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Why Definitions of Resilience Matter: The Example of Funding New Zealand's Transport Sector

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ABSTRACT
Resilience embodies concepts of impact absorption and recovery, adaptation, and transformation. Clarity is needed when using the term as to whether these attributes are being pursued contemporaneously, sequentially, or at all. Land transport funding in New Zealand is examined from a climate change perspective and demonstrates policies and processes applying resilience in the sense of maintaining or improving current levels of service despite perturbations, with elements of medium term adaptation. While this interpretation helps manage immediate uncertainty, it may lock development into a low-resilience trajectory. However, this may change as the full meaning of resilience becomes apparent.

恢复力体现了吸收冲击和恢复、适应、转变的概念。使用这一词汇时需要说明这些属性是同步、先后，还是根本不存在。本文从气候变化的角度考察新西兰陆地运输融资，并说明在非常时期保持或改善服务水平、并做中期调整的恢复政策和过程。这种解读有助于管理短期的不确定，但可能将发展限制在低恢复力的道路上。不过，一旦恢复力的完整意义得到明确，事情就会发生变化

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1. Introduction

The increasing use of the term resilience in planning documents raises an issue as to whether it is replacing sustainable development as a concept playing to planning's "dark side". That is, is it becoming an "empty signifier" open to constant re-articulation (Gunder 2004, Allmendinger and Gunder 2005)? In addition there are claims that its use beyond a particular ecological application results in misuse and poor outcomes (Olsson *et al.* 2015).

A more benign view, though with equally profound implications, is that the potential benefits of resilience are not being realised as policy formulators incorporate the term ignorant of its full meaning. In this scenario, the understanding of resilience may yet gain clarity and eventually significantly influence policy outcomes.

This paper examines empirically the process of adopting resilience terminology in government policy. The objective is to identify the influence this process has on medium to long-term management of climate change risk, and answer the question whether adopting resilience thinking has any significant consequences.

The example used is New Zealand's national land transport funding mechanism. Road transport is a main contributor to New Zealand's growing rate of greenhouse gas (GHG) emissions (MfE 2016). It

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also contributes to barriers making adapting to the effects of climate change financially and politically difficult. This is because funding supports the building and maintaining of transport systems in areas where it is increasingly evident the impacts of climate change will require major protection work, or managed retreat (PCE 2015).

Resilience analysis can be used to identify these evolving vulnerabilities, and possible alternative pathways to address them (Folke *et al.* 2004, Haider *et al.* 2012, Walker *et al.* 2009) by helping to analyse uncertainty in complex systems. The New Zealand case study is an example of a democratic state introducing such a concept at a time when risk assessments are identifying increasing levels of uncertainty across a broadening range of interacting topics such as financial security, infrastructure, health and wellbeing, and climate change (MCDEM 2009, DMPC 2011, NIU 2014b, PCE 2015, Stevenson *et al.* 2015, Treasury 2015).

Using resilience as an umbrella term for complexity analysis is not without controversy given the wide array of other models (e.g. Alexander 2013, Welsh 2014, Olsson *et al.* 2015). But as it is very commonly used, an agreed understanding of the term would be a measure of its utility for planning practice, confirming to practitioners what it is they are supposed to be delivering.

Equally, the paper also examines whether the understanding of what is meant by resilience reflects the evolving understanding of the term in the literature, and why this might matter. While the understanding of those applying the term may be consistent, it may not be precise, accurate or complete.

The paper tests earlier findings that particular interpretations of resilience in New Zealand discount an interpretation that may identify a need to change economic and institutional processes. The latter may not be necessary, but resilience theory and practice suggests it needs to be considered. Deploying decision-making tools such as benefit costs analysis within narrower interpretations of resilience leads to a modified business-as-usual outcome, when a more profound change may be necessary (Knight-Lenihan 2015a, 2015b).

This paper reviews the use of resilience in central government documents relating to infrastructure management broadly and land transport specifically, providing a more nuanced understanding of how resilience is being discussed, interpreted and applied.

2. Planning Context

Road transport is one of five main contributors to New Zealand's 23% increase in gross GHG emissions since 1990, with the others relating to agriculture and industry (MfE 2016). The primary mechanism for managing emissions is the New Zealand Emissions Trading Scheme (NZETS). Due to the under pricing of carbon units, and price inelasticity, the NZETS is recognised as being inadequate for reducing transport emissions (MoT 2011, 2014) and a review is currently underway (MfE 2015). Projections are for emissions to continue increasing (MoT 2014, MfE 2014) on the back of existing trends (MfE 2016) with the rate of increase to be modified by yet-to-be-detailed policy settings and technological breakthroughs (New Zealand Government 2015c).

