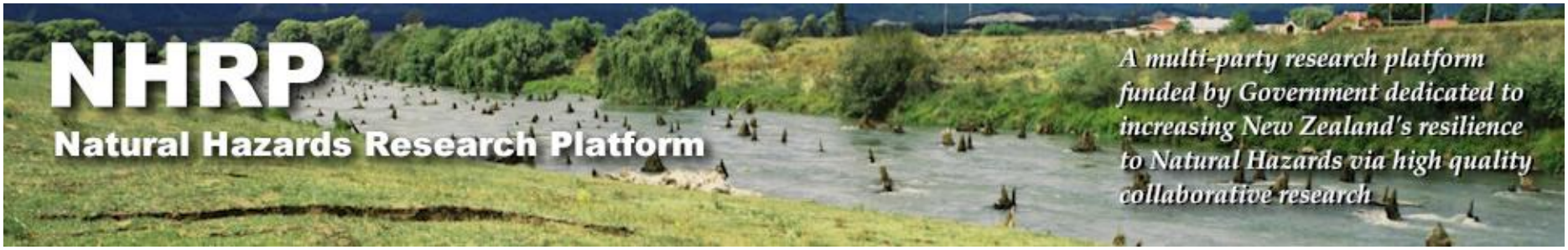

Infrastructure Theme Leader

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November 2013

Facilitate cooperation, collaboration and co-ordination between researchers
Increased linkage of research with practitioners

Key NZ Research Activities

- *Update from the Natural Hazards Research Platform*
- *Economic Modelling – Tony Fenwick*
- *The Resilience of Ports – Liam Wotherspoon, University of Auckland*
- *Projecting Damage and Losses for Building and Infrastructures from the Canterbury Earthquake Sequence - Sonia Giovinazzi, University of Canterbury*
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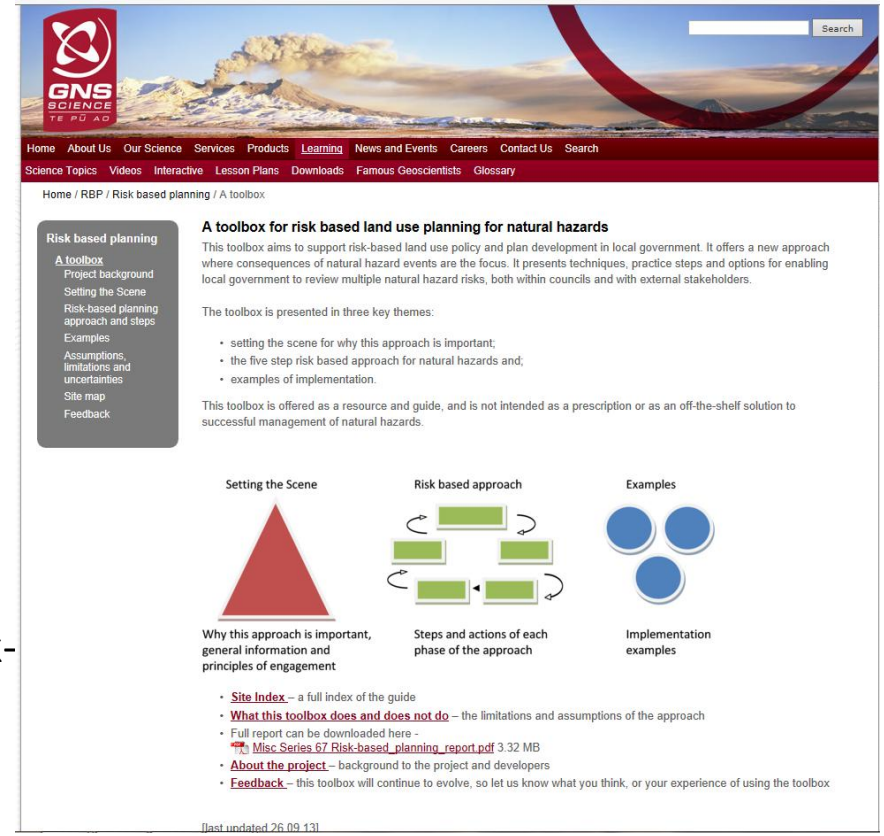
Natural Hazard Risk-Based Toolbox
Available to use

- Wendy Saunders, GNS (w.saunders@gns.cri.nz)
- Toolbox to support natural hazard risk-based land use policy and plan development in local government.
- Developed with planners, it offers an approach that focuses on the consequences of natural hazard events (including those to lifelines and critical buildings).
- Highlights include how to incorporate community engagement processes; a risk-based district plan chapter; and national and international examples.
- The toolbox and full report is available at: http://www.gns.cri.nz/Home/RBP/Risk-based-planning/A-toolbox



Interdependencies of Critical Lifelines and Infrastructure

- Rob Buxton, GNS (r.buxton@gns.cri.nz)

- Developing models to minimise post-earthquake trauma and economic impact for people in urban areas

- Interdependencies examples …. Florida Hurricanes 2004:
  - Energy shortage – closing of ports disrupted supply of petrol, coal and emergency supplies
  - Communications – cooling water supplies cut off shutting down telecommunications in turn disrupting repair crews
  - Electricity – impacted communications, transportation (rail and traffic signalling systems failed)
  - Electricity – impacted water and waste water, pumping stations and treatment plants

(American Lifelines Alliance)

Picture: Metropolitan Transport Authority (New York)

Current Status

- Scoping Study (Completed):
  - Aim – to research the possible approaches for modelling interdependencies
  - Literature review, concentrating on “codeable” approaches that could be implemented as a system
  - Agent-based simulations, scalable multi-graphs, BBNs and input-output inoperability models were considered
  - Napier used as study area for proof of concept.
  - Findings published GNS Science Report 2011/19

