Resilient cities and lost opportunities: the case of transport funding in New Zealand

Stephen Knight-Lenihan
School of Architecture and Planning, University of Auckland

Abstract: Resilience can be seen as a measure of how well systems return to equilibrium after a shock, how well they withstand on-going strains, and/or how a system might shift to a new set of conditions. Objectives could be to protect infrastructure and governance systems, or ecosystems, or both. The growing sophistication of resilience assessment could help cities identify both desired and unwanted outcomes. However, resilience is variably and often narrowly defined in national and local strategic or policy documents. This paper uses the example of New Zealand's national transport funding policy and allocation processes to demonstrate how an unreflective use of the term resilience results in lost opportunities to pursue a low carbon future, and works against the concept of resilience itself. Resilience does not guarantee optimal outcomes. But if national and local governments increasingly use the term, they should be required to demonstrate an understanding of the implications of its application.
Keywords: climate change, adaptation, mitigation, resilience, transport

Introduction

The objective of this paper is to explore how the term *resilience* is used at a policy and planning implementation level. The contention is that using the term in a particular sense ignores more sophisticated and useful interpretations of what resilience means. Consequences include missed opportunities in terms of identifying a full range of realistic policy options. As argued in this paper, this may result in reducing rather than enhancing resilience.

Policy formulation for land transport funding in New Zealand and consequent contributions to the risk of climate change is used as the case study. Central government's approach to the other side of climate change response, adaptation, is then used to further articulate the current regime's approach to climate change risk. Engineering, ecological and evolutionary resilience concepts are used as the theoretical framework for the critique.

Justification for focusing on resilience terminology relates to the increasing use of the term resilience in planning documents, and the possibility of its playing to planning's 'dark side' and becoming an 'empty signifier', open to constant re-articulation (Gunder 2004, Allmendinger and Gunder 2005). It is associated with everything from economies, ecosystems, various engineering programmes, governance systems, urban environments, agriculture, human mental and physical health, and, pertinently for this paper, disaster management. Its definitional malleability reflects in part its long and complex etymology (Alexander 2013). Therefore, government agencies need to clearly define what they mean if they use the term resilience, and the implications of its application.

Setting the scene

New Zealand's greenhouse gas (GHG) gross emissions have increased 21% since 1990, with road transport one of four sectors making the greatest contribution to that increase. As of 2013, the most recently assessed year, the two sectors contributing the most to emissions were agriculture (48%) and energy (39%). Road transport currently contributes 40% of energy sector emissions (MfE 2015). Central and local government investments in roading do not directly consider emission reduction implications as the tool to reduce emissions is the NZ Emissions Trading Scheme (NZETS). However, the NZETS is inadequate in terms of reducing transport emissions (MoT 2011, Knight-Lenihan 2015) and current investment decisions will stimulate more transport emissions at least through to the mid 2020s, with possible declines in emissions beyond that date, depending on policy and technology evolution (MoT 2014, MfE 2014, 2015).[1]

The New Zealand Government's primary policy plank for reducing transport emissions is an expected uptake in electric vehicles (MoT 2014, New Zealand Government 2015). This will contribute to the Government's intended nationally determined emissions reduction contribution of 30% below 2005 levels by 2030, announced as part of the lead up to the 21st United Nations

[1] A review of the NZETS was announced at the time of writing. See www.mfe.govt.nz/publications/climate-change/new-zealand-emissions-trading-scheme-review-2015-16-discussion-document [accessed 25 November 2015].

Framework Convention on Climate Change (UNFCCC) Conference of the Parties in Paris (COP21). At the time of writing, there was no detail as to how this large-scale shift to electric vehicles would occur, leading to doubts over how this policy will materially reduce emissions within the 2015-2030 time frame (MoT 2014).

Method

The term 'resilience' was searched for in three key New Zealand documents shaping the allocation of land transport investment nationally:

- The Government Policy Statement on Land Transport Funding 2015/16-2024/25 (GPS 2015) (statutory, *Land Transport Management Act 2003*, (LTMA) ss 66-72)
- The National Land Transport Programme 2015-2018 (NLTP 2015) (statutory, LTMA s1).
- The Economic Evaluation Manual (EEM) which is the technical and procedural guide for undertaking social cost-benefit analysis[2] when assessing land transport funding applications, and identifies the relative efficiencies of transport investment.

