Social Capital and Health: Preliminary Work On a System Dynamics 'Concept Model'

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Health disparity is identified as a public issue. A short review of literature in public health and sociology is used to create a conceptual framework for discussing disparity. Work in progress on a small System Dynamics model based on the framework is outlined. The model may be useful for discussing the extent to which civic action can address health disparities.

Introduction

This discussion presents work in progress identifying concepts from sociology and system dynamics that might help structure public discussions about health disparities. The aim of the project is to create a generic framework that both captures the essential features of each case and allows comparisons among populations.

The concept of social capital is current in discussions of population health status. High social capital has been associated with good population health and strategies to reduce health disparities. Others criticise references to social capital because the concept is poorly defined, it shifts attention from public health policies to community and household activities, and it implicitly assumes capitalist economics and rational action theory. The discussion has been summarised by Blaxter (2004:117-121).

Both arguments seem to have merit. Citizens can assess the relative merits if we can discuss and share our understandings of the features of social structure that affect health. This type of discussion is problematic for many reasons including differences of language, experience, commitments and power. This paper does not review the wider aspects; it has the limited objective of exploring the use of system dynamics (SD) in deliberative discussions.

The sections that follow: briefly describe a context for the issue; propose a general cause of health disparity (Wilkinson, 2000; Wilkinson, 2005); summarise some social theory that seems relevant (Runciman, 1989; Coleman, 1990; Runciman, 1999); reviews relevant work by SD modellers; and speculates about the application of this material.

Local setting

By New Zealand (NZ) standards the Porirua Basin is geographically divided between high and low deprivation areas (Crampton et al., 2000) (see Appendix). The population of the area shown in the Appendix is about 62,000; approximately 50,000 people live in Porirua City. The main point is the relatively high contrast between the neighbourhoods shown in green (low deprivation) and

those in red (high deprivation). The administrative boundary of the City is at the south end of the areas shown in red. The position of the boundary is indicative of the political dynamics in the Basin. The implications of these indicators for relative health and health services have been documented over the last three decades (Salmond, 1975; Reinken et al., 1980; Gould, 1992; Central Regional Health Authority, 1994; National Research Bureau Ltd, 1994; Porirua City Council, 1999; Porirua Kapiti Healthlinks Project, 2000).

Recently 'health disparity' has been defined as a national public issue. Conceptually discussion of 'health disparities' in NZ follows a similar course to that in the United Kingdom, the United States, the World Health Organisation, and the European Union. The distinctive difference is that Maori (the indigenous people of NZ) and Pacific people (migrants from Pacific nations or their descendants) are the main ethnic populations identified as adversely affected by disparity. Recent legislation, policy frameworks and substantial research programmes have shaped the responses. For example the NZ Public Health and Disability Act 2000 s.22(f) directs District Health Boards to 'to reduce, with a view to eliminating, health outcome disparities between various population groups within New Zealand by developing and implementing, in consultation with the groups concerned, services and programmes designed to raise their health outcomes to those of other New Zealanders.' This illustrates two features of current policy: ambitious objectives and localised responses – localised both geographically and within the health sector (Director-General of Health, 1997b; 1997a; Ministry of Health, 2002)].

This approach has produced a series of initiatives to improve access to community health services in high deprivation areas, particularly reorganisation of primary health services and development of an integrated continuum of care. Local participation in health issues has been reviewed. The City Council included improved health status among its strategic goals; previously health was regarded as the sole responsibility of central government. There was local mobilisation to retain and improve local health services, particular re-thinking the role of the community hospital as a hub for integrated care. There have been instances of 'clustering' to create local capacity across the public health spectrum. This was intended to introduce 'common cause' into the activities of health professionals and interested members of communities by creating social capital (Williams, 1997b) and offset the limiting effects of competitive tendering with government agencies and tightly defined programme delivery.

This has evolved into a proposal to create a Centre of Excellence (Blakeley, 2006) with a major goal 'to eliminate disparities in health status'. This is a substantial attempt to create the local infrastructure required to address this issue and sharpens questions about feasible strategies and system design. Communities adversely affected by disparity have not engaged with the process. The most recent report on the topic concludes current processes are 'too hard'. Energy is reduced by 'mistrust and tension', 'views that have gone unchallenged', 'communities passive in seeking advice', and the 'relentless' action of organisations (Smith, 2006). Emphasising 'disparities' is probably not going to address those points. The comparisons and imposed indicators implicit in the term are often rejected, similar to responses to naming the issue as 'inequality' (Blaxter, 1997) or 'racism'. There is also a question

of scope; for example to what extent with housing, income and employment be included in the agenda of the Centre? Are those factors to be regarded as indicators or causes?