Roads are the dominant form of land transport servicing cities, towns and rural communities. Continued road investment in areas increasingly vulnerable to climate change contributes to maintaining the idea that development in such areas is advisable. This is despite mounting evidence that much of New Zealand's infrastructure is at risk from climate change exacerbated erosion, storm and flooding/drought cycles, and coastal sea level and ground water intrusion (PCE 2015, RSNZ 2016) making some areas potentially very expensive to insure, or uninsurable (ICNZ 2014).

Transport funding does not currently take account of emissions as the NZETS is intended to address this. Meanwhile, impacts and consequently adaptation to climate change effects are increasingly occurring at a case-by-case level as required under the *Resource Management Act 1991* s.7(i). However, there are no guidelines on the extent to which local government should warn land-owners about climate change risk. This leads to threats of legal action relating to property rights losses when councils do try to take action by retrospectively imposing hazard zones, while leaving open future possible legal action if councils do not warn communities about impending risks (Knight-Lenihan 2015b, PCE 2015).

Therefore, road maintenance, construction and use contributes to both enhanced climate change and exposure to its impacts. Disinvesting or reorienting land transport investment requires a significant shift in decision-making, with profound impacts on communities. Resilience assessments are a way to address such wicked problems (Rittel and Webber 1973), depending largely on how the concept is understood and applied.

3. Methods

A literature review was used to identify the range of interpretations (typologies) of resilience. New Zealand central government documents relating to managing infrastructure and disasters published since 2009 were reviewed for their use of the terms: *resilience*, *resilient*, and *sustainable*. The reasoning was as follows.

Pre 2009, the term resilience was used in strategic and policy documents, but primarily relating to disaster management (see discussion in DPMC 2011, LGNZ 2014) including for infrastructure (New Zealand Government 2015a) and roads (New Zealand Government 2015b). The evolution in thinking in this policy space was marked by a Ministry of Civil Defence and Emergency Management publication on community resilience (MCDEM 2009). This canvassed views on resilience to help clarify meaning, because as one contributor observed "… resilience is being presented far and wide as a shining goal for the future—but many are still unsure what it actually means in practice" (Seville 2009, p. 9–10).

Documents were reviewed and a short list identified and analysed. The term *sustainable* was included because it has similar or overlapping meaning to resilience. Another term, vulnerability, was also considered due to its close association with resilience terminology (see for example Manyena 2006); however, on review this was considered unnecessary. Meanings were then interpreted within the resilience typologies described in the next section.

4. Resilience Typologies

Engineering resilience describes the ability or rate at which a system can return to equilibrium after a disturbance (Walker, Anderies *et al.* 2006, Alexander 2013, Rogers 2012) while ecological resilience highlights a systems' ability to cope with perturbations before shifting to a new state, regime, or stability domain (Folke *et al.* 2010, Holling 1973, 1996, Walker Anderies *et al.* 2006, Walker, Gunderson *et al.* 2006). Systems demonstrate varying degrees of resistance to change depending upon their ability to absorb pressure (their latitude) and how much pressure they've been under to date (their precariousness). Panarchy refers to internal and external social, economic and ecological pressures applied to trigger change (Holling 1973, 1996, Walker, Anderies *et al.* 2006, Walker Gunderson *et al.* 2006, Folke *et al.* 2010, Figure 1; see also Manyena 2006).

Systems can bounce back to where they were prior to a disturbance, "bounce forth" to a new state (Davoudi 2012, White and O'Hare 2014), or evolve absent of particular disasters due to internal and external dynamics. Such concepts are applied (with, as noted, some controversy) to socio-ecological systems (Folke *et al.* 2010, Scheffer 2009 cited in Davoudi 2012, Shaw 2012, Olsson *et al.* 2015).

