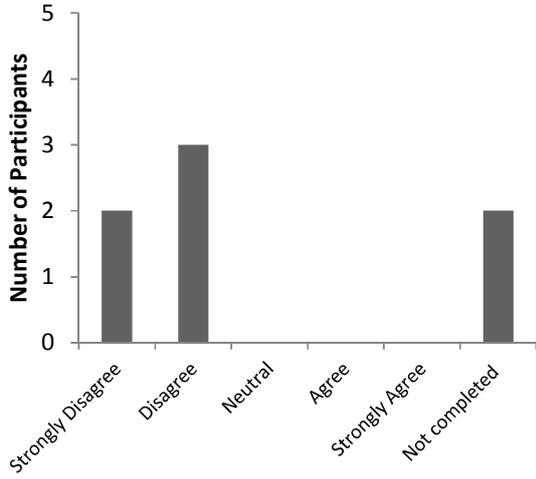
**Figure 89: Do not see 'integration' as an issue for my organisation**



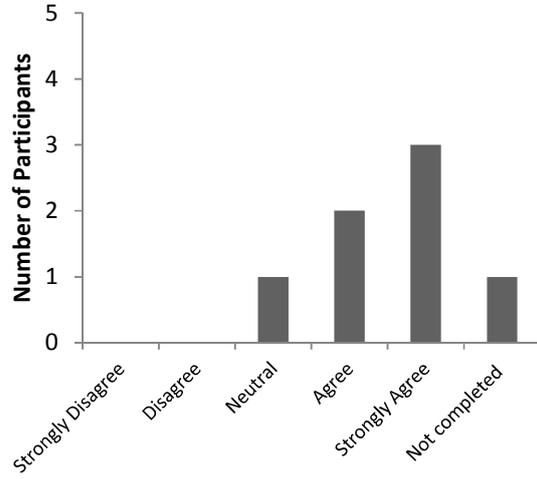
**Figure 90: The appropriate stakeholders were missing**



**Figure 91: Prefer to work in own sphere of influence**

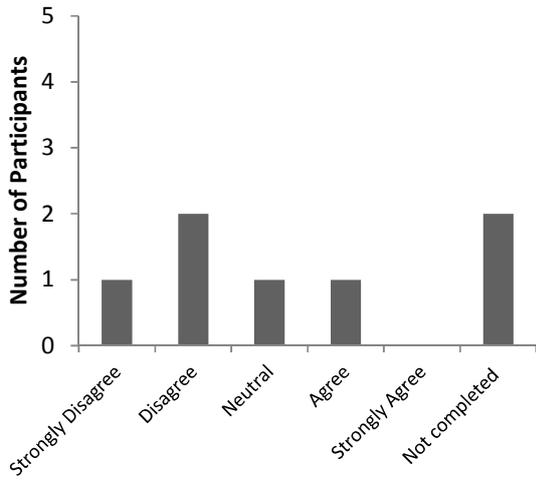


**Figure 92: Did not like workshops in general**

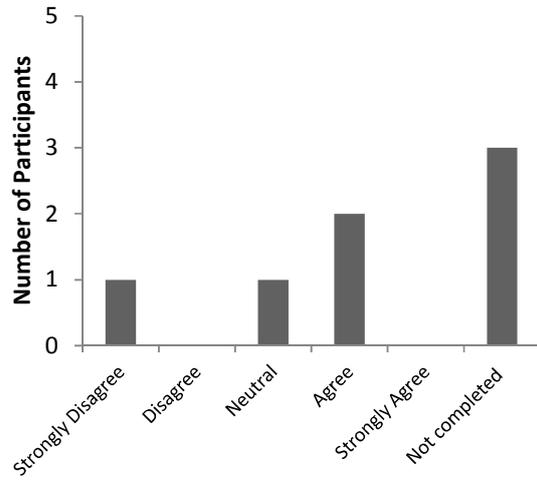


**Figure 93: Did not like this particular workshop structure**

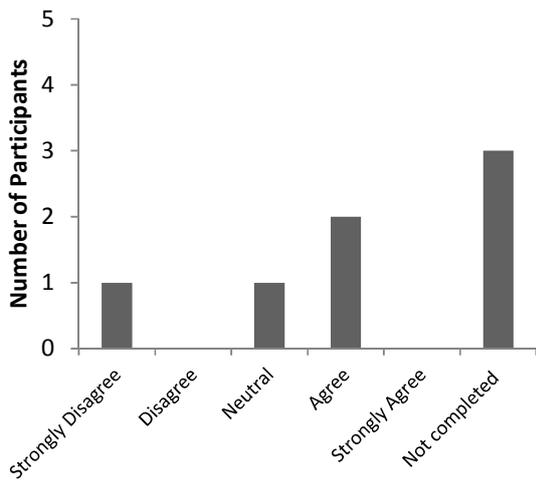
**Figure 94: The time commitment required versus other work priorities is too high**



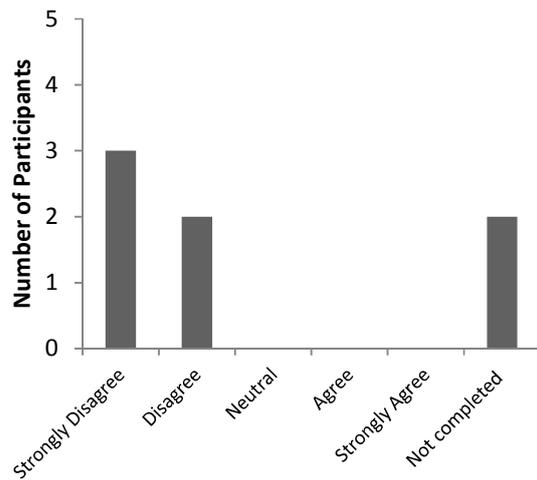
**Figure 95: The system dynamics model is too technical for me to use with ease so it is not useful as a tool for me/my organisation**



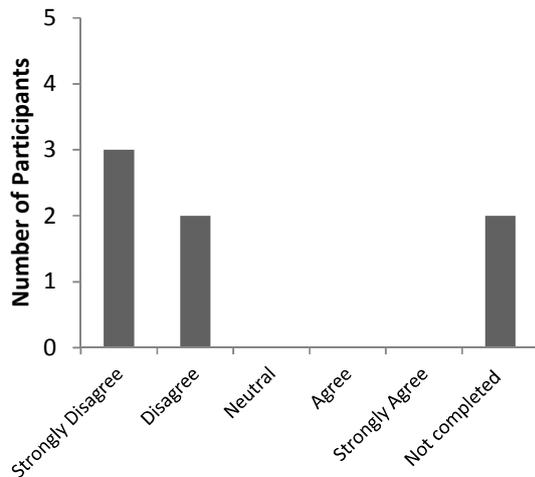
**Figure 96: Process is too academic rather than practical**



**Figure 97: There are too many uncertainties associated with the future to make it worthwhile spending time on scenarios**



**Figure 98: Systems thinking does not help me do my job**

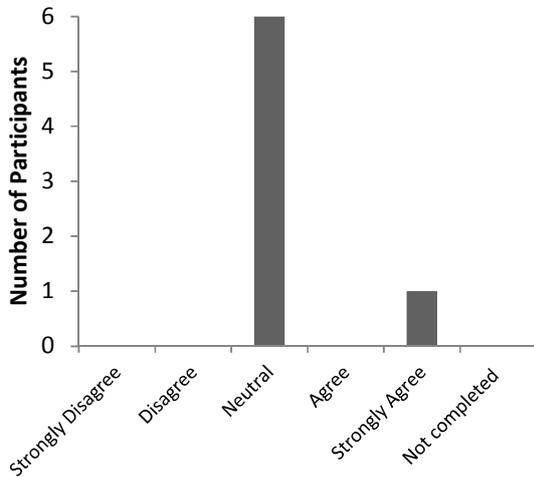


**Figure 99: Linkages with other organisations are not critical enough to my job to sustain interest**

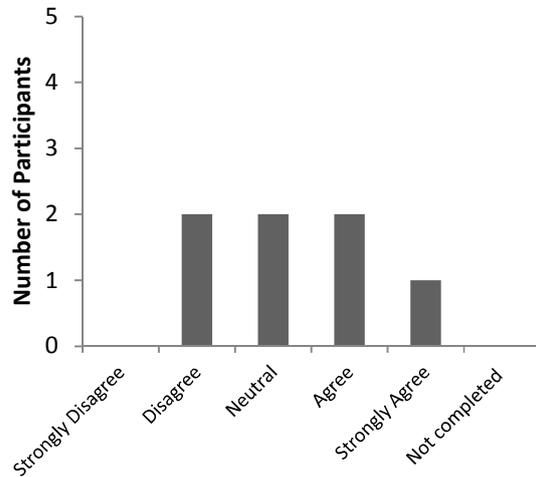
Other reasons given for not continuing to participate in the MM workshops:

- I had to pick up the Acting Director role while my Director was away during the last couple of weeks in March and again, I'm sitting in the Acting role for 11 weeks while my Director is seconded to a special project within the Department.
- The time commitment was too high for me working in a very small agency and the interagency work I was doing directly with the council & other government agencies on the spatial plan and economic development plan was more immediate and relevant to our Ministry at the time. Interagency work is vital so I think the model is relevant. Perhaps the timing was unfortunate as we were working across agencies already and will continue to do so. I have difficulty answering the questions as I only attended the first session.
- The objective was not clear, the benefit to our organisation and rationale for our attendance was unclear and the time commitment too great relative to potential benefits. We are a private sector organisation and don't have the resource for this type of activity.
- "J" the time commitment required versus other work priorities is too high comes closest. I had blocked out the days for all of these workshops but due to unexpected priorities was not able to attend.
- I had a meeting in Wellington come up.
- I had other commitments on the day of the last session, and I could not change them – this clashed with the morning session. Maybe if I had been feeling the process was absolutely 100% valuable, I might have been able to the afternoon, but I was very pressured that week, and I also felt it might not be as valuable to just come to half a day.
- I had work priorities that precluded me from attending the final workshop, no other reason.

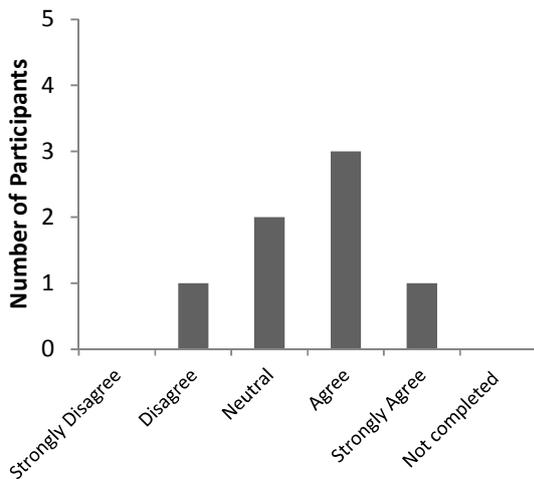
3. Reflecting on the actual workshop participants attended they were asked to indicate their agreement or disagreement with each of the following statements:



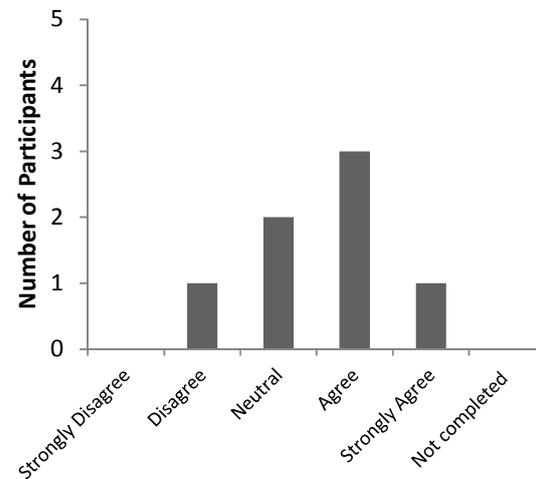
**Figure 100:** My expectations about the workshops were met



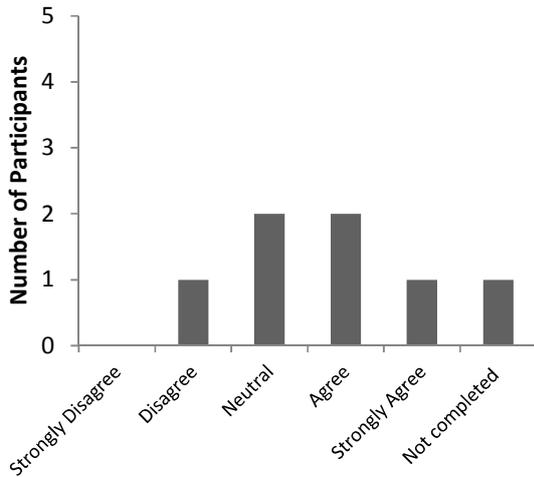
**Figure 101:** The mediated modelling workshops helped in structuring thinking about issues of concern in the Auckland region.