Health disparities

Wilkinson and Marmot provide a considered explanation of health disparities that reaches similar conclusions to lay 'common sense' about causes of poor health (Cody, 1999:57; Milstein, 2005:17 quoting JM Mann 1999). They have concluded that the social gradient in health (at least in 'developed economies') is due to the distribution of stress created by hierarchies of dominance, social isolation and disorder. The processes that translate social relations into physical effects are probably associated with fight-flight responses. This capacity evolved when the response required was intense, short-lived, and essential for survival. Social conditions have changed over the last 15,000 years and this type of stress has become chronic, particularly for those lower in hierarchies. The effect is, in a sense, physical 'wear and tear' and is reflected in different rates of mortality and chronic disease among stratified populations. Peer relations can offset the impact of dominance to some extent. The framework adopted in the NZ study 'Decades of Disparity' (Williams, 1997a; Fawcett et al., 2006:3) seems to adopt a similar line of argument (see Figure 1).

Both Wilkinson and Marmot reflect on the implications of their position. Their views are repeated here, partly because they are informed commentators and partly because they reflect common responses by commentators seeking to reduce inequality. In an early overview Wilkinson asserted that:

"If it is possible for some people to have death rates as low as those in upper social classes, then it should be possible to achieve equally low death rates in all groups" (Wilkinson, 1996:59).

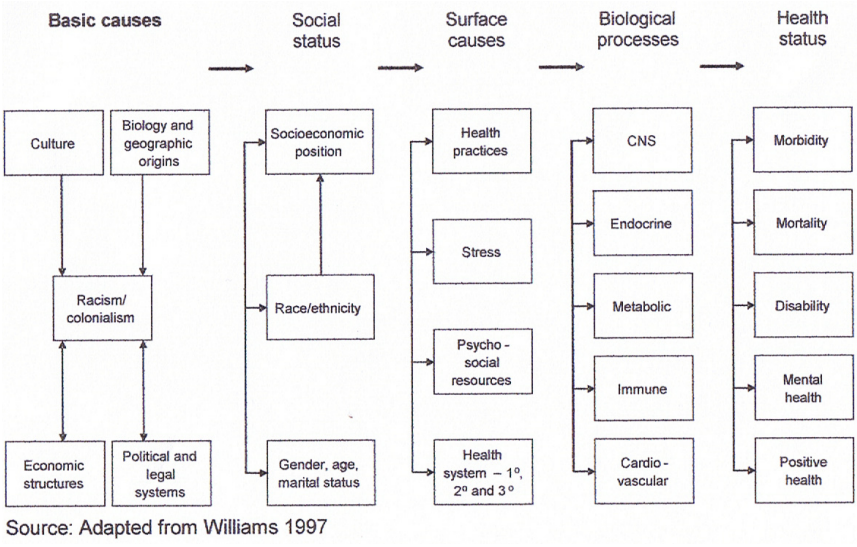

Figure 1 *Health inequalities framework in 'Decades of Disparity'*

Later Marmot takes a different position:

"All societies will have social rankings; ergo all societies will have health gradients… I ask myself if I can envisage a society where all are equal. My answer is not in real life. Hence, health gradients are inevitable." (Marmot, 2004:25)

Further on Marmot seems to shift his position. Firstly he qualifies his comments by introducing a delay:

"There is no reason why the health of today's lowest social group should not, tomorrow, be as good as the health of today's highest group." (Marmot, 2004:255)

But then he concludes:

"There will always be inequalities in society but the magnitude of their effects on health is within our control." (Marmot, 2004:266)

Can sociology help structure a response to questions about the inevitability or necessity of inequalities in health?

Social theory

Dominance, isolation and disorder were identified as the main factors creating inequalities in health status among sub-populations of a society. For these purposes physical stress in taken to be a direct consequence of relatively high effort and risk.