In this context equilibria are sets of conditions existing at a particular point in time, and may only be "normal" at that point. This raises questions over whether resilience is a tool to maintain normality, as in creating resilient communities, economies or societies; or is it a tool that analyses system conditions and anticipates change in order to manage and/or prepare for it. The tension is between extrapolating from past trends and reducing uncertainty (Davoudi 2012) or embracing uncertainty due to no longer being able to rely on past trends. This is exemplified by trying to keep critical infrastructure and systems operating during uncertain times (Pescaroli and Alexander 2016) while creating conditions allowing for evolution in response to existing or predicted challenges (bouncing back versus bouncing forward; Manyena *et al.* 2011).[1] More practically, transformative systems may reduce the probability of an undesirable state occurring while creating conditions for adapting to it if it does occur. To be avoided are institutions or organisations that can prevent positive change due to their being "sticky and unyielding" (Rogers 2012, p. 141; see also Burch *et al.* 2014)

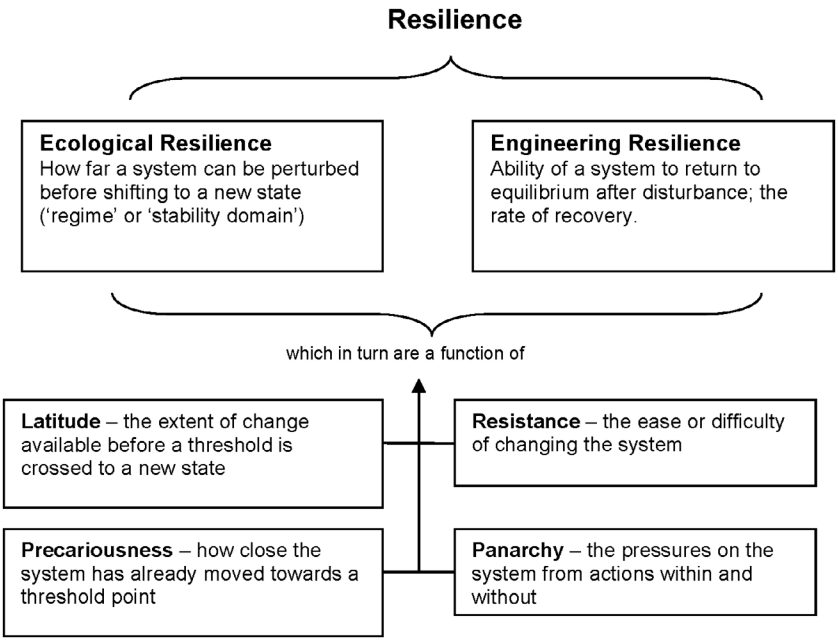

Figure 1. Different and overlapping resilience typologies (summarised from references cited in text).

With the above in mind, and using Walker *et al.* (2009), the following set of categories are formulated as a framework for analysis. These are based on the idea of modifying regimes (adaptation) rather than the more significant changing of systems (transformation). Using examples of climate change response as the metric:

- Expanding stormwater drains or adapting farming to wetter or dryer conditions increases resilience in the current regime and system (absorb and recover).
- Deciding not to maintain certain utilities such as roads or sea walls, or accepting the need to move communities, is a shift to an alternative regime with the current system (absorb, recover and adapt).
- Reviewing the assumptions underpinning the current economy to radically reduce emissions while preparing for significant adaptation. This would be a transformation to different system (absorb, recover and transform).

The degree of recovery required prior to adaptation and/or transformation would depend on the extent to which the impacts were anticipated, accepting that in highly integrated networks, cascading ecological and socio-economic effects will generate unexpected outcomes (Pescaroli and Alexander 2016).These three responses were used to help assess the New Zealand Government's approach to the concept of resilience.

5. Results

The 2009 MCDEM publication discussed resilience primarily from an absorb, recover and adapt viewpoint. Discussions focused on such things as:

- the relationship between resilience and sustainability;
- resilience of what (e.g. an organisation) to what (e.g. a crisis);
- adaptive capacity of systems and communities, particularly to disasters, but also in the sense of being able to evolve as understanding of vulnerability changes;
- risk assessment; and
- the relationship between urban resilience and green spaces.

One observation was that a systems approach to risk management may overtly separate out the probability of events from the scale and locus of the impact to more effectively manage cause and effect. However, the result might be to focus on making those parts of a system likely to be impacted more resilient, but not the system as a whole. This may be because efforts to reduce effects have limited impact due to complex pathways leading back to the cause (Helm 2009, Pescaroli and Alexander 2016). This point will be returned to later.

Central government agencies' broadening views of resilience became evident in a publication outlining challenges to New Zealand's national security (DPMC 2011). The document noted that the concept of national security has been broadened to include pandemics, climate change, cyber attacks and terrorism, and that:

> (O)ur response … has also evolved, shifting from threat-based assessments to the more active management of risk over time. Greater emphasis is now put on building local preparedness and encouraging resilience in communities, organisations, networks, and critical infrastructure (p. 5).