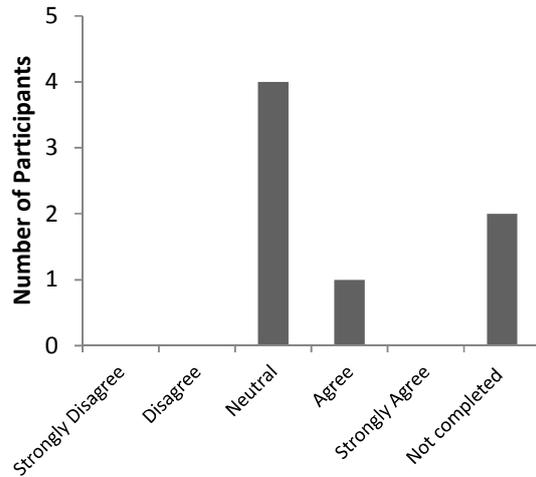
**Figure 102:** The mediated modelling workshops helped in structuring the discussion.



**Figure 103:** I discovered new linkages with other sectors and stakeholders than before the workshops.



**Figure 104: The model progressed significantly over the workshops I was involved in**



**Figure 105: My concerns were addressed during the dialogue at mediated modelling workshops.**

4. Responses to the question can you see a use for the Mediated Modelling process in the Auckland region going forward?
  - Yes my observation was that some participants did not appear to think outside their narrow specialities.
  - Yes
  - Very much so. Most important to continue the conversation with District Health Board representatives with decision making powers and not just analysts. Will maximise cross sector leverage and minimise ‘running interference’ due to ignorance about silo initiatives.
  - No. The mediated modelling process does not adequately account for political reality nor the infinite complexity of social systems. The process essentially seeks to understand/ demonstrate how everything interacts with everything else. At no point did I feel confident the model could successfully present this amount of information, even at a high level. Moreover, because the model does not attempt to provide any accurate detail on the extent to which one variable influences another (for example, we know that education and transport investment are both essential to economic performance, which one influences it more? On what time scale? Under which conditions?), the range of relationships identified through the MM process simply fuels political debate and does not resolve it. I cannot see any decision maker changing their fundamental view on an issue because of results emerging from MM. If no decision maker is going to change their mind from use of the model (and worse, employ it like modern cost-benefit analysis to speciously support a predetermined position), then the model is merely another piece of information to add to the infinite pile we already have. Money for MM would be better off spent on a keg party which will lead to social interaction which will improve connections between attendees which will facilitate knowledge transfer which will improve productivity which will lift Auckland’s economic performance.

- Yes possibly.
  - There is a fundamental issue with stakeholder accountability and some did not see the 'need' for them to consider the social and health issues in their thinking
5. Reflecting on the three mediated modelling workshops, what was the best outcome for you?
- Realising the need for other agencies to work together is a very significant challenge
  - Discovering where other agencies were at for planning particularly where their work addressed the higher level determinants of health and health infrastructure planning
  - Seeing how the modelling system worked – interesting tool which conceivably could be useful.
  - Gain further insight into issues for other sectors and points of commonality
6. Reflecting on the three mediated modelling workshops, what was the worst outcome for you?
- No tangible outcomes
  - Lack of representation from the private sector. Apparent dominance of planning processes by transport, especially roading, land use and growing the regional economy with a view to turning health planning purely into a function of these three key issues
  - I found the process a bit frustrating, mainly because I had not been invited to the first session, so I was starting at a bit of a disadvantage, which meant that the work I did between sessions maybe wasn't exactly what was looked for.
  - Unsure if the invested time would result in a positive outcome
7. Would your organisation (or you) be interested in using STELLA for system dynamics modelling in the future?
- Two participants were interested in using STELLA in the future. One thought this was a possibility. Three participants could not see them or their organisation using STELLA.
8. Do you want to stay involved in the mediated modelling workshops?
- Two participants were keen to be involved in future workshops. Four participants did not want to stay involved though two of these were interested in receiving updates about future mediated modelling workshops.
9. The following additional thoughts, observations, suggestions, recommendations were volunteered:
- I would have liked to complete my time with the group at these workshops, but due to the central government constraints these days, priorities are placed elsewhere. However, I do think that the modelling workshops are useful to get people thinking differently about the "same old" issues.
  - The interagency work we are involved in already is at early stages but looking promising. You may need to check with the various council officers who are involved in this if some of your findings may be able to be utilised by them in the current work streams

- A good initiative but didn't seem to integrate into the Auckland Plan process
- Continue to engage with high level decision makers or none of this good work will be utilised in the way it should be. For health engagement with DHB chief executives and Board chairs is critical
- I think the modelling system is very interesting but I am still not entirely convinced that it offers much more than can be done in a simple diagram – except for situations where there is really strong data on the relationships between variables, so that the figures plugged in to the model are meaningful. I was sorry I didn't get to see the data side of the model in action – maybe that would have answered these concerns. I also think we lost an opportunity, maybe due to the timing of the process. If we had done this modelling a year earlier, it could have fed into the Auckland Plan development. It was frustrating to be going through this process, knowing that the Auckland Plan was being shaped, but not making explicit links between them.

## Appendix E Auckland Regional Model Description

The Auckland regional model is currently composed of nine interlinked sectors and a culture sector which is there as a placeholder (see Figure 106). The nine interlinked sectors are: 1) Population and Ethnic Groups, 2) Employment Economics ‘attractiveness’ and Funding, 3) Education, 4) Health, 5) Land Use and Natural Capital, 6) Transport, 7) Social, 8) Government or Policy solutions, and 9) External Factors. Each of the interlinked sectors is detailed in the following discussion.

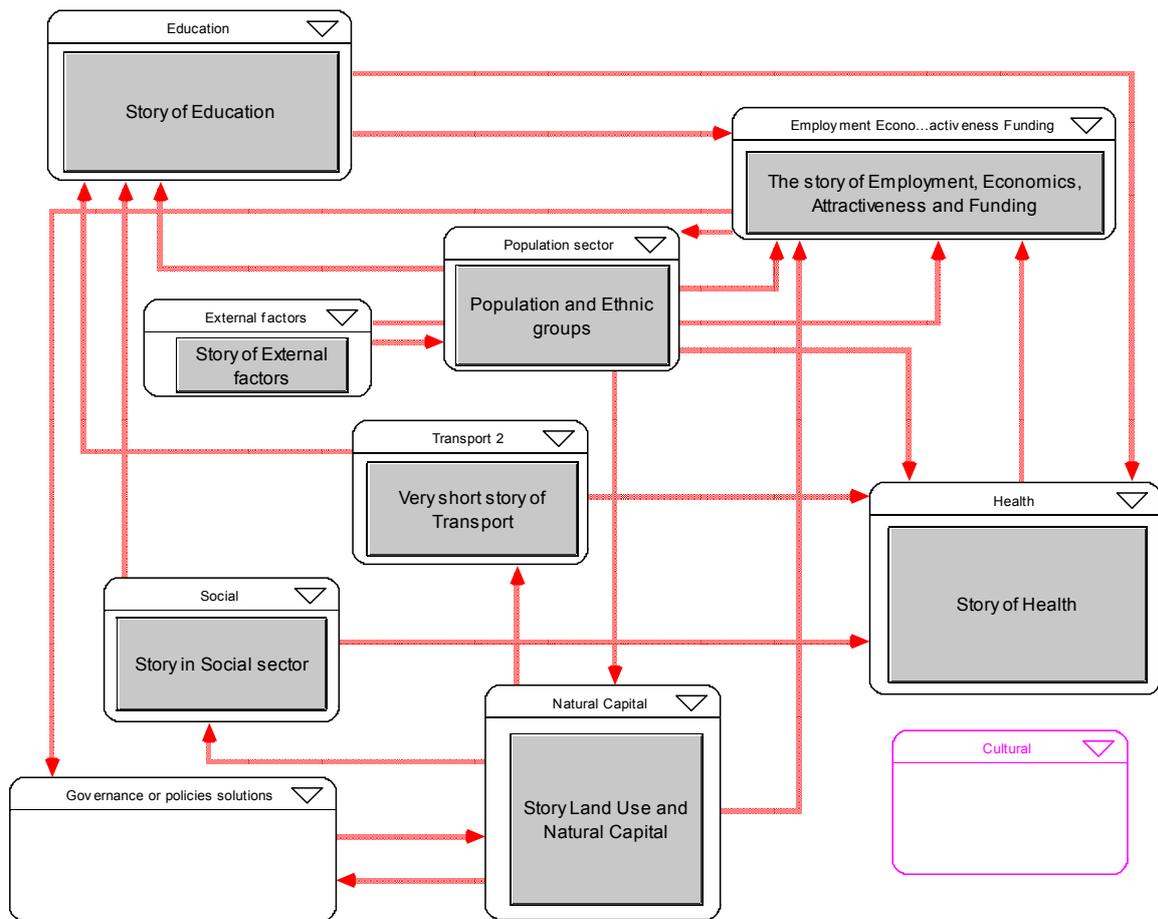


Figure 106: Sector overview of the Auckland regional model

### Sector Population and Ethnic Groups

The model divides population into four ethnic groups: 1) Pacifica, 2) Asians, 3) Maori, and 4) Europeans and everybody else. The model structure that captures the population dynamics is basically the same for each of the ethnic groups. The number of people in each ethnic group change due to 1) births, 2) deaths, 3) immigration, and 4) emigration (see equation 1 and summarized in Figure 111).

$$\text{Population}[\text{Ethnic Group}](t) = \text{Population}[\text{Ethnic Group}](t - dt) + (\text{Birth}[\text{Ethnic Group}] + \text{Immigration}[\text{Ethnic Group}] - \text{Death}[\text{Ethnic Group}] - \text{Emigration}[\text{Ethnic Group}]) * dt \quad (1)$$

INITIAL VALUES:  $\text{Population}[\text{Pacifika}] = 165000 \text{ \{People\}}$ ,  $\text{Population}[\text{Asian}] = 200000 \text{ \{People\}}$ ,  
 $\text{Population}[\text{Maori}] = 120000 \text{ \{People\}}$ ,  
 $\text{Population}[\text{European\_and\_everybody\_else}] = 650000 \text{ \{People\}}$

However, the rates at which change occurs differ for the different ethnic groups. In addition, the reasons for immigrating and emigrating also differ by ethnic group. The model assumes that immigration of Pacifika to Auckland will increase due to climate change (see equation 2). It is also assumed that the Asian immigration pattern is due to the ‘attractiveness’ of Auckland as a region (see equation 3) and that Maori might emigrate due to social and minority issues (see equation 4). So, based on the population dynamics within these ethnic groups, the ratios of ethnicity (when compared to the total population) change over time.

$$\text{Immigration\_Rate\_Pacifika} = 0.01 + \text{Climate\_Change\_Refugee\_rate} \quad (2)$$

$$\text{Immigration\_Rate\_Asian} = 0.02 + A\_migration\_due\_to\_Education + A\_Migration\_rate\_due\_to\_overall\_‘attractiveness’ \quad (3)$$

$$\text{Emigration\_Rate\_Maori} = \text{Emigration\_rate\_Maori\_due\_to\_minority\_issues} \quad (4)$$

The fit between historical data (source: Statistics NZ) and the model run for the population of each of the ethnic groups is given in Figure 107 to Figure 110 and all illustrate good fits.