Coleman makes some precise comments about how social capital can be introduced into this discussion. In his use of the concept:

"The power of an actor at equilibrium … is a direct measure of the social capital available to the actor within that system" (Coleman, 1990:315)

And when discussing public policy decisions based on the criterion of efficiency he says:

"The calculation of economic efficiency can be carried out only after a particular distribution of power or resources is taken as given … all persons' benefits and costs are not counted equally." (Coleman, 1990:799)

So social capital is essentially a measure of power and when 'efficiency' is a primary criterion it is likely that those with less power will be required to commit proportionally more effort or resources than those with greater power. Lin outlines some applications of the concept. His contribution provides the basis for distinguishing between 'lateral' relations based on trust or a freely given mandate to exercise authority, and 'vertical' relations when there are structural differences in power (Lin, 2001:Chap 10).

Coleman described the value of the concept of social capital in these terms:

"Whether social capital will come to be as useful a quantitative concept in social science as are the concepts of financial capital, physical capital, and human capital remains to be seen; its current value lies primarily in its usefulness for qualitative analyses of social systems and for those quantitative analyses that employ qualitative indicators." (Coleman, 1990:305-6)

That describes what is being attempted here. Coleman concluded that he had exhausted the potential of linear modelling of social interaction. He anticipated evolutionary modelling would address some of the limitations (Coleman, 1990:931). Turner subsequently indicated how the central element of Coleman's theory (the development of norms) related to his general theories of societal evolution (Turner, 2003:15). Lenski (1966; 2005) provides a link to the other major contemporary contributor to evolutionary sociology, Runciman.

Runciman seems to be the sociologist who has framed the modelling issues most succinctly. He proposes a scheme based on two modes of interaction between institutionalised roles – dominance and co-operation. Unique social configurations emerge from combinations of selection pressures and random variations. The elementary structure of the system is depicted in Figure 2.

This figure represents the three dimensions of power – economic, ideological and coercive – defined in terms of institutionalised roles (Runciman, 1999:71). The depth of the diagram indicates the extent of inequality in the system; roles at the same level can interact laterally. This scheme seems to be generally applicable. For example local discussions are drawn to work through the interactions involved in investing, owning, employing and purchasing.

Sympathetic commentators have noted two particular problems with Runciman's approach. Anderson (1992:218-224) is not convinced that Runciman has adequately defined and applied the concept of 'selection pressure'. That problem is also a feature of the approach outlined here. (See Beinhocker (2006) for an attempt to more specific about this process.)

Carling (2004) points to problems with conflating the orientation of role

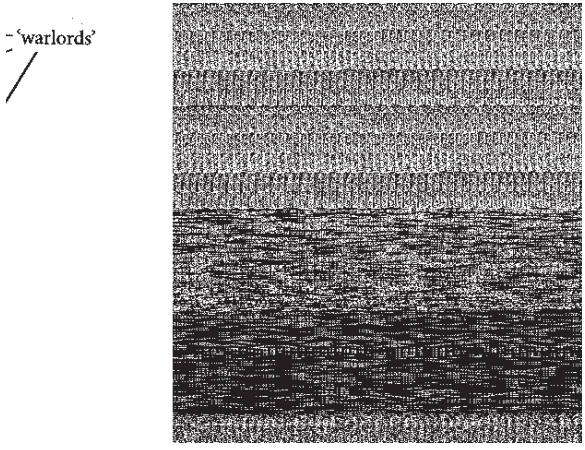

Figure 2 *Runciman's 'device' for visualizing the social space created by power (Runciman, 1999:72)*

holders and the nature of the relation. Taking Carling's point Runciman's scheme has been amended here so that his 'interaction' is interpreted as the 'orientation' of a role. That implies that there are four forms of social capital: cooperation (two co-operators); conflict (two dominators); dominance (a dominator and a co-operator); and an absence (when no combination exists). This is similar to many other schemes, for example the 'boundary relations' identified by Tilly (1998) as the basis of durable inequality, and the cycles of asibya, conflict and imperial dominance that Turchin (2006) identified in the historical dynamics of empires. This framework might provide a basis for sketching a concept model.