An assessment was then made of how the term was defined and applied relative to a resilience typology framework described below. Conclusions were made about the breadth of the interpretation of the term resilience and what the implications were for transitioning to low carbon societies. Analysis of recent (2014-2015) critiques of New Zealand's approach to disaster risk management was then undertaken, emphasising climate change adaptation. This is because resilience is a key theme underlying disaster risk management, and so analysis of a country's approach to such management usefully reveals societal and governmental attitudes towards resilience. Focusing on climate change reveals an understanding of the extent to which resilience links mitigation and adaptation.

Resilience Typologies[3]

Taking a lead from Dobson (1998) when summarising attitudes to sustainable development, resilience can most usefully be seen as a set of concepts or types, rather than a range of definitions.

The first typology describes the ability or rate at which a system can return to equilibrium after a disturbance, a measure of its engineering resilience (Walker, Anderies *et al.* 2006, Alexander 2013, Rogers 2012). A second main typology highlights a systems' ability to cope with perturbations before shifting to a new state, regime, or stability domain. Systems demonstrate varying degrees of resistance to change, with some having already been subject to pressures placing them closer to the point of change (their precariousness), which in turn is influenced by how much a system can absorb before it changes (its latitude). Panarchy refers to internal (social-economic-ecological) and external (largely social-economic) pressures applied to trigger change (Holling 1973, 1996, Walker, Anderies *et al*. 2006, Walker, Gunderson *et al.* 2006, Folke *et al*. 2010, Figure 1).

An example is a lake. Large lakes might be able to absorb more nutrients than small lakes (have high latitude) but are still sensitive to those nutrients (have low resistance), exemplified by localised algal blooms. The lake may have been absorbing nutrients over several decades and show few signs of change, but may be close to a point of shifting from an oligotrophic to a mesotrophic state, and therefore it has high precariousness. The new state may be stable (that is, variable about a set of means), but different from the initial state.

Human-ecological systems similarly evolve, both in a non-directed and directed (deliberated) way. A lake can appear stable over human generation time-scales, but may be evolving from an oligotrophic to a mesotrophic and then a eutrophic state. Such a trajectory is natural but can also be influenced by human behaviour and so can be consciously directed. Critical thresholds relating to how much extra human-induced nutrient is entering the lake can be monitored and analysed for trends, and unwanted outcomes avoided through, for example, farm management or riparian planting. Practical applications of this approach can be found in the literature (e.g. Folke *et al*. 2004, Walker *et al.* 2009, Haider *et al.* 2012) with varying efficacy in identifying and avoiding unwanted or attaining desired end-states. Indicators can cover geological, geographical and climatic trends, as well as historical, local, international and economic trends,

---

[2] Social cost-benefit analysis is defined by the New Zealand Transport Agency as considering the costs and benefits to the nation as a whole, and accounting for non-market benefits and costs such as safety, pollution, and accessibility, as well as commercial benefits and costs.

[3] This section is summarised from Knight-Lenihan 2015.

to create a picture of ecological-human social systems in order to characterise ‘uncertainty, surprise and complex interactions across various spatial and ecological scales’ (Haider *et al*. 2012, p. 317). This leads to identifying how resistant systems are to change, how far they have changed already, how close they may be to transitioning to a different state, and whether and how this may be averted or embraced (Walker *et al.* 2004, Figure 1).