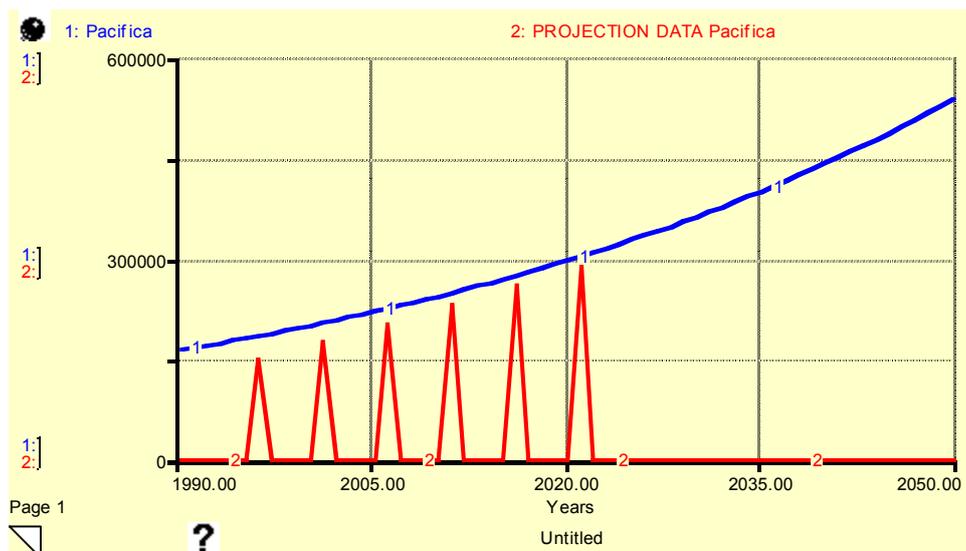


Figure 107: Fit for population of the Pacifika between model generate data and historic data.

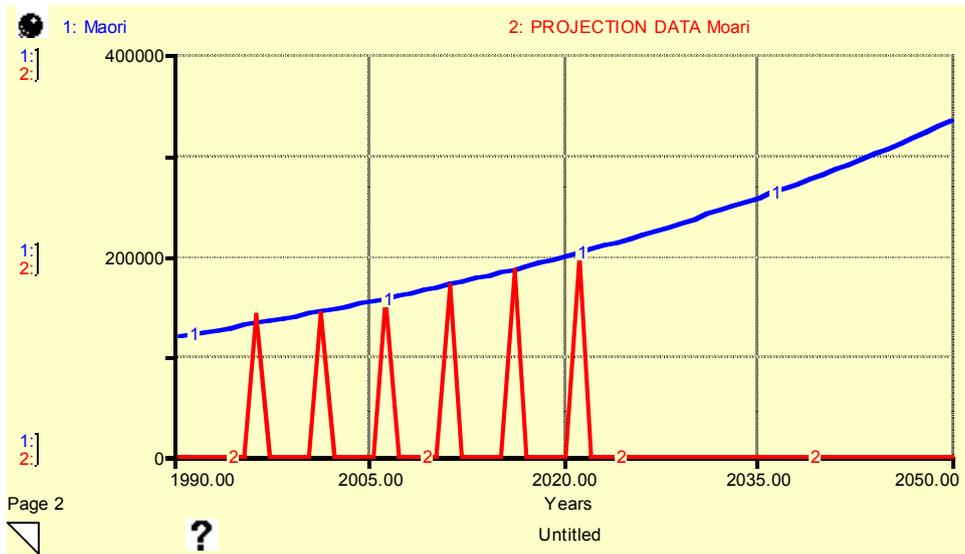


Figure 108: Fit for population of the Maori between model generate data and historic data.

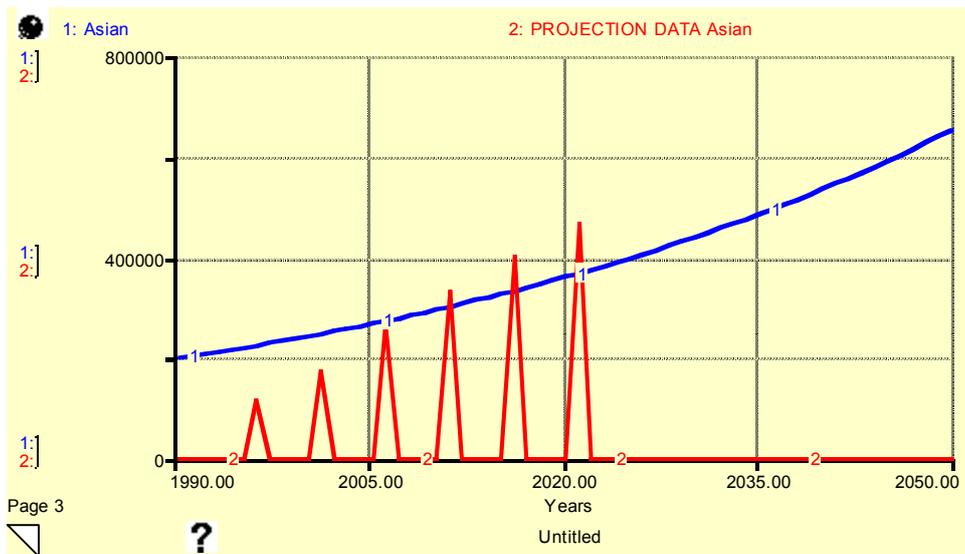
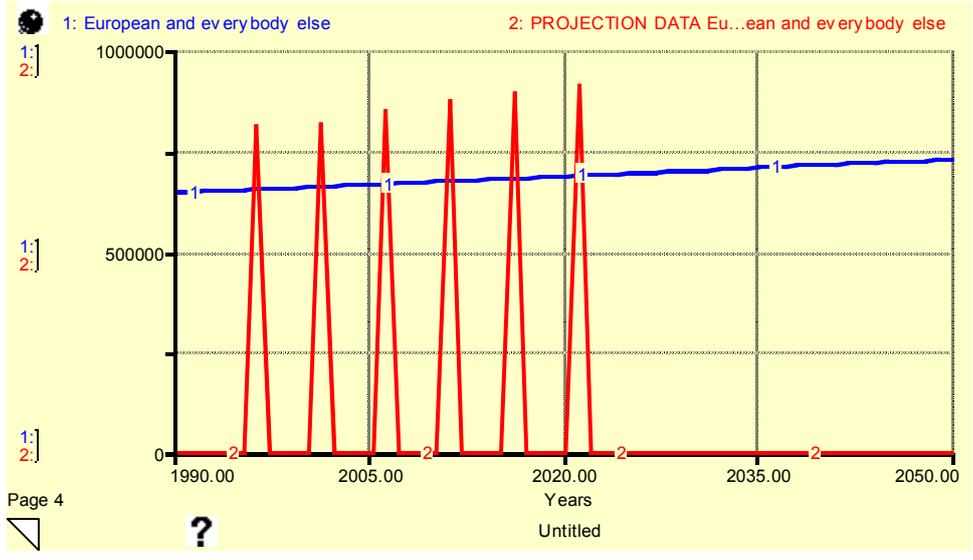


Figure 109: Fit for population of the Asians between model generate data and historic data.



**Figure 110: Fit for population of the Europeans (and everybody else) between model generate data and historic data.**

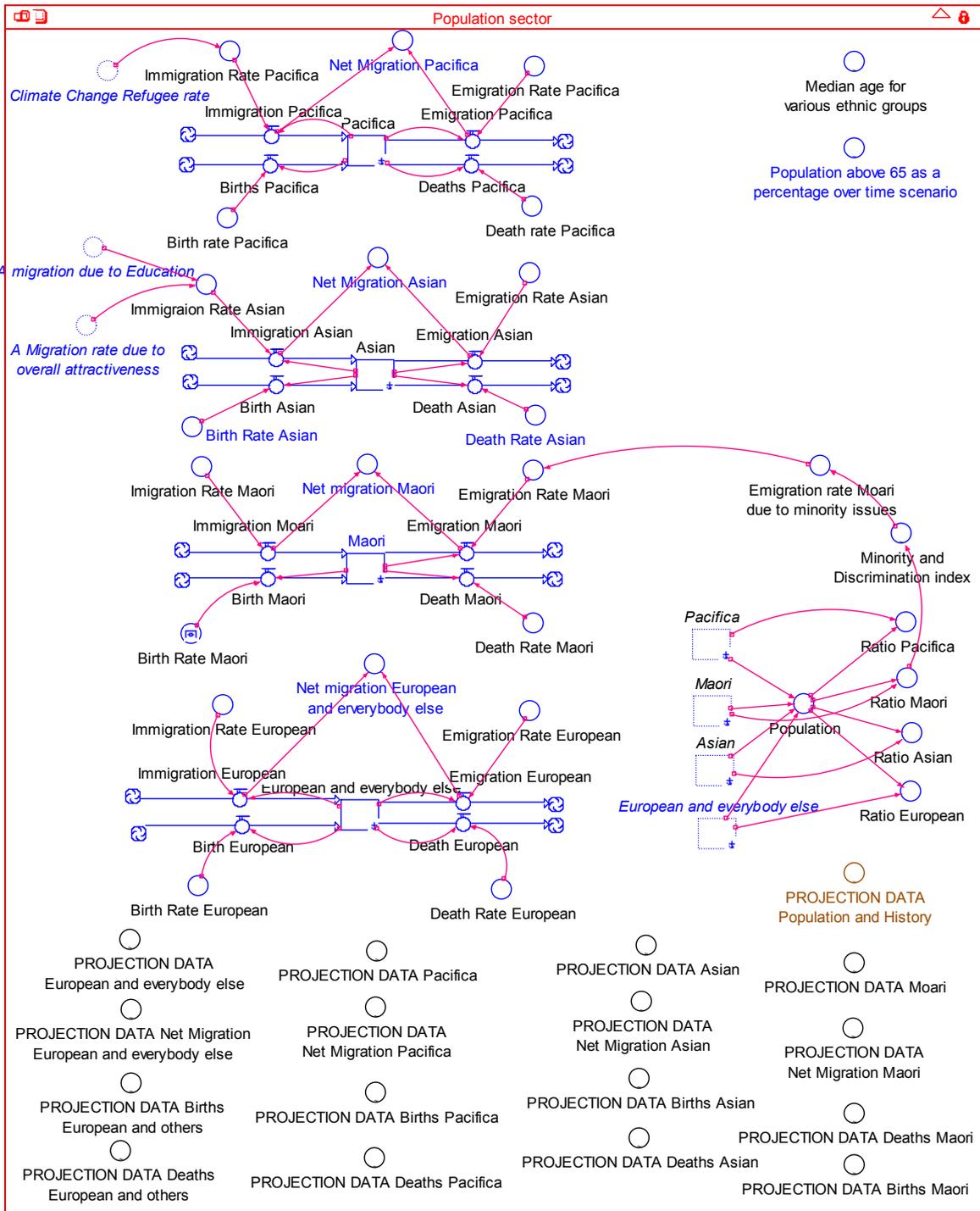


Figure 111: Sector Population and Ethnic Groups

## Sector Employment Economics 'attractiveness' and Funding

This sector currently contains four themes: 1) employment, 2) 'attractiveness' of the region, 3) GDP, and 4) funding (summarised in Figure 113). But, up till now, GDP and funding are not actively pursued in this model in part due to a lack of interest in funding/GDP issues after workshop 1 (See notes from workshops in Appendix A).