Seven objectives were identified: preserving sovereignty, protecting communication to enable trade and global engagement, contributing to strengthening international order and security, sustaining economic prosperity, maintaining democratic institutions, ensuring public safety, and protecting the natural environment. National security involves balancing competing interests by following a set of principles:

- All significant risks should be addressed.
- There should be accountability that meets a government's responsibilities while respecting civil liberties and the rule of law.
- Subsidiarity should be applied, meaning the responsibility and authority for decisions, and use of resources, ordinarily rests at the level of those closest to the risk and best able to manage it.
- Sovereignty benefits from the norms of international law and state behaviour.

(DPMC, 2011, p. 4)

Emphasis in the DPMC document was on minimising harm or disruption, being able to respond quickly to adverse events and return society to normal functioning "quickly and efficiently" (p 5). Central government's role in particular was to maintain confidence in normal conditions through policy settings, state institutions, the regulatory environment and the allocation of resources, and provide leadership when crises did occur to ensure a return to normality. Governments take particular interest in risks that have unusual features of scale, nature, intensity or possible consequences, have multiple or inter-related problems, and may involve interdependent issues and a high degree of uncertainty or complexity (DMPC 2011, p. 9).

This challenges the subsidiarity principle. The DPMC report identified risk response thresholds triggering local or national responses, noting how more complex problems tended to trigger national responses. However, climate change, as a slow catastrophe, arguably requires all levels to be operating simultaneously. The current demarcation ceding control over emissions with central government and adaptation to impacts with local government is questionable (Harker *et al.* 2016).

During 2014 and 2015, further resilience interpretation for central government came through a series of publications from the National Infrastructure Unit housed within the New Zealand Treasury (NIU 2014a, 2014b, 2015). These were part of a review of the 2011 National Infrastructure Plan. In this context, resilience encompassed service delivery, community preparedness, interdependence of different infrastructure sectors, financial strength and organisational performance. This fits within the absorb-and-recover typology.

Also noted was that resilience dealt with "emergent as well as shock events" (NIU 2014b, p. 2). The NIU identified how resilience is the capacity of natural, human, social, financial and manufactured capitals to "adjust to changing conditions caused by sudden shocks, gradual stresses and cumulative change, without loss of form or function" (NIU 2014b, p. 3) while anticipating and adjusting to deeper trends and so avoid forced change. The NIU notes climate change is an example of preparing for the future and being able to respond to both opportunities and risks.

It is in this context that the Treasury places risk management, described as the identification of variability in a system as well as those things that are known to be unknown, that is, limits and assumptions. This is a subset of resilience, labelled as "adaptability", which includes unknown unknowns that result in part from complex systems and dynamic interdependencies. This is then linked through to sustainability and future generations (NIU 2014b).

How this link might be calibrated was alluded to by Treasury in a response to a 2014 petition calling for a national risk assessment.[2] Treasury noted that "[b]ecause resilience measures involve trade-offs and costs, a view is required on what is the desired level of resilience against risks to ensure advice is consistent and reasoned" (Finance and Expenditure Committee 2015, p. 11). This is a reasonable position, balancing exposure or vulnerability against mitigation, particularly in the normative context noted earlier. However, because resilience's system conditions include redundancy, uncertainty and change, attempts to quantify a desired level may favour bouncing back over bouncing forward. This may favour short-term stability over longer-term resilience.

However, Treasury continues

> [T]he expectation is that assessment of desired levels of resilience will reveal the major gaps and pinch-points that require prioritisation to get to desired levels, and the extent we want to safeguard against not achieving the objective of higher living standards for New Zealanders

(Finance and Expenditure Committee 2015, p. 11). This suggests the main objective is to minimise the likelihood that parts of a system might be overlooked, rather than an attempt to quantify accepted levels of resilience.

While not explicitly discussed by Treasury in this document, system behaviour may revolve around protecting the system, whereas system resilience may accept the failure of part of a system. That is, in order for example a transport network to survive, parts may need to degrade. Eventually this might result in a change in the nature of the system due to cumulative changes over time. This philosophy focuses on maintaining the services of systems (mobility and connectivity) rather than the peculiarities of how service delivery may have evolved to date (roads), leaving open the prospect of shifting from the current system manifestation to another manifestation. In this case, resilience means a system loses its current form, but ultimately not its function.

As an example, cumulative regime changes (shifts in the mix of land transport options) within a system (a private vehicle-dominated hierarchy) moves to where road transport is no longer dominated by private vehicles, or by the current type of private vehicle. This could lead to a system change.