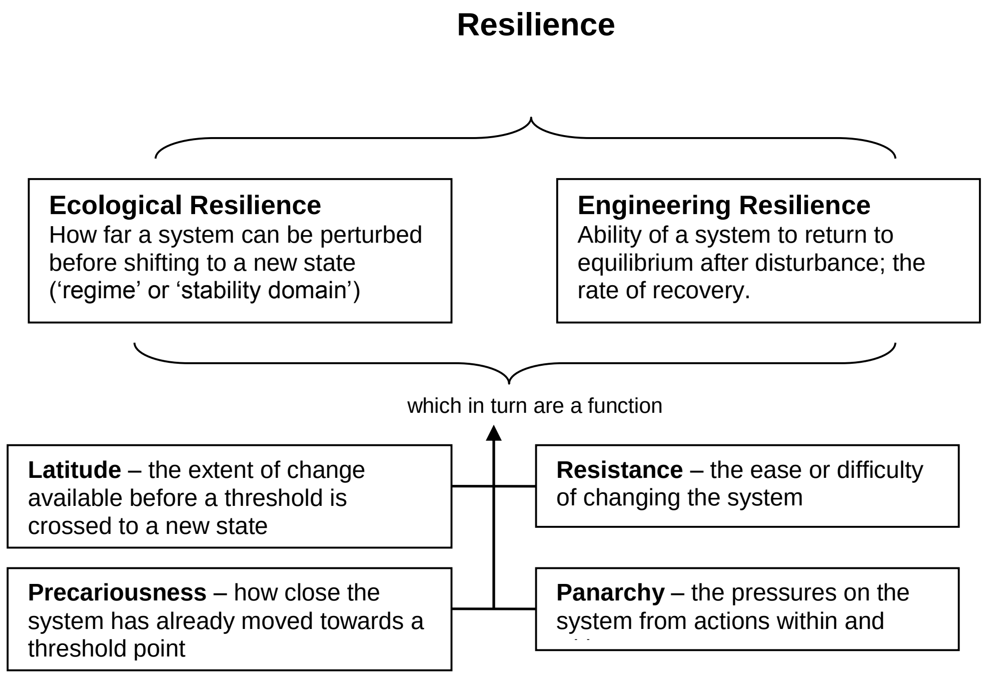

Figure 1 – different and overlapping resilience typologies. See text for details.

Engineering-ecological resilience suggests systems attain equilibrium, whether it be one that systems *bounce back to* (engineering) or new ones to which it *bounces forth* (Davoudi 2012, White and O’Hare 2014). A third typology, evolutionary resilience, also known as socio-ecological resilience (Folke *et al*. 2010) suggests the very nature of systems may change with or without an external disturbance (Scheffer 2009 cited in Davoudi 2012) with the potential for transformation to a new state (see for example Shaw 2012) and challenging the idea of (re)attaining equilibrium.

Organisational resilience is a form of equilibrium resilience, where the aim is to ensure the ability to provide services during times of stress, that is, maintaining stability around a norm (White and O’Hare 2014). In contrast evolutionary resilience favours the transitional aspects of social-ecological systems theory, dealing with wicked problems and post-normal threats, and draws on critiques of the ‘contested interfaces of science and policy … [where] … typically facts are uncertain, values in dispute, stakes high and decisions urgent‘ (Ravetz 2004, p. 349). This would seem to fit the description of climate change modelling.

The ability to deliver services while coping with stress can be seen both as a positive attribute as well as a liability. For example, transformative systems may lead to both reducing the probability of an undesirable state occurring, while at the same time creating conditions for adapting to it if it does occur. Alternatively, maintaining the ability to provide services during stress can result in ‘sticky and unyielding institutions or organisations that can prevent positive change from occurring, even unto regression to a less open alignment of social order’ (Rogers 2012, p. 140; see also Burch *et al*. 2014), thereby potentially decreasing resilience.

The distinction lies in being clear about what is meant by a service. Ecosystem services relate to maintaining or enhancing biological systems. Equally, maintaining existing economic and social systems is also defined as service protection or enhancement. However, maintaining biophysical capacity and adaptability may conflict with maintaining existing economic and social systems. If so, the former leads to questioning the efficacy of maintaining the latter if this is identified as leading to outcomes such as anthropogenically-induced climate change. In contrast, the latter emphasises the need to maintain economic and social systems while coping with the same set of threats. Proof of success for the latter is minimising disruption while adapting to change, typifying the 'bounce-back ability' of engineering resilience. This can be seen as a modified business-as-usual (MBAU) approach. The focus is on best practice risk management associated with assuring core profit-making functions and the maintenance of statutory service delivery obligations. Once these are assured, other areas begin to get more attention (Rogers 2012).

Thus the engineering, and to an extent ecological, view of resilience privileges the need to maintain current economic and social structures while reducing risk, whereas evolutionary resilience requires consideration of political and institutional structural change as part of a risk assessment and response process. The Catch 22 for this second approach to resilience is the assessment, interpretation, and response, is done within the confines of the existing structures.