Employment is mainly a function of the potential workforce adjusted for education and health (see equation 5). The potential workforce in the Auckland region is defined as all people between 20 and 65 years old (i.e., the fraction of the total population who are not dependents (see equation 6). Unemployment (in number of people) is then the difference between the potential workforce and those being employed. The unemployment rate is determined by taking the ratio of unemployed and the potential workforce. The unemployment rate was compared with the available historical unemployment data to calibrate the model.

$$\begin{aligned} \text{Number\_of\_People\_Employed} = & \text{DELAY}(\text{Potential\_Workforce} * \\ & \text{Fraction\_of\_Potential\_workforce\_employable,} \\ & \text{time\_lag\_impact\_education\_on\_employment}) * \\ & \text{Fraction\_of\_Potential\_Workforce\_Employed\_due\_to\_health} \end{aligned} \quad (5)$$

$$\begin{aligned} \text{Potential\_Workforce} = & (\text{Population} * \\ & \text{Fraction\_of\_total\_population\_that\_is\_potential\_workforce}) - \text{Dependents} \end{aligned} \quad (6)$$

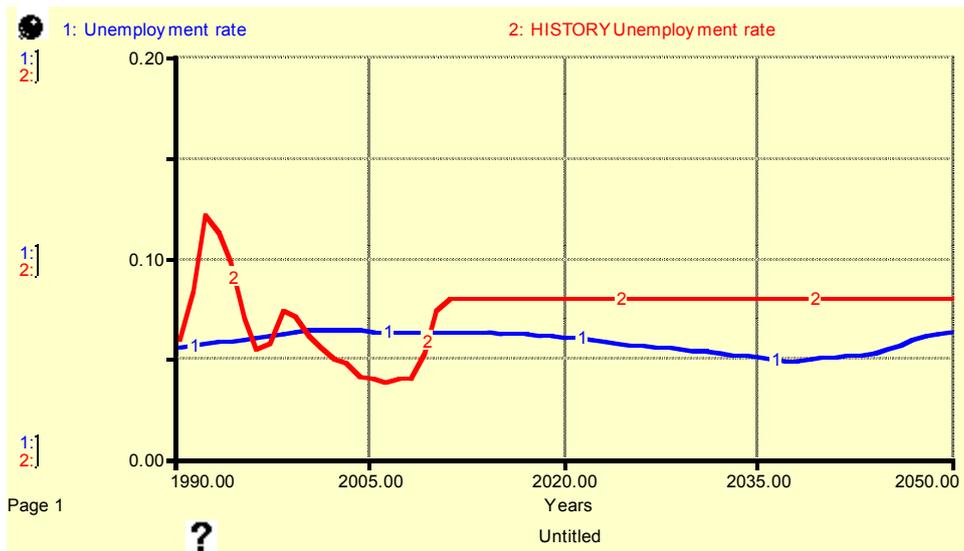


Figure 112: Fit for unemployment rate between model generate data and historic data.

Next, the 'attractiveness' of the Auckland region is an equally weighted average of 'attractiveness' due to 1) employment (i.e., a function of the unemployment rate in the Auckland region relative to the unemployment rate outside the region.), 2) health, 3) education and 4) Ecosystem services (see equation 7). The overall 'attractiveness' of the region affects the immigration rate to the region (see equation 8). However, some ethnic groups (mainly Asians) are attracted more by educational possibilities and standard of living in the region (see equation 3).

$$\text{Auckland\_ 'attractiveness' } = \tag{7}$$

$$\begin{aligned} & (\text{'attractiveness' due to benefits derived from Ecosystem Services} + \\ & \text{'attractiveness' due to employment} + \text{'attractiveness' due to health} + \\ & \text{'attractiveness' of the Auckland region based on education}) / 4 \end{aligned}$$

$$\text{Migration rate due to 'attractiveness' } = \text{Auckland\_ 'attractiveness' } / 100 \tag{8}$$

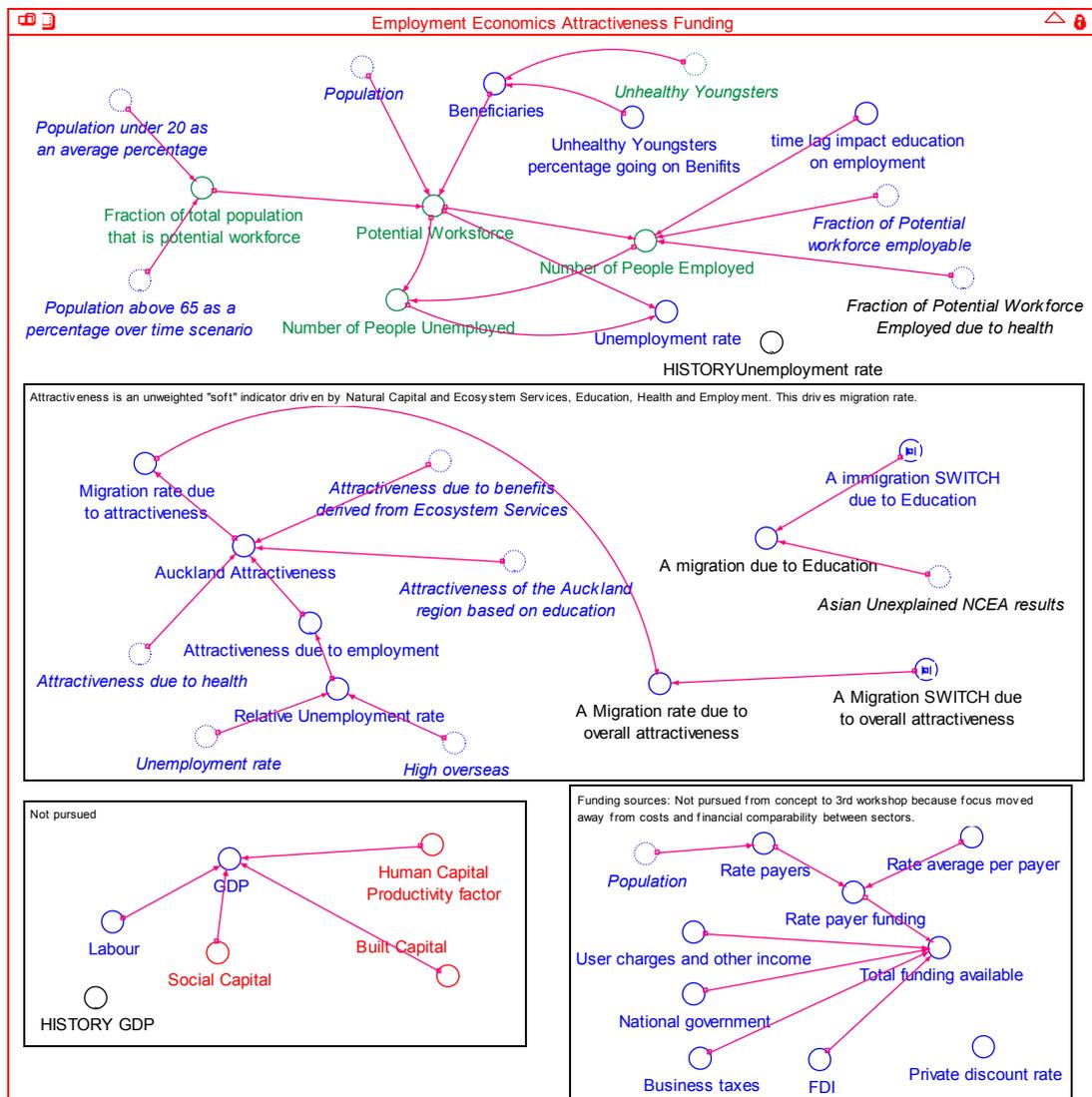


Figure 113: Sector Employment Economics 'attractiveness' and Funding

## ***Sector Education***

The goal for the education system is to deliver students with NCEA level 2 or higher qualifications. At this level, students are considered to have an adequate education to be employed in the workforce. The model assumes that variations in NCEA level achievement associated with ethnic groups are static characteristics, exacerbated by crowding. Crowding of students in the school system is the main cause in this model for not reaching NCEA level 2. Hence, the educational section (Figure 115) is primarily about adjusting the capacity of schools to meet the demand by additional students for education.

Student numbers for each ethnic group are a percentage of the under 20 years old ethnic group. Based on the recommended number of students per school and estimated student numbers, a demand for schools is forecasted (see equation 9).

$$\text{Forecasted\_demand\_for\_schools} = \frac{\text{Forecasted\_students\_need\_for\_education}}{\text{Recommended\_number\_students\_per\_school}} \quad (9)$$

Where:

$$\text{Forecasted\_students\_need\_for\_education} = \text{Population} * \text{Population\_under\_20\_as\_an\_average\_percentage} \quad (10)$$

Schools are built based on this demand-forecast but it takes time to adjust schools to this forecast (see equation 11).

$$\begin{aligned} \text{Schools}(t) = & \text{Schools}(t - dt) + (\text{IF TIME} > 2012 \text{ AND Forecasted\_demand\_for\_schools} \\ & > \text{Schools AND Schools} < \text{Maximum\_number\_of\_schools THEN} \\ & (\text{Forecasted\_demand\_for\_schools} - \text{Schools}) / \text{Time\_to\_adjust\_building\_of\_schools} \\ & \text{ELSE } 2) * dt \\ & \text{INITIAL VALUE: } 500^4 \end{aligned} \quad (11)$$

Due to this time delay and based on the actual number of students, there may be crowding in the schools.

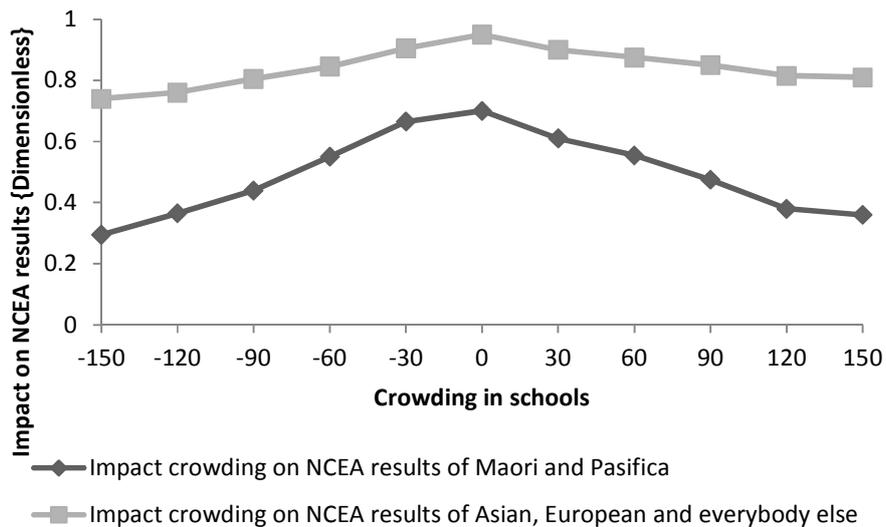
$$\text{Crowding\_in\_schools} = \frac{(\text{Forecasted\_students\_need\_for\_education} / \text{Schools}) - \text{Recommended\_number\_students\_per\_school}}{\text{Recommended\_number\_students\_per\_school}} \quad (12)$$

---

<sup>4</sup> Approximation made during a personal communication with Mr. John Karl.

Where “recommended number of students per school” = 500 {Students/School}

It is assumed that crowding will reflect on NCEA results for Pasifika and Maori differently from Asians and Europeans. Education records show there is a discrepancy in achievement across the different ethnic groups. **Figure 114 illustrates the effect crowding has on the NCEA results for the different ethnic groups.**



**Figure 114: The effect of crowding on NCEA results of the different ethnic groups**

Students exiting schools with NCEA level 2 increase their chance to become employed which feeds into the ‘attractiveness’ of the region. Finally, a budget was added to this sector based on ballpark information from the current annual education budget. This allows the calculation of education costs per forecasted student.