System dynamics modelling

Sociologists seem to have made relatively little use of system dynamics models and the weight of opinion favours agent-based modelling (Halpin, 1999; Macy and Willer, 2002; Sawyer, 2003; Cederman, 2005; Gilbert and Abbott, 2005; Gilbert and Troitzsch, 2005). The main examples that informed this project are an early model by Phillips (1972) with Senge, a substantial body of work by Hanneman and colleagues (Hanneman and Collins, 1987; Hanneman, 1988; Jacobsen and Hanneman, 1992; Hanneman, 1995; Hanneman et al., 1995; Collins and Hanneman, 1998), and other work by Jacobsen (1987; 1990; 1995; 1999a; 1999b). The SD literature contains one extended argument suggesting that SD modellers made greater use of social theory, Giddens in particular (Lane, 2001a; 2001b). However there is a great deal of implicit social theory in SD models developed to address issues of public policy, economics and environmental impacts. While this makes models practical and useful to specific users it may constrain the options that can be considered and, in a situation such as this, limit the possibilities that can be considered.

Two sets of SD models are directly relevant to this project. Firstly, cumulative discussions of health service organisation and health outcomes (Koelling and Schwandt, 2005) that has recently address the political dimension of system change (e.g. Hirsch, 2006; McDonnell et al., 2006). Those models are designed for 'decision makers' who are familiar with the sector. For these purposes the models are important because they introduce political factors and have a generic core that can be used with the module outlined below. The core is an 'ageing chain' depicting relative health in a population as flows through levels of those in good health, at risk, afflicted, and afflicted with complications (Homer et al., 2004; Rees, 2005; Homer et al., 2006; McLeroy et al., 2006). The single published SD model that addresses the dynamics of social capital, defined as trust (Dudley, 2004) supplements this set.

Secondly, there are the 'small' and 'concept models' provided by Richardson (Richardson, 2006). Rahn (2005) has drawn on other aspects of Richardson's work (Weaver and Richardson, 2006) to propose an SD representation of a political archetype. The archetype (see Figure 3) consists of two balancing loops oscillating around a threshold. The loops represent constituencies that seek to either lower or raise the value of the threshold.

This project is seeking to establish whether this dynamic can be applied to social structure more generally. If it can it would emulate a form of social theorising advocated by sociologists such as Fararo (1989:72), Mackenzie (2005:57) and Faia (1986; 2002). It also offers the possibility of reducing the complexity of numerous

causal loops and intervening variables that can stifle users' responses (Woog et al., 2006).

An unanswered question at this stage is whether making greater use of the tacit knowledge of participants can offset the loss of detail. The working assumption is that people who are active in their communities develop common sense knowledge that is well grounded. Ford and Sterman (1998) provide a way to introduce this type of knowledge into SD models through structured development of non-linear functions. The wider issue of how tacit knowledge can be elicited from a wide range of participants and organised (Maani and Cavana, 2000; Woog et al., 2006) is not included in this discussion.

Application

Can this selection of concepts be drawn together to structure a systematic response to the local impacts of the issues raised by Wilkinson and Marmot? The following CLD (in Figure 4) takes the Rahn archetype and extends it to include three sources of pressure.

If this has some merit the model could be progressively developed by refining endogenous and exogenous 'selection pressures', bearing in mind Wolstenholme's (2003) distinction between problem and solution archetypes. The stock-flow representation of that CLD model is provided in Figure 5.

The values of the variables are derived by:

- 'Mapping' main institutionalised roles (see Figure 2)
- Estimating current levels (or ratios) of interaction (initial values)
- Estimating 'fitness functions' for each type of interaction.