Different approaches to resilience can be identified in policy responses to threats (Walker *et al.* 2009). In the context of climate change, a basic protection of the asset response, such as expanding stormwater drains, building stronger defences against landslides, or adapting farming to wetter or drier conditions, increases resilience in the current regime within the current system. Deciding against maintaining certain utilities, such as roads or stormwater systems or coastal protection due to a hazard reassessment, or accepting the need to move communities, is a shift to an alternative regime within the current system. The final approach would be to consider a new economy that radically reduced emissions while accepting significant adaptation. This would include a full ecological and economic analysis, and would represent a transformation to a different system.

New Zealand Land Transport Investment and Resilience

Government Policy Statement on Land Transport Funding 2015/16-2024/25

The GPS sets out Government transport strategic and policy goals, and the associated funding direction required to achieve them. This directly influences the expenditure of $3.4 - $4.4 billion per annum of central government investment, and approximately $1 billion per annum from local government (New Zealand Government, 2014). The New Zealand Transport Agency (NZTA) must give effect to the GPS (*Land Transport Management Act 2003* s70(1)) but the GPS cannot require the NZTA to approve or decline funding for a particular activity (s70(2)).

Resilience is addressed in the GPS 2015, in relation to meeting future needs and enduring shocks, both manmade and natural (pp 21 and 31). The document notes the need to conduct risk assessments, prevent the worst effects of likely events, and respond to emergencies and re-establish infrastructure (p. 21). The emphasis is therefore on maintaining land transport systems as a form of engineering resilience, although the term is not defined this way.

In addition, the document notes as a short-to-medium-term result the need to improve 'transparency of investment in mitigating environmental effects, including climate change' (p. 31). It is unclear how this is to be done, or indeed if it is looking at reducing the probability of climate change, or creating systems capable of bouncing back from the impacts of climate change. It could be both: under environmental mitigation (p. 31) the GPS notes the need to invest in mitigating the most adverse environmental effects of land transport, such as storm water retention ponds in new projects, as well as (again) improving transparency in mitigating adverse effects, including climate change.

The GPS 2015 says 'reducing greenhouse gas emissions from transport is an important consideration in investment policy' (p. 23), balanced against the need to better understand the costs involved relative to the environmental benefits. The wording remains broad, but the emphasis appears to be on improving national, regional and local transport efficiency with emissions reduction considered as a measurable by-product. The wording applied to resilience is repeated against various outputs, that is, improve 'transparency of investment in mitigating adverse environmental effects, including climate change' (pp 27-32). The weighting to be applied to reducing emissions as part of this benefit-cost analysis is unclear.

National Land Transport Programme 2015

The NLTP 2015 details the land transport programmes to be funded by the NZTA over the three years to 2018. It includes a need to ensure effective and resilient networks. Emphasis is placed on the need for disaster recovery, coupled with where feasible avoidance of exposure to disasters and ensuring networks can "bounce back". Disaster avoidance leaves open the possibility of altering, moving or removing infrastructure, shifting things towards a 'bouncing-forth' type of resilience which incorporates a shift in the current regime [4]. However, responses are tempered by economic and social costs and short-term planning horizons, making such shifts unlikely.

An example is assessing road links over the Southern Alps between the West Coast and regions on the east coast. A September 2013 landslip triggered over a year's worth of significant remedial work in Haast Pass. Given limited alternative routes, this created heavy social and economic costs while the work was done. The response was to engineer a high-capacity rock fall protection system designed to cope with boulders up to 16 tonnes travelling at speeds in excess of 90 km/h. This increased resilience within the current regime and system. The importance of keeping links open to protect the regional economy justified the NZ$8 million investment.

However, not addressed was whether long-term there would be an increase in adverse weather events leading to further, larger, significant landslips. The engineered response further entrenches development trajectories predicated on the assumption links will be maintained, therefore potentially increasing hazard exposure. A more rounded resilience assessment may have the engineered response but would include provision to reduce dependence on this link, and query the underlying economic development assumptions requiring such links to be maintained.