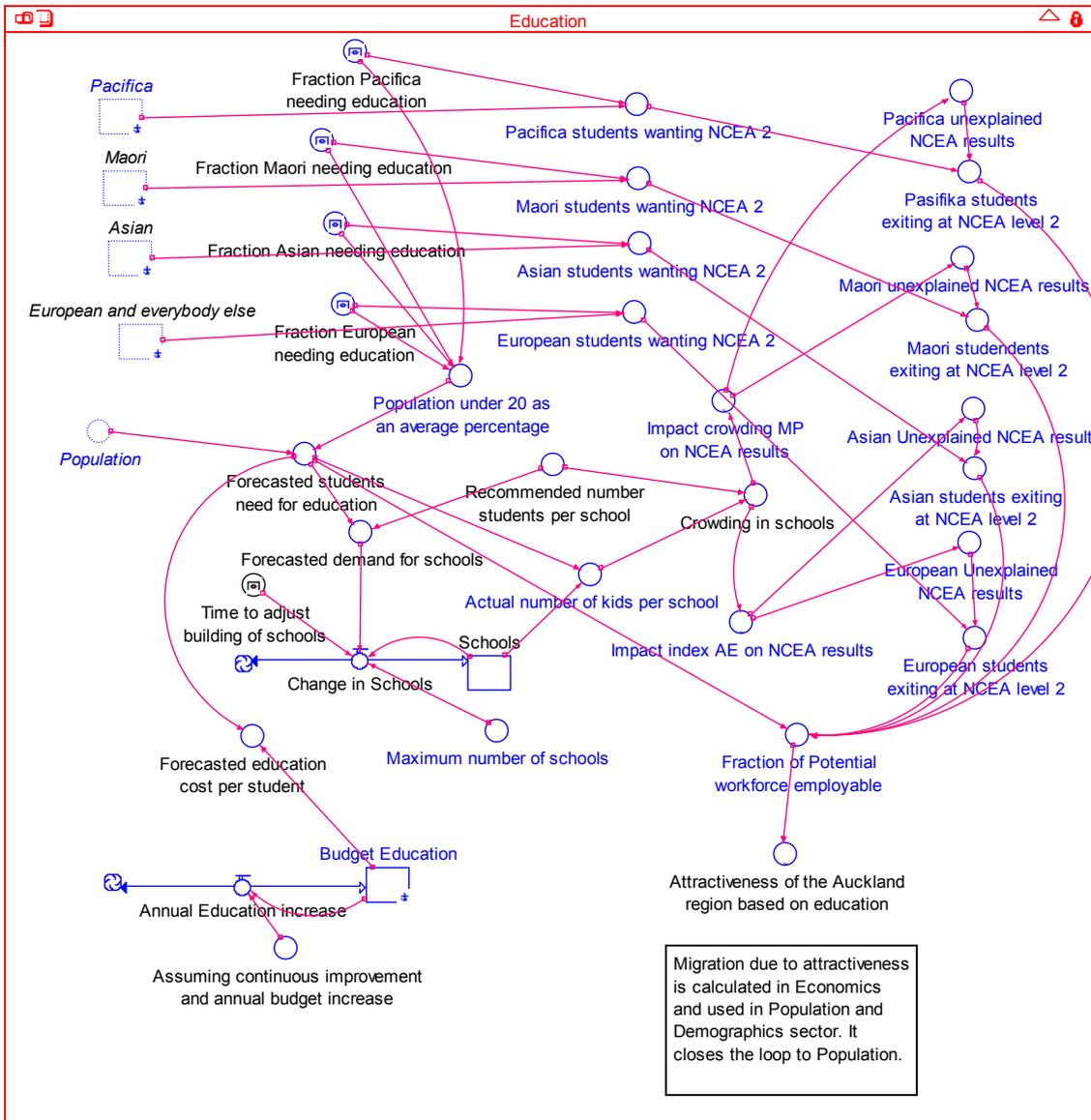


Figure 115: Sector Education

## ***Sector Health***

The health care sector (Figure 116) in the model is restricted to health care for children and elderly as the workforce is considered healthy and not in need of health care services. If health care for children is reduced this impacts on the workforce long term as children grow up to become the workforce. All elderly are considered to require health care while only a fraction of children need health care. This fraction increases if housing is working against their health status. Options for active mode transportation increase the health outlook for both children and the elderly.

The demand for healthcare drives the need to develop this service (see equation 13) but it takes time to adjust provision to demand and there exists a maximum level of provision (see equation 14).

$$\text{Demand\_for\_health\_infrastructure} = (\text{Young\_people\_needing\_health\_care} + \text{Elderly\_needing\_health\_care}) \{\text{Number of People}\} \quad (13)$$

$$\begin{aligned} \text{Capacity\_of\_health\_care\_infrastructure\_in\_number\_of\_people}(t) = & \quad (14) \\ \text{Capacity\_of\_health\_care\_infrastructure\_in\_number\_of\_people}(t - dt) + (\text{IF TIME} & \\ >2012 \text{ AND Demand\_for\_health\_infrastructure} > & \\ \text{Capacity\_of\_health\_care\_infrastructure\_in\_number\_of\_people AND} & \\ \text{Capacity\_of\_health\_care\_infrastructure\_in\_number\_of\_people} < & \\ \text{Maximum\_Capacity\_HC\_infrastructure\_in\_number\_of\_people THEN} & \\ (\text{Demand\_for\_health\_infrastructure} - & \\ \text{Capacity\_of\_health\_care\_infrastructure\_in\_number\_of\_people}) / & \\ \text{Time\_to\_adjust\_Health\_service\_infrastructure ELSE 500}) * dt & \\ \text{INITIAL VALUE: 200000} \{\text{Number of People}\} & \end{aligned}$$

A slide bar on the interface allows allocation of health care provision to elderly or children. The base case is 50-50%. Depending on who uses the capacity, unused capacity is re-allocated.

The sum of children not needing health care and those who receive health care are the healthy youngsters. The same is true for the elderly except that we assumed that there were no healthy elderly. The healthy children grow up to contribute to the workforce. Healthy elderly may extend their economic contribution for a longer period of time. Together these changes add to, or subtract from, the overall 'attractiveness' of Auckland due to health services.

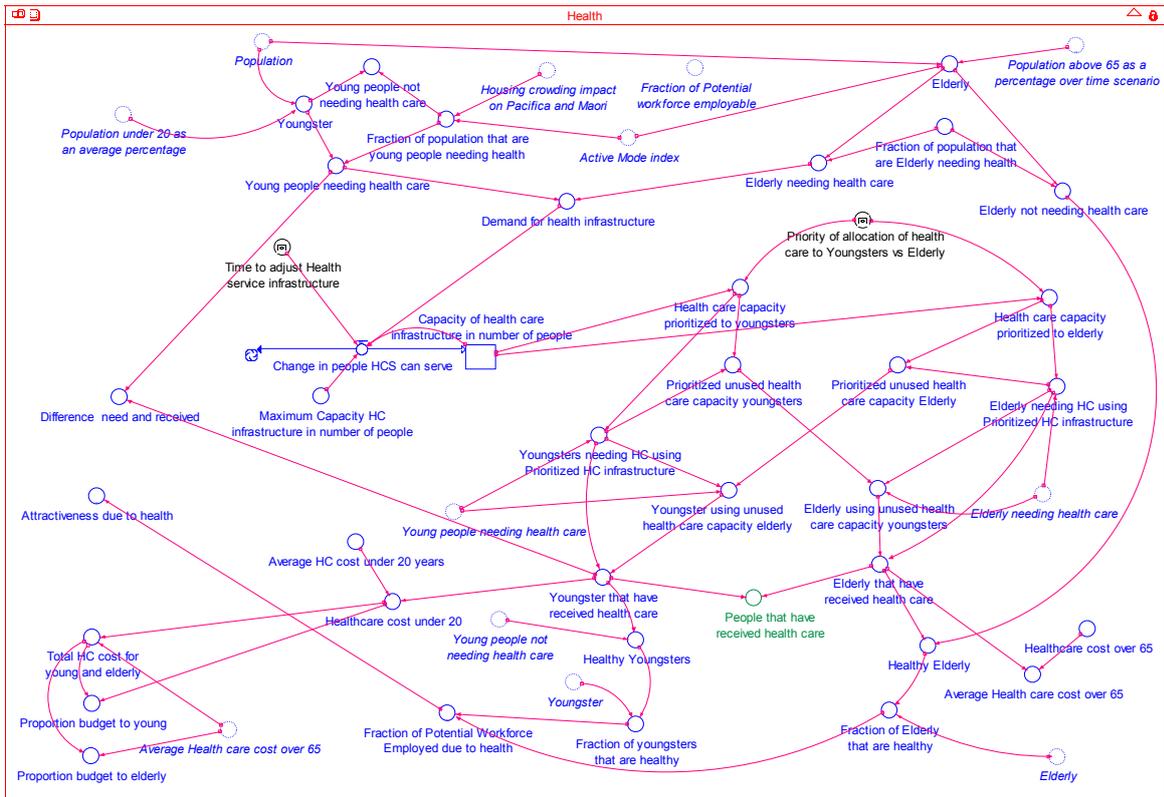


Figure 116: Sector Health

## Sector Land Use and Natural Capital

Population causes urbanisation and terrestrial natural capital is therefore over time converted to urban area and infrastructure (Figure 119). It is assumed in the modelling that when urban area is created, open spaces such as sports fields are incorporated in the urban design and the whole metropolitan urban area (MUA, equation 15) is zoned to be within a certain size limit.

$$\begin{aligned}
 \text{Metropolitan\_Urban\_Area\_and\_Infrastructure\_in\_km2}(t) = & \quad (15) \\
 \text{Metropolitan\_Urban\_Area\_and\_Infrastructure\_in\_km2}(t - dt) + & \\
 (\text{Conv\_TNC\_to\_Urban} + \text{No\_Conversion} - \text{Conv\_Urban\_to\_Open\_Urban}) * dt &
 \end{aligned}$$

INITIAL VALUE: 450 {Km<sup>2</sup>}

In addition to terrestrial natural capital being depleted due to urbanisation, it is also reduced by stressor pressure. Terrestrial natural capital can also be restored at a certain rate but restoration involves a significant time lag and it requires active governance. Base on the input of expert participants this model

assumes that it takes longer to restore ecosystems than to degrade ecosystems with stressor pressure. Terrestrial natural capital is conceptualised as a stock based on the following equation:

$$\begin{aligned}
 \text{Terrestrial\_natural\_capital\_in\_km2}(t) &= \text{Terrestrial\_natural\_capital\_in\_km2}(t - dt) \quad (16) \\
 &+ (- \text{Conv\_TNC\_to\_Urban} - \text{Convert\_TNC\_to\_Open\_Urban\_Spaces} - \\
 &\quad \text{Net\_Rate\_Natural\_Capital}) * dt \\
 \text{INITIAL VALUE: } &800 \{ \text{Km}^2 \}
 \end{aligned}$$

There are other forms of natural capital included in the model, such as, sea grass beds which provide critical habitat for fish and attenuate the impacts of storms. These provide benefits to people and are also classed as ecosystem services.