The NIU identified system attributes to be used in a resilience assessment. These include:

- A focus on national, business and community service delivery.
- Ensuring national infrastructure has the capacity to adapt by withstanding disruption, absorbing disturbance, acting effectively in a crisis, and recognising changing conditions over time.
- Infrastructure providers and users understand the infrastructure outage risks faced and take steps to mitigate these at a community-specific level.
- Individual and collaborative responsibilities are clear between owners, operators, users, policy-makers and regulators.
- A system approach applies to the identification and management of risk (including consideration of interdependencies, supply chain and weakest link vulnerabilities).
- Financial capacity is adequate to deal with investment, significant disruption and changing circumstances.
- On-going resilience activities provide assurance and draw attention to emerging issues.

(NIU 2014b, p. 5)

None of the above attributes has indicators attached: the emphasis is on demonstrating that all these attributes are recognised and addressed. The attributes form a key part of New Zealand's current

national infrastructure plan (New Zealand Government, 2015a). The NIP highlights the need to be service-driven rather than asset-driven, that is, become better at analysing external pressures and development pathways and options, rather than relying on extrapolating from past trends. Emphasis is placed on the need for a robust economic analysis on, for example, investing in the New Zealand roading network while at the same time adapting to slower changes, including climate change, and that "…increased resilience is not necessarily about making things stronger or investing more, and is quite often achieved by operational changes" (New Zealand Government 2015a, p. 47).

The NIP vision is that by 2045 New Zealand's infrastructure, including roads, is resilient and co-ordinated and contributes a to a strong economy and high living standards. Factors to be taken account of include climate change and limits on development due to resource over use.

The NIP notes the need for "clear overall social, environmental and fiscal benefits that increase economic prosperity and living standards…" (2015a, p. 11) suggesting the need to demonstrate net benefits in each sector. This is a challenging assumption in a country where debate continues over whether a sustainable development approach means establishing non-negotiable bottom lines and net benefits across all sectors, or, as established by the majority of court decisions that are only recently being challenged, allows an overall broad judgement and trading off of values.[3] This accepts degradation in one sector if compensatory improvements in other sectors occur, and usually means ecological loss for economic gain.

The significance for resilience terminology is the connection being made between long-term infrastructure planning (the NIP time horizon is 30 years), transitioning away from existing decision-making mechanisms, and the need to demonstrate net benefits across all sectors. This highlights how strategic but non-statutory documents can introduce significantly disruptive ideas when, as discussed further below in the context of land transport, the legal and decision-making framework does not yet allow for such a shift.

The attributes also mix an absorb-and-recover form of resilience tested during a crisis, and a transformative type informed by experience and tested over the medium to long term. The latter assumes a consensus, goal-oriented process, suggesting a further necessary attribute to those listed above is evidence of a political system able to absorb and embed both the attributes listed and the need to assess them.

The NIU also notes the need to prioritise infrastructure requiring high resilience, although it did not directly address resilience divergence, that is, the ability to discern and manage situations where increasing resilience in one sector decreases it in another. For example, securing agricultural water supplies by damming can, and does, compromise the ecological resilience of associated water bodies. This relates to distinguishing between addressing system risks as well as event risks (Helm 2009, Pescaroli and Alexander 2016). New Zealand is currently debating how it manages its water resources for multiple purposes,[4] following the release in 2014 of the National Policy Statement for Freshwater Management.

The NIU links its infrastructure-focused document to broader Treasurer research on a Living Standards Framework.[5] The LSF identifies five key aspects to improving living standards—economic growth, sustainability, equity, risk management and social infrastructure. Resilience is included in the risk management aspect, countering the earlier observation that risk management is a subset of resilience, which in turn is a subset of sustainability. The LSF sees sustainability as focusing on sustainable resource management. Further, resilience is crystalised as assessing the influence of policy on the ability to withstand unexpected shocks and "in particular, does [policy advice] impact on our macro-economic position as a primary buffer against shocks?" (Au and Karacaoglu 2015, p. 30).

On the other hand, there is also recognition that building resilience requires a much broader view, with resilience improvement encompassing previously alien topics such as investing in the teaching of different languages or cultures (Au and Karacaoglu 2015). Treasury notes the overall objective is to boost the four capitals relating to nature, finance, social systems, and human attributes (Treasury 2015) and, overlapping with the 2011 national security system review, the LSF ask whether, for example, the defence force is primarily about managing risks at home and abroad, or about social cohesion through peace-keeping (Au and Karacaoglu 2015).

Importantly the LSF proposal notes the use of multi-criteria analysis of community preference for policy options on a complex topic. This results in preference rankings enabling a quantification of the individual's self-assessed living standards (Au and Karacaoglu 2015). This recognises resilience analysis requires a more sophisticated understanding of the implications of policy options.