Economic Evaluation Manual

The EEM provides procedures for approved organistions (mainly local government agencies) to evaluate the economic efficiency of transport investments using a cost-benefit approach and assessments of alternatives (NZTA 2013). The document does not use the term resilience. This indicates that while the term is used at a higher strategic level, it has not been incorporated into the guidelines for those applying for state funding for land transport.

However, concepts related to resilience, most particularly the consideration of alternative transport options, are part of the EEM process. As it accounts for non-market benefits and costs including safety, pollution, and accessibility, as well as commercial benefits and costs, potentially it can account for climate change impacts of emissions. For example, analysis of the economic costs of an additional ton of carbon dioxide (or its equivalent) (the social cost of carbon – Nordhaus, 2014) can be used to put a dollar value on benefits associated with rules and regulations reducing greenhouse gases and climate effects (Sussman et al., 2014).

However, in terms of climate change, while the EEM allows applicants to account for emissions, this can only be done in a narrow sense relating to vehicle operating costs (Section A9.7 and Appendix 5). These are pegged at $40 per tonne of carbon dioxide, or four per cent of the operating cost changes. In effect, the EEM rules out considering the impacts of emissions in a way that materially alters the benefit-cost analysis.

In addition, the Government can by-pass the EEM process, exemplified by the Roads of National Significance (RoNS). Cabinet decided RoNS were needed to stimulate economic development and, despite Appendix A10 of the EEM requiring careful scrutiny of claimed national strategic factors, this decision was not subject to critical analysis (Knight-Lenihan, 2015). Consequently there was a failure to correctly assess the influence of RoNS on current network resilience, and effects on future resilience related to contributing to the risk of climate change.

Summary

As a result of analysing these documents, it is evident the Government has limited interest in climate change-associated emissions reductions from the transport sector, nor is it considering more transitional land transport options as part of increasing resilience. The approach focuses on a modified BAU, that is, increasing resilience of the current regime within the current system.

[4] For a full description see http://www.nzta.govt.nz/planning-and-investment/2015-18-national-land-transport-programme/2015-18-nltp-investment/national-land-transport-programme-at-a-glance/network-resilience/ [Accessed July 2015].

Disaster risk management and resilience

An October 2014 Insurance Council of New Zealand report (ICNZ 2014) clearly flagged the need to better prepare infrastructure for future climate change impacts. The report notes most New Zealanders live by the coast or rivers, and "often developed cities suffer from under-investment and poor maintenance of infrastructure" (p 5). Climate change will increase risks by increasing both the intensity and frequency of weather-related events and that "[i]mproving New Zealand's resilience involves much more than risk management. It includes adapting to shocks, gradual stresses and cumulative change. So, we must take a long view while acknowledging it is better to invest early than spend more after the event" (p 6).

Importantly in the context of transport funding, the ICNZ goes into some detail on the need for a centralized response to hazard management. That is, the current system focuses on explaining how to recover from risk; very little is spent discussing how to avoid hazards in the first place. In a contemporaneous report, Local Government New Zealand agrees that too little investment is made in risk reduction and the "effect of climate change, in particular, is not accounted for" (LGNZ 2014 p. 3). Both documents note the poorly co-ordinated response to hazard management, with LGNZ emphasising the need for a community resilience strategy with national guidance. In the context of this paper, adaptation is the focus for resilience, but tempered by acknowledging the under-investment in hazard avoidance. This overlaps with the ICNZ observations on risk mitigation and avoidance.

In November 2015, the New Zealand Parliamentary Commissioner for the Environment underscored these concerns in a report that included calculations of homes, businesses and roads exposed to the risk of sea level rise (PCE 2015). As with LGNZ, the concerns are over sea level rise and storms causing increased coastal erosion, higher water tables and consequent inundation, coupled with higher intensity rainfall affecting catchments (LGNZ 2014; PCE 2015)