Many types of natural capital add to supply of ecosystem services (see equation 17) but urban areas put stress on nearby ecosystems (Figure 117) which impacts, with a time lag, on the way ecosystems function (see equation 18). Reduced functioning impacts the supply of ecosystem services and benefits.

$$\begin{aligned}
 \text{Supply\_of\_Ecosystem\_Services} &= (\text{Seagrass\_beds\_in\_km2} + \quad (17) \\
 &\text{Sea\_Natural\_Capital\_in\_km2} + \text{Open\_Urban\_Spaces\_in\_km2} + \\
 &\text{Other\_area\_in\_human\_production\_in\_km2} + \text{Terrestrial\_natural\_capital\_in\_km2} \\
 &+ \text{Mangroves}) / (\text{Seagrass\_beds\_in\_km2} + \text{Sea\_Natural\_Capital\_in\_km2} + \\
 &\quad \text{Metropolitan\_Urban\_Area\_and\_Infrastructure\_in\_km2} + \\
 &\text{Open\_Urban\_Spaces\_in\_km2} + \text{Other\_area\_in\_human\_production\_in\_km2} + \\
 &\quad \text{Terrestrial\_natural\_capital\_in\_km2} + \text{Mangroves} + \\
 &\quad \text{Metropolitan\_Urban\_Area\_and\_Infrastructure\_in\_km2}) * \\
 &\quad \text{Ecosystem\_Functioning\_Indicator} \{ \text{Dimensionless} \}
 \end{aligned}$$

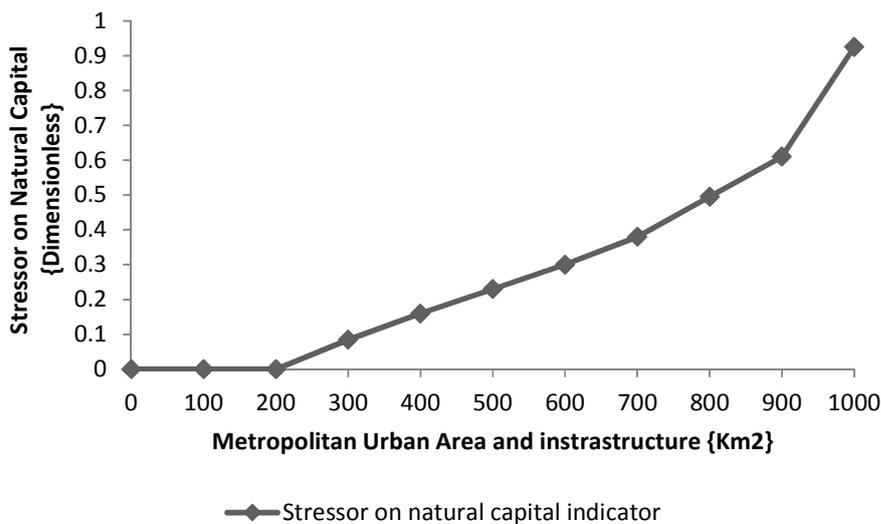
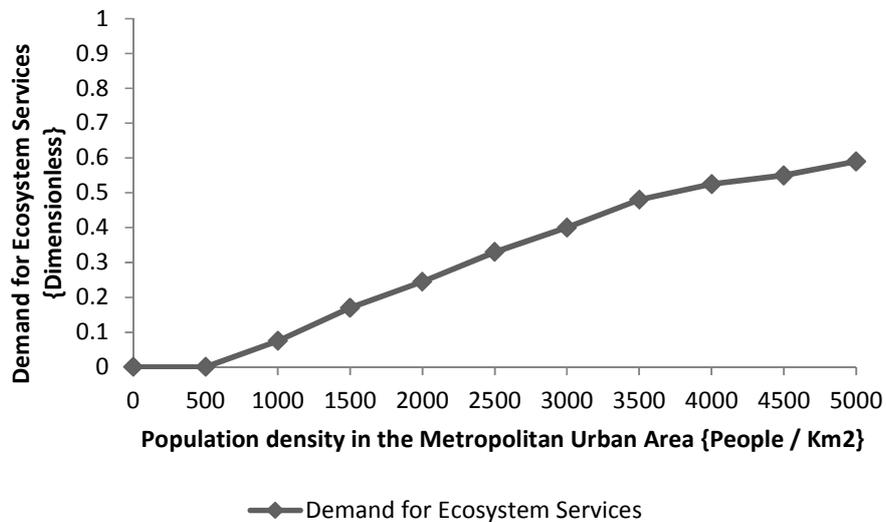


Figure 117: The effect the metropolitan urban area has as a stressor on natural capital

$$\begin{aligned}
 \text{Ecosystem\_Functioning\_Indicator} = & \text{DELAY}((1- \\
 & \text{Stressors\_on\_Natural\_Capital\_indicator}), \\
 & \text{Urban\_Impact\_on\_Ecosystem\_time\_lag})
 \end{aligned}
 \tag{18}$$

We have assumed that an increased density of population in the metropolitan urban area leads to an increase in demand for ecosystem services, such as recreation. A next step in the research could be to look at the various demand profiles of ethnic groups for ecosystem services and determine if there are ethnic differences. For example, is location proximity to natural capital important or does the perception of what counts as natural capital differ between ethnic groups?



**Figure 118: Demand for ecosystem services as a function of population density in the Metropolitan Urban Area**

Finally, the match between demand and supply for ecosystem services determines the ‘attractiveness’ of the Auckland region based on natural capital and ecosystem services.

$$\begin{aligned}
 \text{'attractiveness'_{due\_to\_benefits\_derived\_from\_Ecosystem\_Services}} = & \\
 \text{MAX(Supply\_of\_Ecosystem\_Services-Demand\_for\_Ecosystem\_Services, 0)} &
 \end{aligned}
 \tag{19}$$

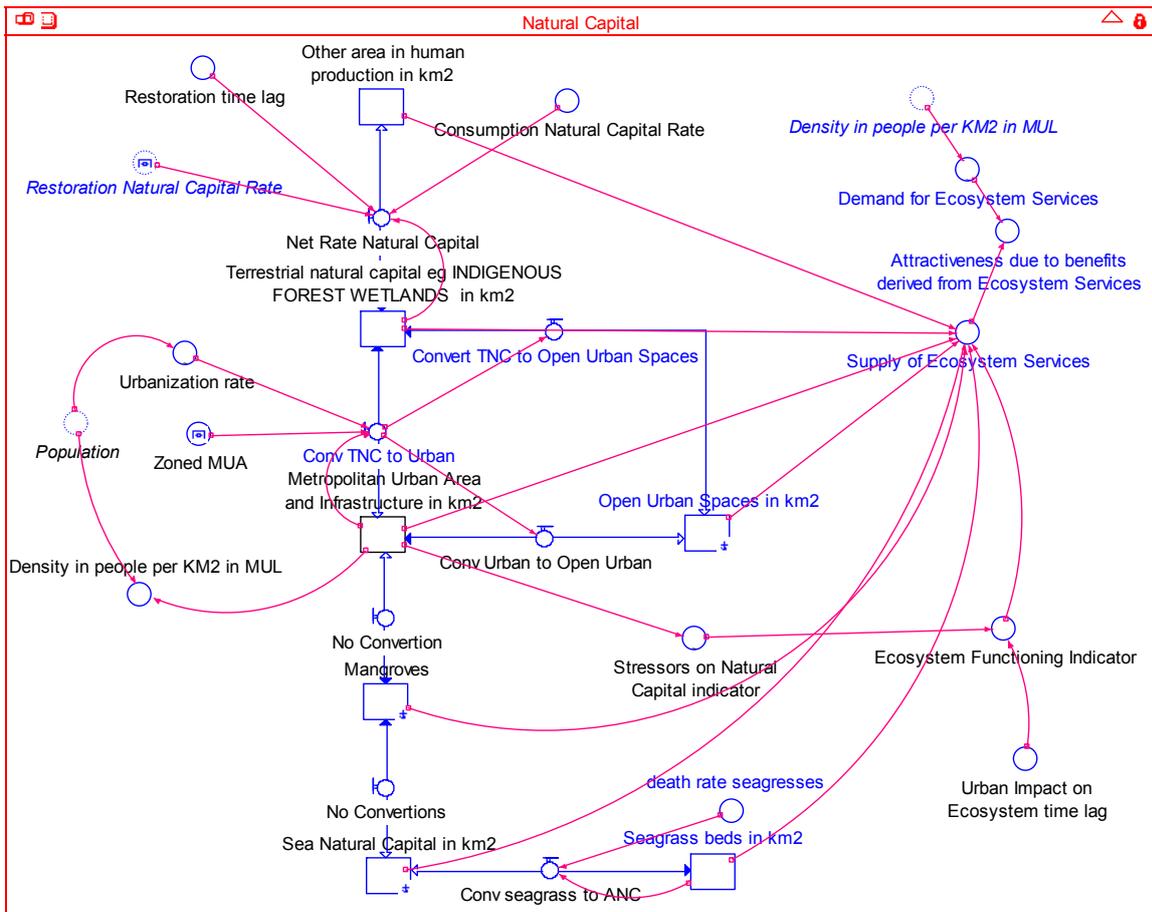
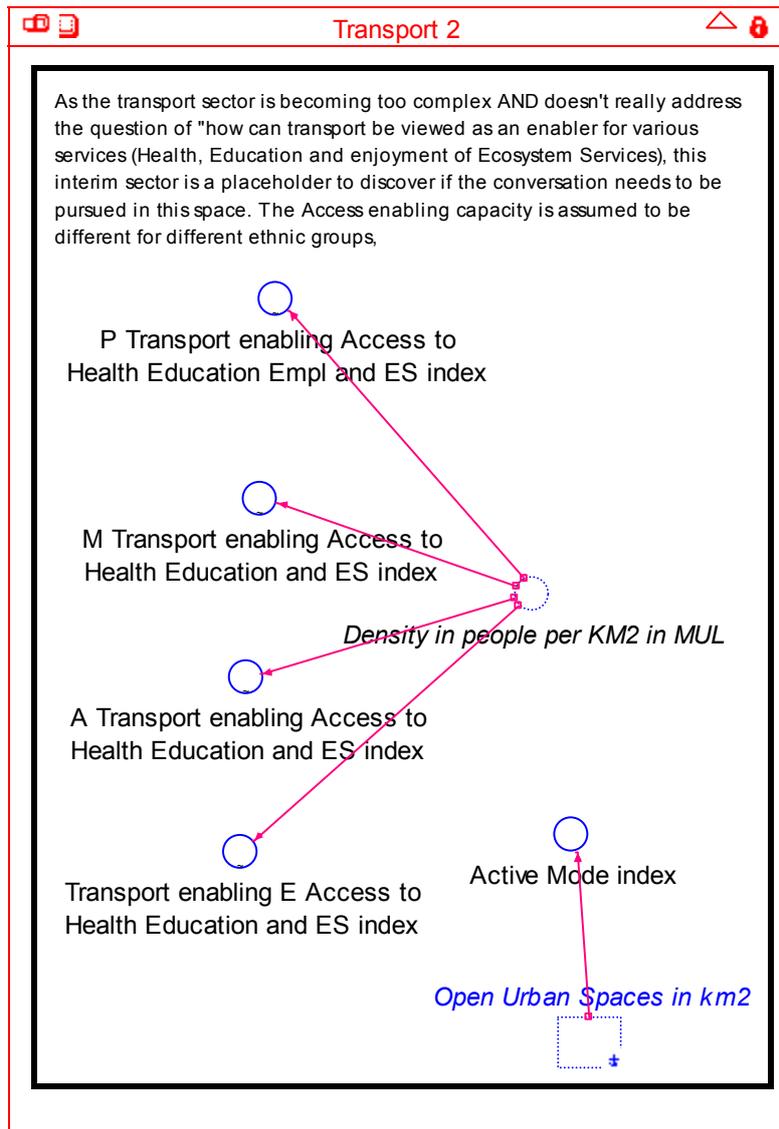


Figure 119: Sector Land Use and Natural Capital

## Sector Transport

The transport sector turned out to be very small (Figure 120) because a full scale transport model is very complex and it was felt it would not address the key question of interest for participants which was ‘how does transport provide access to health, education and ecosystem services?’ In this sector it is assumed that: 1) open spaces in urban areas add to the active mode (walking, biking) of transport (i.e., active is a transport mode along with public, private and perhaps freight), and 2) population density in the metropolitan urban area affects accessibility of education, health, employment and ecosystem services (not all yet included in the current version of the model).



**Figure 120: Sector Transport**

## Sector Social

The Social sector (Figure 122) is linked in through population density which leads to crowding in housing. This relationship is illustrated in Figure 121.