Specific to roads, NIP 2015, as well as emphasising efficiency and affordability of supply, highlights an expectation of an increased investment in demand management and a greater co-ordination between land use and central and local government planning initiatives. Overall, the NIP recognises a need to move the approach to resilience from disaster management toward considering ways to address long-term threats and challenges. While there are parts of the document that leave open an interpretation that resilience is seen as an addition to rather than a framing of long-term planning, it does introduce a potentially institutionally disruptive interpretation of the term.

However, as discussed below, decisions currently being made locking land use and development into a medium to long term (30-year plus) pathway may counter NIP considerations. This also reflects the general approach to resilience and climate change in the planning system.

6. Resilience, Planning and Climate Change

Current Central Government thinking on managing risk and increasing resilience favours absorb and recover, with some adaption, rather than transitioning (ICNZ 2014, LGNZ 2014). There is an over-emphasis on disaster recovery and lack of investment on risk assessment and preventing disasters, including assessments associated with climate change. Thus resilience is applied in a narrow sense that does not reflect evolving views on the concept.

A 2015 New Zealand Parliamentary Commissioner for the Environment report identified homes, businesses and roads exposed to sea level rise associated with increased erosion, higher water tables and consequent inundation, coupled with higher intensity rainfall affecting catchments (PCE 2015). The implications for roads include not just current and future placement and protection of assets from effects such as flooding, slips or ground water intrusion, but the induced land development outcomes resulting from where roads go. Under the *Resource Management Act 1991*, local authorities must control land use to avoid or mitigate natural hazards (s62(1)(i)). However, local authority attempts to attach predictions of climate change-associated impacts either to property files, or in plans, have been successfully opposed, or have had insufficient support, in the courts, planning hearings and panels (PCE 2015).

Thus while analysis suggests much of New Zealand's infrastructure is at risk of climate change impacts and associated costs (PCE 2015) and these costs may make some areas very expensive to insure, or uninsurable (ICNZ 2014), local government lacks clarity as to how to respond to such information. This may change,[6] but it is currently difficult deciding to what extent (for example) roads should continue to be maintained or built in areas where it is becoming apparent there is a significant and increasing risk of climate change-related impacts.

A more engineering resilience approach may lead to protecting existing communities rather than relocating them. This may reduce political risk for both central and local government sensitive to the threat of property rights-related legal action. But it may also contribute to lower long-term resilience and likely higher costs. In essence, adopting the term resilience in a narrow sense implies the need to change and evolve while in fact entrenching behaviours that may lead to increasing, not decreasing, risk. This is because resilience is seen to mean protecting the current system, not identifying the need to consider new systems.

7. New Zealand Land Transport Investment and Resilience

7.1. Government Policy Statement on Land Transport Funding 2015/16–2024/25

The GPS is the funding guideline for achieving Government transport strategic and policy goals. 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)). GPS 2015 (New Zealand Government 2015b) addresses resilience in the context of meeting future needs and enduring natural and manmade shocks (pp. 21 and 31) by conducting risk assessments, preventing the worst effects of likely events, and responding to emergencies and re-establishing infrastructure (p. 21). This engineering resilience approach aims at maintaining land transport systems.

The wording applied to resilience in the sense of protecting natural systems 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 is unclear, as are the mechanisms available for achieving this goal.

The wording also leaves unclear whether the emphasis is on reducing the probability of climate change, or creating systems capable of bouncing back from its impacts. Presumably it is 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, and on p. 23 says that "reducing greenhouse gas emissions from transport is an important consideration in investment policy". The latter is to be balanced against the need to better understand the costs involved relative to the environmental benefits. The emphasis appears to be on improving national, regional and local transport efficiency with emissions reduction considered as a measurable by-product (Knight-Lenihan 2015b).

7.2. National Land Transport Programme 2015

The NLTP 2015 details NZTA land transport programme funding over the three years to 2018 and includes a need to ensure effective and resilient networks. Emphasis is placed on disaster avoidance and recovery 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 incorporating a shift in the current regime.[7] However, responses are tempered by economic and social costs and short-term planning horizons, making such shifts unlikely (Knight-Lenihan 2015b)

One example cited by the NZTA is a road link over the South Island's Southern Alps. A September 2013 landslip resulted in the installation of a high-capacity rock fall protection system. The importance of keeping links open to protect the regional economy justified the NZ$8 million investment. In effect, this increased resilience within the current regime and system. Not addressed was a possible long-term increase in adverse weather events leading to further, larger, significant landslips. The response entrenches development trajectories predicated on the assumption road links will be maintained, and so potentially increasing hazard exposure. A more rounded resilience assessment may have considered reducing dependence on this link, and queried the underlying economic development assumptions requiring such links to be maintained (Knight-Lenihan 2015b).