Implications for infrastructure planning, using roads as the example, include not just the placement and protection of roads, but also the land development implications of where roads go. Under the *Resource Management Act 1991*, local authorities must control land use to avoid or mitigate natural hazards (s62(1)(i)). When New Zealand's Kapiti Coast District Council (KCDC) interpreted this as needing to find out the best available information on where coastlines would be in 50 and 100 years, and commissioned a coastal scientist to undertake the research, a predictable property owner backlash ensued (Giblin 2013; PCE 2015). The KCDC argued that once it receives credible information, it is legally bound to include the hazards exposure on Land Information Memoranda (LIM) attached to every property title. The Coastal Ratepayers United (CRU) argued the scientific analysis used as the basis for the LIM warning was inaccurate, unreliable and alarmist as it did not reflect what is likely, but what is worse-case (Giblin 2013). CRU says the action would affect 1,800 properties or 4,000 people. An interim High Court decision agreed that while placing the erosion risk on a LIM was required by law, the way it was done was inadequate and misleading. At the same time, a proposed district plan was notified. The Council appointed an independent scientific panel to assess the original hazard lines: the panel concluded in 2014 the coastal erosion assessment was not robust enough for incorporation into the proposed district plan (PCE 2015).

In essence, this leaves the KCDC in limbo. While scientific and insurance analysis suggests much of New Zealand's infrastructure is at risk of climate change impacts and associated escalating costs, and these costs may make some areas very expensive or uninsurable (ICNZ 2014), local government has no current central government guidance as to how to respond to such information. This favours the MBAU approach of short-term engineering resilience, quite literally in terms of the building of hard structures such as sea walls, as well as through having to build new, or maintain existing, transport routes. This reduces political risk for both central and local government sensitive to the threat of property rights-related legal action. But doing so increases longer-term probabilities of significant negative impacts as hard structures encourage BAU development and long-term exposure to climate change impacts, thereby reducing system resilience. Long term, landowners may try to claim against councils for allowing development to remain in hazard zones.

The PCE report captures the difficulty: not encouraging a transition away from BAU in the knowledge of increasing certainty of the risks being run is poor governance, but managing the process requires acknowledging legitimate community uncertainty over dealing with an unprecedented change. This is because increasing long-term systems resilience, not just

regime resilience, may require shifting to not just a different land use and settlement regime, but possibly a new set of socio-economic-ecological assumptions underpinning the current system.
Historically New Zealand has invested in transport and land use patterns that now expose assets to climate change impacts (ICNZ 2014, PCE 2015). A resilient transport system could link the benefits of shifting investment away from current roading strategies to reduce such exposure, while at the same time investing in emissions reductions strategies to help reduce the magnitude of predicted enhanced climate change. Currently, there is little evidence of an appreciation of this link.

The missed opportunity

The Ministry of Transport's post-2014 election briefing to incoming ministers (MoT 2014) links the increasing emissions profile from transport, the country's exposure to oil imports, the threat of extreme weather events, and resilience (e.g. p 36). However, the link is not detailed: the document's subsequent discussion is on how to engineer protection for some transport assets, or to accept it will be more cost-effective to respond to damage once it happens. Coupled with a lack of co-ordination on how to prepare for the impacts of climate change, New Zealand is on a development pathway that both contributes to the increasing likelihood of significant climate change while not fully preparing for its consequences, other than with short-term fixes.
This is in part due to the New Zealand Government not clearly identifying that its approach to resilience is to focus on keeping things as they are. This fails to consider possible options for transitioning to alternative and possibly less risky states. Narrow definitions of resilience locks development into a non-resilient pathway because it attempts to reduce uncertainty and create the illusion that things are under control. Used this way resilience becomes a Lacanian *master signifier* or stopping point, (apparently) creating order out of disordered aggregations of knowledge, beliefs and practices (Fink 1998 cited in Gunder 2004). It favours the MBAU approach that minimises political risk while failing to engage with a full resilience risk assessment.
Used correctly, resilience thinking can provide a structured way of considering complexity, uncertainty and interrelatedness of systems and processes (Slootweg and Jones 2011), augmenting strategic environmental assessments and creating a formalised mechanism for analysing the interplay between ecosystem and human development, their interdependence, and desired or unwanted changes to be avoided or embraced (Walker *et al.* 2009). Applying resilience analysis to transport planning could help identify entirely new pathways that would justify a different kind of investment regime, contributing to avoiding hazards, and accepting that in some cases a whole new approach might be needed to the road transport-land use development process. This would contribute to identifying low carbon pathways.