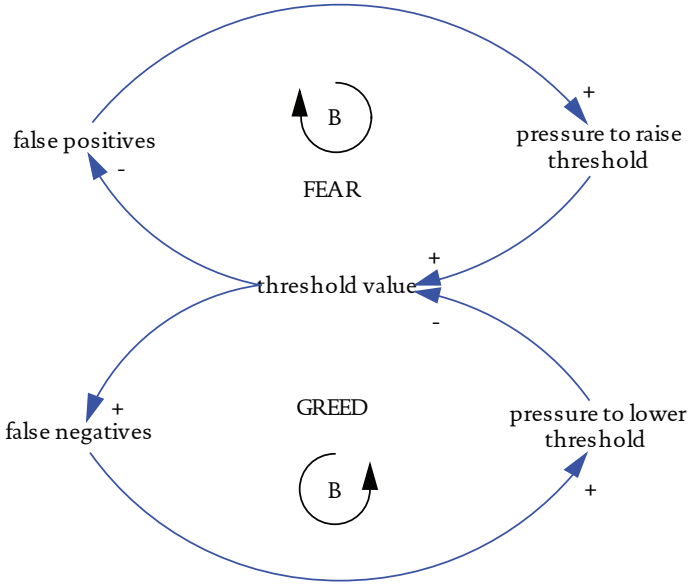

Figure 3 *Rahn's political archetype (Rahn, 2005:6)*

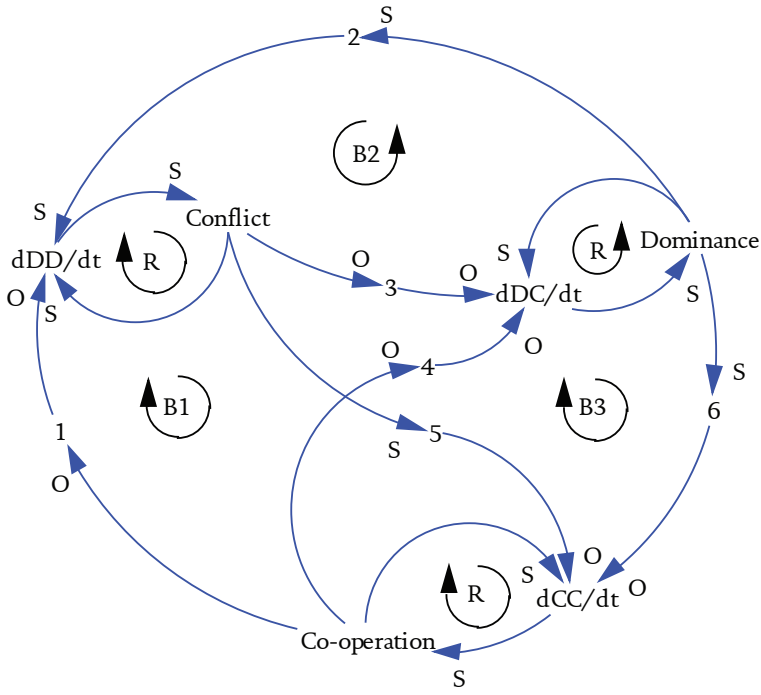

Figure 4 *The basic Causal Loop Diagram for the proposed model*

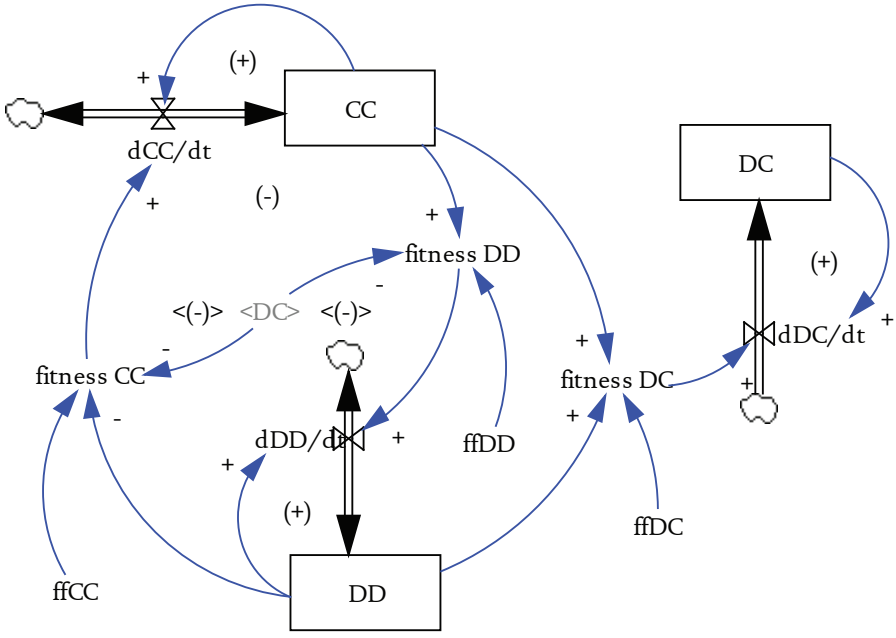

Figure 5 *The Stock-Flow Diagram for the proposed model*

The illustrations here are exaggerated for effect and are produced using linear functions. The reference mode for the model is provided in Figure 6.

The interpretation is that the maximum number of interactions in the system is about 10,000 per iteration. Each iteration is the same time period, between a week and a month. The system oscillates. Current levels are a quarter of the maximum amount with equal proportions of cooperation and dominance. The system is sensitive to conflict, which is actively managed. Cooperation has a tendency to increase when conflict is low. Increasing interaction increases conflict. Dominance rises to contain and conflict and depresses the level of cooperation as well so total interaction falls.