7.3. Economic Evaluation Manual

The EEM provides procedures for funding applicants (mainly local government) to evaluate the economic efficiency of transport investments and assessments of alternatives. The 2013 version used concepts relating to resilience, but not the term itself, while the 2016 version overtly referred to resilience in the context of risk analysis and uncertainty.[8] Climate change impact assessment procedures, absent from the 2013 version, were also introduced in 2016 (sA9.6).

Potentially the EEM could account for climate change impacts of emissions by analysing the economic costs of an additional ton of carbon dioxide (or its equivalent) (the social cost of carbon—Nordhaus 2014). This could 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, the EEM limits emissions accounting to the equivalent of about five per cent of vehicle operating costs which in turn limits the impact on benefit-cost analysis, or on policy formulation.

In addition, Cabinet previously has by-passed the EEM process by creating Roads of National Significance to stimulate economic development. Despite Appendix A10 of the 2013 EEM requiring careful scrutiny of claimed national strategic factors, various RoNS were not subject to critical analysis (Knight-Lenihan 2015a). 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 (Knight-Lenihan 2015b).

Overall, the EEM's role reflects the current regime and ensures levels of service are maintained and improved. Its processes allow for a regime shift, if that is indicated through the GPS or the NZTP.

8. Discussion

Evidence from infrastructure management document analysis shows recent interest from particularly the New Zealand Treasury in exploring resilience theory in terms of absorb, recover and adapt, and possibly transitioning to a new regime and system. However, this is not fully reflected in key statutory decision-making documents related to land transport funding. The term itself appears, but its application favours absorb and recover, with some adaptation.

A more nuanced application would be expected to include a strong connection between the implications of transport funding and New Zealand's contribution to global atmospheric carbon emissions. This is because resilience analysis and practice would require a risk assessment identifying the extent of the required adaption to predicted change while at the same time identifying how to reduce the probability of it happening. A resilient transport system could link the benefits of investing to reduce vulnerability in terms of both adaptation and emissions reductions.

Emphasising the point, a Ministry of Transport 2014 post-election briefing to incoming ministers 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 document subsequently discusses how to engineer protection, or consider the cost-effectiveness of responding once the damage has occurred. The need to link the emissions implications of transport investment is not discussed.

Such narrow definitions of resilience locks development into a non-resilient pathway by apparently reducing uncertainty and creating an illusion of control (Knight-Lenihan 2015b) by focussing on aspects of the system rather than the whole (Helm 2009, Pescaroli and Alexander 2016). In 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).

Alternatively, resilience thinking can help structure analysis of complexity, uncertainty and interrelatedness of systems and processes (Slootweg and Jones 2011). This can augment strategic environmental assessments and create a formalised mechanism for analysing the interplay between ecosystem and human development, their interdependencies and desired or unwanted changes to be embraced or avoided (Walker *et al.* 2009).

Equally there is legitimate community uncertainty over how to deal with an unprecedented change. Who bears the cost becomes a particularly difficult problem. Uncertainty and cost-bearing become particularly acute if a new set of socio-economic-ecological assumptions are identified as part of a resilience analysis. This is part of the discussion on responding to climate change, and it is one governments such as New Zealand's have yet to overtly tackle. Analysis post the December 2015 Paris Climate Conference (COP 21) suggest current country emission reduction intentions will be inadequate and that profound social and economic changes will be required, and quickly.[9]

A full resilience analysis has yet to be done of risk exposure and action required to meet New Zealand's intended greenhouse gas emissions reduction target, tabled at Paris, of 30% below 2005 levels by 2030. The country's main transport emissions reduction policy plank focuses on shifting travel to public transport, walking, cycling, biofuels and electric vehicles (New Zealand Government 2015c). As noted earlier, declines in transport emissions hinge on technological and policy changes. The former appears to be advancing, but the latter has yet to be detailed. Under such conditions a resilience analysis would likely highlight the need for significant shifts in transport investment policy

in ways that might be politically challenging. Hence adopting resilience in its full meaning remains politically difficult.

Of course all this presupposes the adoption of resilience terminology actually matters. In many ways it does not: if actions are taken to tackle the problem, how they are labelled is unimportant. Indeed, adopting a new term can hamper existing work as clarity is sought over what actions should be included in its meaning (see for example Manyena 2006). Such relabelling may result in little change. And this appears to be the nub of the problem in this case.