Conclusion

It is necessary for government agencies to clarify whether the term resilience is being used to create an analytical framework to preserve existing systems, identifying ways to modify them, and/or mechanisms to transition to a new system. This is because analysis may help identify justifiable alternative pathways to avoid unwanted outcomes, and embrace desired ones, but only if the concept of resilience is understood.
The New Zealand Government's approach to transport funding uses resilience in the sense of preserving existing systems, with some modifications. While transport is recognised as influencing the exposure of assets to climate change impacts through land use, as well as a main player in contributing to the likelihood of enhanced climate change occurring, funding policy and implementation provides little scope for accounting for these factors. The Government's approach to adaptation shows signs of accepting the need to change current development patterns to reduce exposure to the impacts of climate change, but still focuses on protecting existing regimes and systems rather than considering ways of increasing long-term resilience. It also relies on local government delivering the solutions while providing minimal guidance.
If governments and agencies use resilience they should be required to demonstrate an understanding of what the term embraces, and what the implications of adopting the term are. This may well lead to considering more meaningful responses to climate change than the current modified business-as-usual response. However, any resilience analysis would be conducted within the dominant MBAU mind-set, and the MBAU approach is self-limiting. That is, while resilience analysis may point to the need for a profound change in the way things are done, MBAU analysis concludes that requiring a profound change by definition can't be true, so

the logic of this option is discounted. Instead, tinkering is the best way forward and is politically lower risk.
Any good insurance actuary would point out this approach exposes underwriters to unquantifiable but inevitable catastrophic costs at some undefinable future point. This will wipe out short- to medium-term gains that accrue by taking an MBAU approach. Given the underwriters are not just all of humanity, but all of life, this should shift the focus away from MBAU. This is not currently the case in New Zealand.

References

Alexander, D. E., 2013. Resilience and disaster risk reduction: an etymological journey. *Natural hazards and earth system sciences,* 13, 2707-2716.

Allmendinger, P. and Gunder, M., 2005. Applying Lacanian insight and a dash of Derridean deconstruction to planning's 'dark side' *Planning theory,* 4(1), 87-112.

Burch, S., Shaw, A., Dale, A., and Robinson, J., 2014. Triggering transformative change: a development path approach to climate change response in communities. *Climate policy*, 14, 467-487. doi:10.1080/14693062.2014.876342

Climate Action Tracker, 2015. New Zealand deploys creative accounting to allow emissions to rise. *Climate Action Tracker policy brief.* Retrieved from http://climateactiontracker.org/news/215/New-Zealand-deploys-creative-accounting-to-allow-emissions-to-rise-.html [Accessed 15 July 2015].

Davoudi, S., 2012. Resilience: a bridging concept or a dead end? *Planning theory and practice* 13, 299-307. doi: 10.1080/14649357.2012.677124.

Dobson, A., 1998. *Justice and the environment: conceptions of environmental sustainability and dimensions of social justice.* London: Oxford University Press.

Folke, C., Carpenter, S., Walker, B., Scheffer, M., Elmqvist, T., Gunderson, L., and Holling, C. S., 2004. Regime shifts, resilience and biodiversity in ecosystem management. *Annual review of ecology, evolution and systematics*, 35, 557-581.

Folke, C., Carpenter, S. R., Walker, B., Scheffer, M., Chapin, T., and Rockstrom, J., 2010. Resilience thinking: integrating resilience, adaptability and transformability. *Ecology and Society* 15(4), 20 retrieved from http://www.ecologyandsociety.org/vol15/iss4/art20/ [Accessed 15 July 2015].

Giblin, R., 2013. Kapiti erosion: head to head [online]. Stuff.co.nz/Farifax NZ. Available at http://www.stuff.co.nz/dominion-post/comment/8410415/Kapiti-erosion-Head-to-head [Accessed 25 June 2015).

Groser, T., 2015. Climate change target announced. Press release from the Office of Climate Change Minister the Hon Tim Groser, Wellington.

Gunder, M., 2004. Shaping the planner's ego-Ideal: a Lacanian interpretation of planning education *Journal of planning education and research,* 23, 299-311.

Haider, L. J., Quinlan, A. E., and Peterson, G. D., 2012. Interacting traps: resilience assessment of pasture management systems in northern Afghanistan. *Planning theory and practice,* 13, 312-319. doi: 10.1080/14649357.2012.677124.