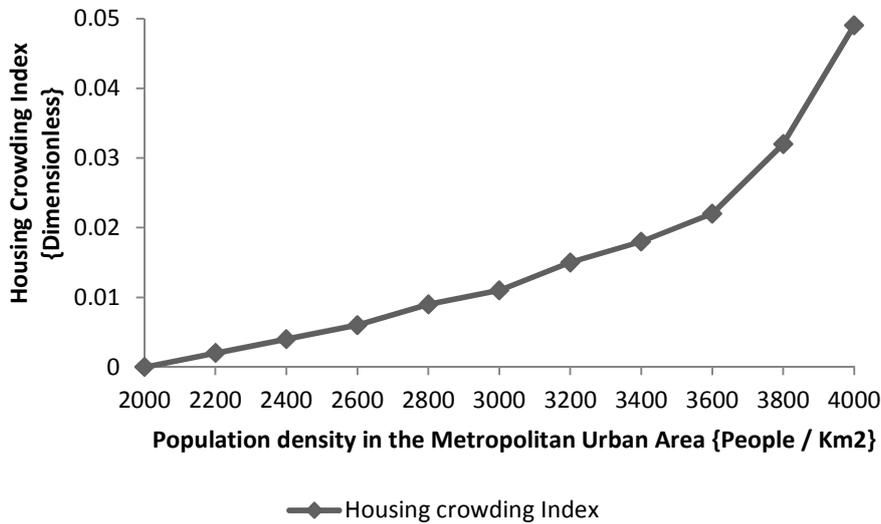


Figure 121: Crowding in housing as a function of the population density in the Metropolitan Urban Area

In the model a higher rate of house crowding is assigned to Maori and Pacifica (see equation 20) than Asians and Europeans (see equation 21). This is simply assumed to test the structure and linkages. In reality there is more detail to this link including distribution within ethnic groups, however, there is no proxy or information available. The next step should be to agree on definitions and ways to create proxy information to refine the model structure.

$$\text{Housing\_crowding\_impact\_on\_Pacifika\_and\_Maori} = \text{Housing\_crowding\_index} \quad (20)$$

$$\text{Housing\_crowding\_impact\_on\_Asians\_and\_Europeans} = \text{Housing\_crowding\_index} / 2 \quad (21)$$

Crowding (and quality) of housing impact on educational achievements in different ways depending on ethnic group. However, the difference in educational achievements may also be explained by the school system and/or access to the school system.

Poverty and crime were mentioned during the dialogue, but have not been included in the model.

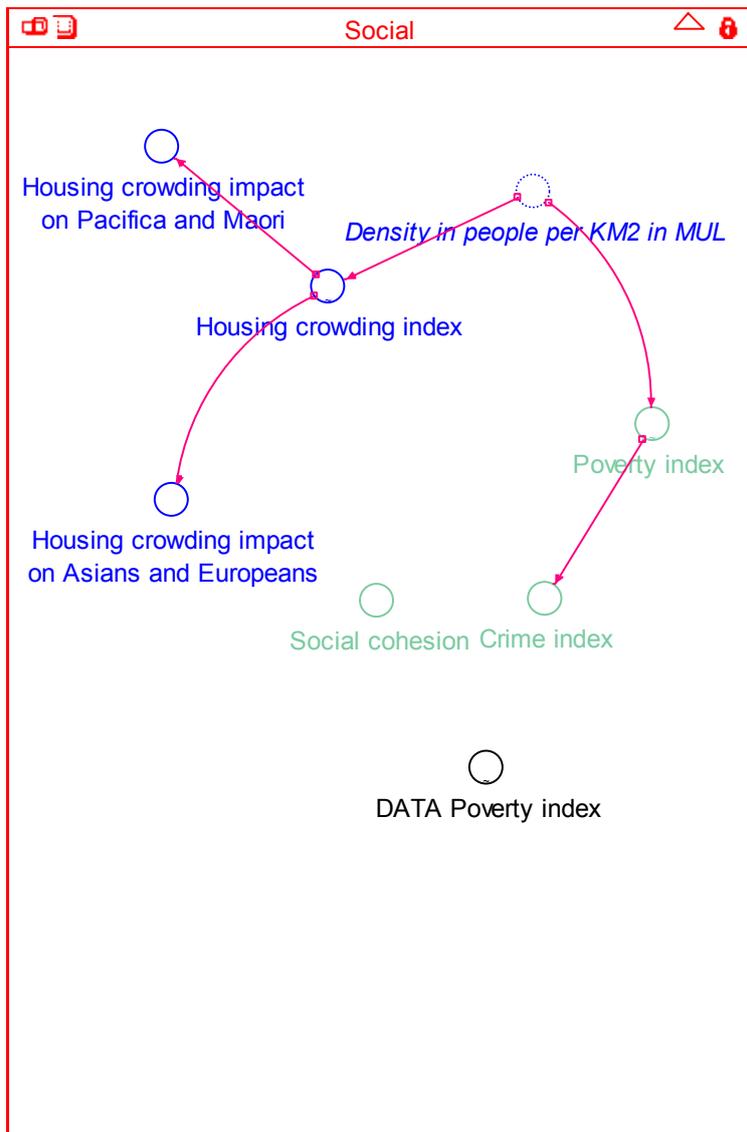


Figure 122: Sector Social

## Sector Government or Policy solutions

This sector groups all governance and policy solutions that can be tested through the model (Figure 123). At the moment, some of them are just placeholders. The ones that work are: 1) restoration rate of natural capital, 2) zoned metropolitan urban area, and 3) time to adjust health care service infrastructure (to demand for health care), 4) priority of allocation of health care to children versus elderly, and 5) time to adjust the number of schools (to the demand for schools).

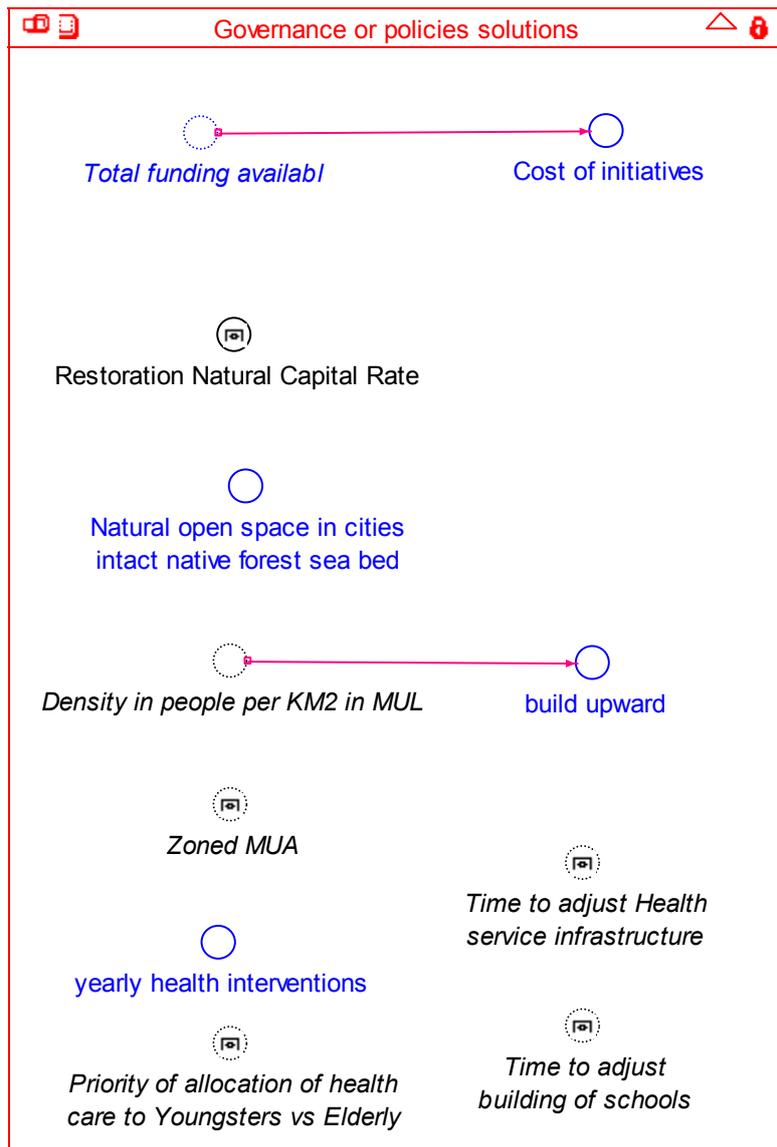


Figure 123: Sector Government or Policy solutions

## Sector External Factors

Factors external to the region are flagged, but not actively pursued, except for 1) Climate Change causing additional Pacifica immigration (see equation 2) and 2) scenarios related to the relative employment in the Auckland region (Figure 124). The latter compares unemployment in the Auckland region with unemployment outside its region.

Other external issues flagged during the mediated modelling workshop discussions were 1) ecosystem functioning outside the Auckland region, 2) water and power supply to the region, and 3) the global financial crisis. Comparative "systemic behaviour" could be introduced into the model by, for instance, weighting the availability of ecosystem functioning and service supply with similar levels abroad or in other New Zealand regions.

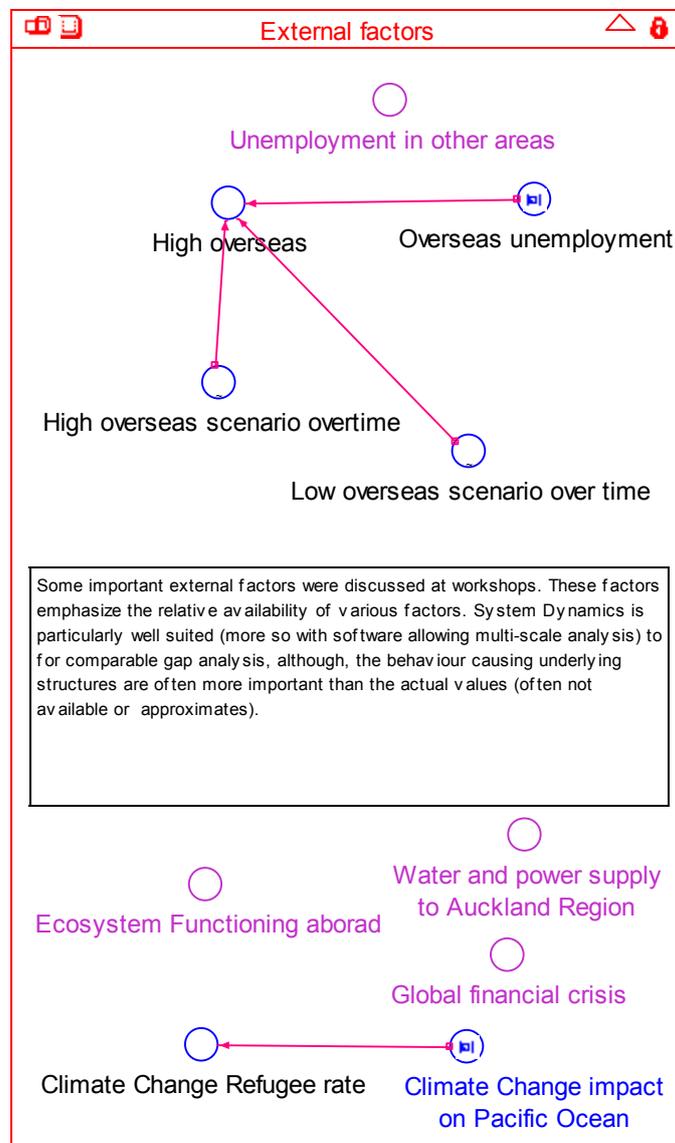


Figure 124: Sector External Factors

## List of figures

Figure 1: Workshop feedback on context and process .....	9
Figure 2: Workshop feedback on tools.....	10
Figure 3: Appropriateness of issues addressed during MM workshops .....	10
Figure 4: Creative tension between now, future and how to get there.....	11
Figure 5: Rating of group characteristics during workshops .....	12
Figure 6: Reflections on MM workshops.....	12
Figure 7: Reflection on Causal Loop Diagram .....	13
Figure 8: Reflection on the model.....	14
Figure 9: Reflection on capacity of tools to support ‘story telling’ .....	14
Figure 10: SP2 website visitation .....	16
Figure 11: Topic according to partial participants.....	17
Figure 12: Preliminary Causal Loop Diagram of Auckland regional dynamics, presented at workshop1 ..	20
Figure 13: Causal Loop Diagram of Auckland regional dynamics, presented at workshop 2.....	20
Figure 14: Final Causal Loop Diagram of Auckland regional dynamics, presented at workshop 3.....	22
Figure 15: User-interface.....	23
Figure 16: Simulation results for population in the Auckland region for five different scenarios related to the question of “what if projected population growth and associated ethnic diversity happens, how does this affect ‘attractiveness’ of Auckland”. The runs are: (1) a base run, (2) climate change impacting on Pacifika, (3) immigration to the Auckland region for education, (4) immigration to the Auckland region because of its overall ‘attractiveness’, and (5) an increased Maori birth rate (6% instead of 5% of the Maori population). .....	26
Figure 17: Simulation results for the ratio of Pacifika in the Auckland region for five different scenarios related to the question of “what if projected population growth and associated ethnic diversity happens, how does this affect ‘attractiveness’ of Auckland”. The runs are: (1) base run, (2) climate change impacting on Pacifika, (3) immigration to the Auckland region for education, (4) immigration to the Auckland region because of its overall ‘attractiveness’, and (5) an increased Maori birth rate (6% instead of 5% of the Maori population). .....	26
Figure 18: Simulation results for the ratio of Maori in the Auckland region for five different scenarios related to the question of “what if projected population growth and associated ethnic diversity happens, how does this affect ‘attractiveness’ of Auckland”. The runs are: (1) base run, (2) climate change impacting on Pacifika, (3) immigration to the Auckland region for education, (4) immigration to the Auckland region because of its overall ‘attractiveness’, and (5) an increased Maori birth rate (6% instead of 5% of the Maori population). .....	27