The term is being adopted in policies and programmes, and its broader implications are available through the literature, with aspects being communicated to central government through agencies such as Treasury. Yet, as noted, transport funding policy and process show limited evidence of being influenced by the evolving understanding of what resilience means. Therefore, while adopting the term, the approach remains business-as-usual: that is, a form of relabelling. This may lead to decisions perversely reducing long-term resilience. Funding allows continuing development in areas increasingly at risk from the effects of climate change, and does not adequately accounting for increased emissions from transport investment.

9. Conclusion

The term resilience, as applied in New Zealand's national transport funding process, focuses on improving the ability to absorb impacts, recover, and maintain business as usual. There is limited consideration of transport as both a contributor to climate change as well as underpinning development exposing New Zealand communities to climate change impacts. In this context, resilience terminology creates the illusion of control over uncertainty while possibly making systems less resilient in the long-term.

Balancing this are influential government agencies such as the Treasury actively investigating the broader theoretical and practical application of the concept when assessing a suite of risks facing New Zealand. This includes absorbing impacts, recovering from them, adapting to changing conditions, and possibly transforming to a new system. Given observations from the insurance industry, local government and the Parliamentary Commissioner for the Environment of the need for a more strategic and realistic approach to managing climate change, resilience analysis may still generate consideration of transitional change ultimately influencing transport funding policy.

In terms of lessons for the international community, testing how the understanding of resilience is evolving may be one part of the puzzle of how to shift communities to a climate-constrained future. The primary premise for resilience analysis is to identify the ecological limits of systems and how development pathways may operate within those limits.

This is not a new concept. For example, strategic environmental assessments take a similar philosophical position (Pardiário 2012). The difference lies in a possible Trojan Horse effect: seeing the term resilience rapidly adopted raises the possibility of unpacking its true meaning and potential. Whether communities are willing and able to accept the implications of the message is not easily answered. However, it might be that the current process is the correct one: engage in a discussion on what resilience really means, and then get it to influence resource allocation. This may improve the likelihood of community understanding and acceptance.

In summary, there is no one clear definition of resilience in New Zealand documents influencing transport spending. There is however an apparent meaning relating to maintaining and improving current levels of service while considering to an extent adaptation to new climate conditions. This provides a degree of agreement on what is meant by resilience for decision-makers, suggesting the term has some (albeit implicit) utility for explaining and understanding complex systems. However, this apparent understanding does not reflect the evolution of thinking in the literature, nor analysis by government agencies. Thus while future funding allocations may need to overtly demonstrate how climate change is being addressed, current funding reinforces a non-resilient development trajectory.

Notes

1. Responses to recent November-December 2016 South Island earthquakes included deciding on the balance between rebuilding roads and rail (bouncing back) versus investing more in coastal shipping (bouncing forward) (www.stuff.co.nz/business/86945807/kiwirail-offering-coastal-shipping-service-in-response-to-quakeaffected-rail-line accessed December 2016).
2. The petition called for the New Zealand Governent to undertake a national risk assessment of economic security, energy and climate, business continuity, ecological and environmental security, and genuine well-being.
3. New Zealand's *Resource Management Act 1991* uses the term sustainable management but arguably defines it using sustainable development terminology (s5). The overall broad judgement approach has dominated court interpretations, but this may be shifting to accepting the dominance of certain values in particular situations (Daya-Winterbottom 2014).
4. See http://www.mfe.govt.nz/publications/fresh-water/next-steps-fresh-water-consultation-document accessed April 2016.
5. For details see http://www.treasury.govt.nz/abouttreasury/higherlivingstandards accessed April 2016.
6. Local Government New Zealand's 2016 commentary is at www.lgnz.co.nz/home/news-and-media/2016-media-releases/local-government-strengthens-its-climate-change-policy-response/. Central government's reponse began in 2004, promotes a justifiable risk management response, and is being updated (http://www.mfe.govt.nz/climate-change/adapting-climate-change/adapting-sea-level-rise), including a recently announced Government-appointed adaptation working group (https://www.beehive.govt.nz/release/climate-change-adaptation-experts-appointed) (All websites accessed November 2016).
7. 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).
8. See www.nzta.govt.nz/resources/economic-evaluation-manual (Accessed May 2016).
9. See for example Averchenkova & Bassi, 2016; Climate Action Tracker http://climateactiontracker.org/ accessed May 2016.

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