Holling, C. S., 1973. Resilience and stability of ecological systems. *Annual review of ecology and systematics,* 4, 1-23

Holling, C. S., 1996. Engineering resilience versus ecological resilience. *In* P. Schulze, ed. *Engineering within ecological constraints*. Washington D. C.: National Academy Press, 31-44.

ICNZ., 2014. *Protecting New Zealand from natural hazards: an Insurance Council of New Zealand perspective on ensuring New Zealand is better protected from natural hazards.* Wellington: Insurance Council of New Zealand.

Knight-Lenihan, S., 2015. Benefit cost analysis, resilience and climate change [on line] *Climate policy,* available from
http://www.tandfonline.com/doi/full/10.1080/14693062.2015.1052957
[Accessed 25 June 2015].

LGNZ., 2014. *Managing natural hazard risk in New Zealand – toward more resilient communities*. Wellington: Local Government New Zealand.

MoT., 2011. *Briefing to the incoming Minister of Transport: policy challenges and upcoming decisions.* Wellington: Ministry of Transport.

MoT., 2014. *Briefing to the income Minister*. Wellington: Ministry of Transport.

MfE., 2014. *Briefing to the incoming Ministers: environmental stewardship for a prosperous New Zealand* Wellington: Ministry for the Environment.

MfE., 2015. *New Zealand's Greenhouse Gas Inventory 1990-2013.* Wellington: Ministry for the Environment.

New Zealand Government., 2015. Government policy statement on land transport 2015/16-2024-25. Wellington: New Zealand Government.

New Zealand Government., 2015. *New Zealand's climate change target: our contribution to the new international climate change agreement.* Wellington: New Zealand Government.

Nordhaus, W., 2014. Estimates of the social cost of carbon: concepts and results from the DICE-2013R model and alternative approaches. *Journal of the association of environmental and resource economists,* 1, 273-312.

NZTA., 2013. *Economic evaluation manual.* New Zealand Transport Agency, Wellington.

PCE., 2015. *Preparing New Zealand for rising seas: certainty and uncertainty*. Wellington: Parliamentary Commissioner for the Environment.

Ravetz, R., 2004. The post-normal science of precaution. *Futures,* 36, 347-357.

Rogers, P., 2012. *Resilience and the city: change, (dis)order and disaster*. Surrey: Ashgate.

Slootweg R., and Jones M., 2011. Resilience thinking improves SEA: a discussion paper. *Impact assessment and project appraisal,* 29(4), 263-276.

Shaw, K., 2012. 'Reframing' resilience: challenges for planning theory and practice. *Planning theory and practice,* 13, 308-312. Doi: 10.1080/14649357.2012.677124.

Sussman, F., Weaver, C., & Crambsch, A., 2014. Challenges in applying the paradigm of welfare economics to climate change. *Journal of benefit cost analysis* 5, 347-376.

Walker, B., Holling C.S., Carpenter, R. and Kinzig, A., 2004. Resilience, adaptability and transformability in social-ecological systems *Ecology and society* 9(2): 5 Available from http://www.ecologyandsociety.org/vol9/iss2/art5 [Accessed 12 July 2015].

Walker, B., Anderies, J., Kingiz, A. P. and Ryan, P., 2006. Exploring resilience in social-ecological systems through comparative studies and theory development: introduction to the special issue. *Ecology and society* 11 (1):12. Available from : http://www.ecologyandsociety.org/vol11/iss1/art12/ [Accessed 12 July 2015].

Walker, B., Gunderson, L. H., Kinzig, A. P., Folke, C., Carpenter, S. R. and Schultz, L., 2006. A handful of heuristics and some propositions for understanding resilience in social-ecological systems. *Ecology and society* 11(1),13. Available from http://www.ecologyandsociety.org/vol11/iss1/art13/ [Accessed 10 July 2015].

Walker, B. H., Abel, N., Anderies, J. M., and Ryan, P., 2009. Resilience, adaptability and transformability in the Goulburn-Broken catchment, Australia. *Ecology and society* 14(1), 12

White, I. and O'Hare, P., 2014. From rhetoric to reality: which resilience, why resilience, and whose resilience in spatial planning? *Environment and Planning C: government and policy,* 32: advance online publication, doi:10.1068/c12117 [Accessed 18 February 2015].