A contrasting scenario is a 'cluster' option that maintains higher levels of interaction with less dominance and conflict is contained.

Conclusion

The discussion outlined the exploratory phase of a project that aims to use system dynamics modelling to represent the composition of social capital. Many issues have not been addressed such as concepts of causality, the varied and changing meaning of variables, and logical implications of a 'genetic' model.

The initial motivation for the study was to develop a structured approach to statements made in public discussion about population-level health disparities. Typically statements have been recorded on paper and written up for reference after the meeting. This restricts consideration of the implications and seems to lead to a premature sense of consensus or, alternatively, argument on poorly defined issues and options. System Dynamics modelling might contribute to more deliberative public discussion.

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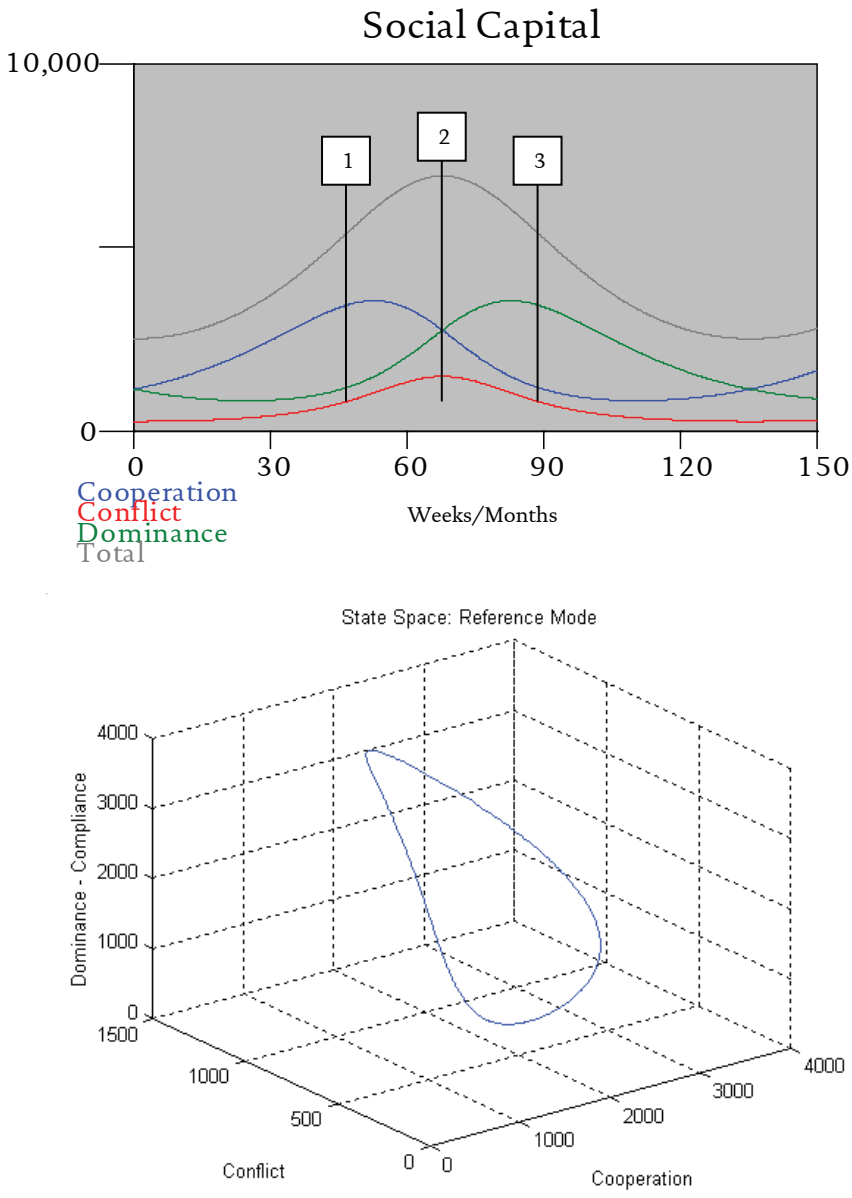

Figure 6 *Reference mode - behaviour over time and state-space graphs*

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Appendix 1: The Porirua Basin showing relative deprivation for small areas