Figure 19: Simulation results for the ratio of Asians in Auckland region for five different scenarios related to the question of “what if projected population growth and associated ethnic diversity happens, how does this affect ‘attractiveness’ of Auckland”. The runs are: (1) base run, (2) climate change impacting on Pacifika, (3) immigration to the Auckland region for education, (4) immigration to the Auckland region because of its overall ‘attractiveness’, and (5) an increased Maori birth rate (6% instead of 5% of the Maori population). .....	27
Figure 20: Simulation results for the ratio of Europeans (and everybody else) in the Auckland region for five different scenarios related to the question of “what if projected population growth and associated ethnic diversity happens, how does this affect ‘attractiveness’ of Auckland”. The runs are: (1) base run, (2) climate change impacting on Pacifika, (3) immigration to the Auckland region for education, (4) immigration to the Auckland region because of its overall ‘attractiveness’, and (5) an increased Maori birth rate (6% instead of 5% of the Maori population). .....	28
Figure 21: Simulation results for the ‘attractiveness’ of the Auckland region for five different scenarios related to the question of “what if projected population growth and associated ethnic diversity happens, how does this affect ‘attractiveness’ of Auckland”. The runs are: (1) base run, (2) climate change impacting on Pacifika, (3) immigration to the Auckland region for education, (4) immigration to the Auckland region because of its overall ‘attractiveness’, and (5) an increased Maori birth rate (6% instead of 5% of the Maori population). .....	28
Figure 22: Fraction of youngsters that is healthy for (1) the baseline and (2) more health care to elderly .....	29
Figure 23: Fraction of elderly that is healthy for (1) the baseline and (2) more health care to elderly .....	30
Figure 24: Metropolitan Urban Area Infrastructure when (1) 563 km <sup>2</sup> (= base run) and (2) 800 km <sup>2</sup> is being zoned .....	31
Figure 25: Population when (1) 563 km <sup>2</sup> (= base run) and (2) 800 km <sup>2</sup> is being zoned .....	31
Figure 26: ‘Attractiveness’ of the Auckland region due to Ecosystem Services when (1) 563 km <sup>2</sup> (= base run).....	32
Figure 27: Open urban spaces when (1) 563 km <sup>2</sup> (= base run) and (2) 800 km <sup>2</sup> is being zoned.....	32
Figure 28: Stressors on natural capital when (1) 563 km <sup>2</sup> (= base run) and (2) 800 km <sup>2</sup> is being zoned ...	33
Figure 29: Terrestrial natural capital when the restoration rate of natural capital equals (1) 0.02 (baseline) and (2) 0.1 .....	33
Figure 30: The results for the variable “Other area in human production” when the restoration rate of	34
Figure 31: ‘Attractiveness’ of the Auckland region due to ecosystem services when the .....	34
Figure 32: Fixes that Fail example for Auckland .....	44
Figure 33: CLD based on interviews .....	45
Figure 34: CLD based on Spatially Dynamic Model for Auckland.....	47

Figure 35: Overview of STELLA sectors after day 1 .....	49
Figure 36: Provides an example of Stella modelling. This population module reflects participants desire to include the various ethnic groups and associated birth/death and migration rates. ....	50
Figure 37: Model Progression .....	64
Figure 38: My issue was addressed during the workshops .....	72
Figure 39: My issue was part of the integrated picture that has emerged through the workshops .....	72
Figure 40: My views on my issue have been modified through the mediated modelling workshops.....	73
Figure 41: My issue can benefit from an extended mediated modelling process.....	73
Figure 42: An appropriate topic for the Auckland Region .....	73
Figure 43: The long term goal/vision for the Auckland Region.....	73
Figure 44: The implementation process toward future goals/vision for the Auckland Region.....	74
Figure 45: Reflecting on the discussion during the mediated modelling workshops, please rank the relative importance of the 4 aspects of well-being for the stakeholder group you represent. Rank in order of priority for your stakeholder group.....	74
Figure 46: Please rank the relative importance by which each of the 4 aspects of well-being was discussed in the mediate modelling workshops.....	75
Figure 47: Inclusiveness: i.e. the level of inclusiveness of different perspectives .....	75
Figure 48: Long Term Time Preference: i.e. a strategic, long term emphasis.....	75
Figure 49: Leadership: i.e. the ideas developed in this group will be implemented.....	76
Figure 50: Creativity: i.e. this group developed innovative ideas .....	76
Figure 51: With how many of the participants do you intend to interact on a regular basis in the future? .....	76
Figure 52: My expectations about the workshops were met.....	77
Figure 53: The mediated modelling workshops helped in structuring the thinking .....	77
Figure 54: The mediated modelling workshops helped in structuring the discussion.....	77
Figure 55: I discovered more linkages with other sectors and stakeholders than before the workshops.	77
Figure 56: The model progressed significantly over the three workshops .....	78
Figure 57: My concerns were addressed during the dialogue at mediated modelling workshops .....	78
Figure 58: The causal loop diagram represents well the problem the group set out to investigate .....	78
Figure 59: This causal loop diagram is a good representation of the group discussions .....	78
Figure 60: I contributed to the design of this causal loop diagram.....	79

Figure 61: This causal loop diagram is of enough interest to show to others .....	79
Figure 62: This causal loop diagram is a helpful tool for me in communicating problems facing the Auckland Region to others .....	79
Figure 63: It is useful to continue developing the causal loop diagram.....	79
Figure 64: I will use this causal loop diagram to explain issues to others .....	80
Figure 65: The model addresses the problems identified during the workshops .....	80
Figure 66: The model behaved logically when running scenarios .....	80
Figure 67: I have faith in the results of the simulation model.....	81
Figure 68: The model is an acceptable representation of the current dynamics of the Auckland Region	81
Figure 69: I learned about the dynamics of the Auckland Region .....	81
Figure 70: The current model can be used as a decision support tool for the Auckland Region .....	81
Figure 71: I will show this model to others.....	82
Figure 72: I could follow the stories that were presented to me during the workshops.....	82
Figure 73: Storytelling helped me understand the causal loop diagram .....	82
Figure 74: Storytelling is a helpful tool for me in communicating problems facing the Auckland Region to others.....	83
Figure 75: I intend to tell the developed story in the CLD to others.....	83
Figure 76: I intend to tell the developed story in the Stella model to others .....	83
Figure 77: Running the scenario was insightful .....	84
Figure 78: Additional scenarios with the current model will be insightful.....	84
Figure 79: Improvement of the simulation model is required to generate insightful scenarios.....	84
Figure 80: How many times have you visited the project website .....	86
Figure 81: My issue was addressed during the workshops .....	87
Figure 82: My issue was part of the integrated picture that has emerged through the workshops .....	87
Figure 83: My views on my issue have been modified through the mediated modelling workshops.....	88
Figure 84: My issue can benefit from an extended mediated modelling process. ....	88
Figure 85: Did not see the process going anywhere useful.....	88
Figure 86: Do not have confidence in the model outcomes.....	88
Figure 87: The topic was too broad.....	89
Figure 88: The topic was not relevant to me .....	89
Figure 89: Do not see 'integration' as an issue for my organisation.....	89

Figure 90: The appropriate stakeholders were missing .....	89
Figure 91: Prefer to work in own sphere of influence.....	90
Figure 92: Did not like workshops in general.....	90
Figure 93: Did not like this particular workshop structure .....	90
Figure 94: The time commitment required versus other work priorities is too high.....	90
Figure 95: The system dynamics model is too technical for me to use with ease so it is not useful as a tool for me/my organisation .....	91
Figure 96: Process is too academic rather than practical.....	91
Figure 97: There are too many uncertainties associated with the future to make it worthwhile spending time on scenarios.....	91
Figure 98: Systems thinking does not help me do my job.....	91
Figure 99: Linkages with other organisations are not critical enough to my job to sustain interest.....	92
Figure 100: My expectations about the workshops were met.....	93
Figure 101: The mediated modelling workshops helped in structuring thinking about issues of concern in the Auckland region. ....	93
Figure 102: The mediated modelling workshops helped in structuring the discussion. ....	93
Figure 103: I discovered new linkages with other sectors and stakeholders than before the workshops. ....	93
Figure 104: The model progressed significantly over the workshops I was involved in .....	94
Figure 105: My concerns were addressed during the dialogue at mediated modelling workshops. ....	94
Figure 106: Sector overview of the Auckland regional model .....	97
Figure 107: Fit for population of the Pacifika between model generate data and historic data.....	98
Figure 108: Fit for population of the Maori between model generate data and historic data. ....	99
Figure 109: Fit for population of the Asians between model generate data and historic data.....	99
Figure 110: Fit for population of the Europeans (and everybody else) between model generate data and historic data.....	100
Figure 111: Sector Population and Ethnic Groups .....	101
Figure 112: Fit for unemployment rate between model generate data and historic data. ....	102
Figure 113: Sector Employment Economics ‘attractiveness’ and Funding.....	103
Figure 114: The effect of crowding on NCEA results of the different ethnic groups .....	105
Figure 115: Sector Education .....	106

Figure 116: Sector Health .....	108
Figure 117: The effect the metropolitan urban area has as a stressor on natural capital .....	109
Figure 118: Demand for ecosystem services as a function of population density in the Metropolitan Urban Area .....	110
Figure 119: Sector Land Use and Natural Capital.....	111
Figure 120: Sector Transport .....	112
Figure 121: Crowding in housing as a function of the population density in the Metropolitan Urban Area.....	113
Figure 122: Sector Social.....	114
Figure 123: Sector Government or Policy solutions.....	115
Figure 124: Sector External Factors.....	116

## **List of tables**

Table 1: Auckland MM workshop attendance .....	7
Table 2: Relative importance of 4 aspects of well-being .....	11

## REFERENCES

- Couclelis, H. (2005). "Where has the future gone?" Rethinking the role of integrated land use models in spatial planning. *Environment and Planning A* 37: 1353-1371.
- Feeney, C. (2010) Integrated Catchment Management – a review of literature and practice. Report for the Ministry for the Environment prepared by Clare Feeney Environmental Communications Ltd.
- Fenemor, A., Neilan, D., Allen, W., Russell, S. (2011) "Improving Water Governance in New Zealand stakeholder views of catchment management processes and plans", in *Policy Quarterly* – Volume 7, Issue 4 – November 2011
- Morecroft, J. (2007) *Strategic Modelling and Business Dynamics: A Feedback Systems Approach*. Wiley, UK.
- Sterman, J. (2000) *Business Dynamics Systems Thinking and Modeling for a Complex World*. Irwin McGraw-Hill, USA
- van den Belt, M. (2011) *Integrated Freshwater Solutions: a case study of the Manawatu River, New Zealand*. AWRA 2011 Summer Specialty Conference on Integrated Water Resources Management: The Emperor's New Clothes or Indispensable Process. June 27-29, Snowbird, Utah, USA.
- Wadsworth, Y. (1997) *Everyday Evaluation On The Run*. 2nd edition, 1997, Allen & Unwin.