- Future:
  - Advisory Group established
  - Complete current model development
  - An interdependencies data collection framework (crossover with Economics of Resilient Infrastructure)
  - Alternative visualisation techniques (3d)
  - Develop methods for modelling reinstatement strategies
  - Modify model approach to include societal impacts from organisational outages
  - Support to Lifelines activities

Measuring Resilience of Transport Infrastructure

James Hughes, AECOM (james.hughes@aecom.com)
Kristina Healy, AECOM

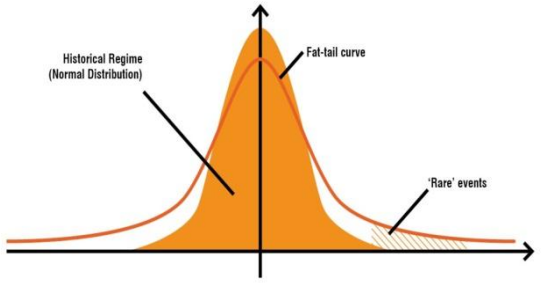
Findings:

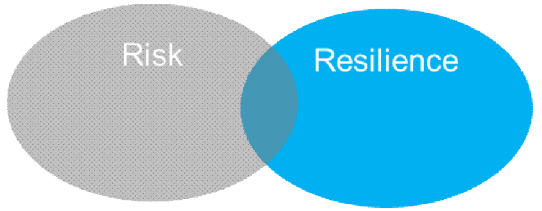
- Hazards: a range of types, shock and stress events, and level of predictability (probable, possible, plausible). 'All hazards' vs 'specific hazard'. Complex failure modes. Black swans.

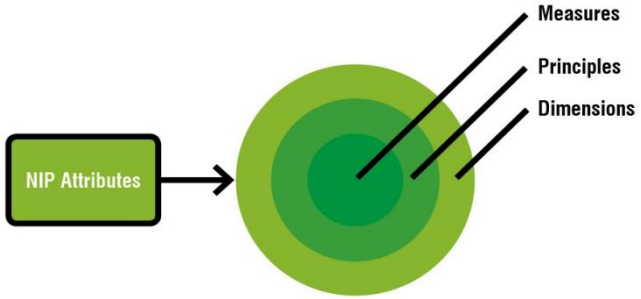
- Risk management approaches alone are insufficient. Move 'beyond risk' to consider consequence scenarios.

- Framework developed across key dimensions of **technical** and **organisational** resilience

- A measurement tool was developed across a range of principles that is able to assess the resilience of **regions**, **networks** or **specific assets** and enable prioritisation of improvements.



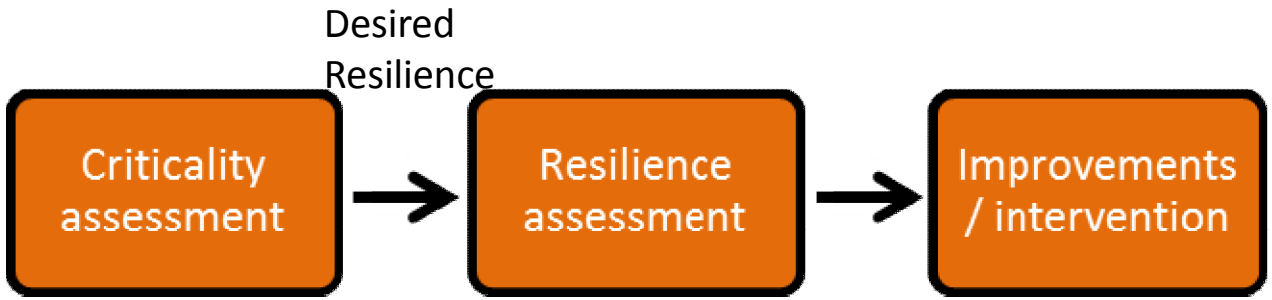




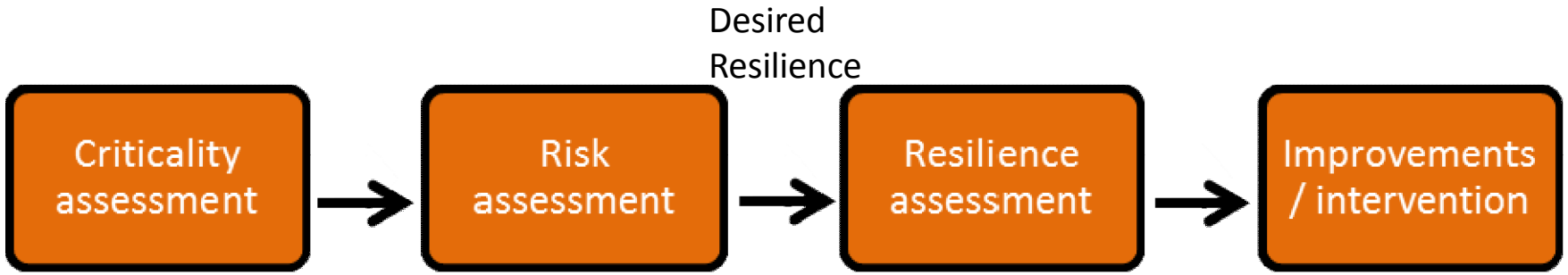
Reflections on recent international research

- Resilience in engineering systems is a characteristic of how the system *behaves* (process), as opposed to a property that the system *has* (state).
- Due to the unpredictability of complex systems, a resilience assessment demands a constant, recursive process, often across multiple organisations.
- *A resilience assessment requires recognition of incompleteness:* inherent uncertainty and incompleteness in our knowledge
- *New approaches to design:* embrace uncertainty and failure via anticipation and adaptation
- *A traditional risk-based approach is not sufficient to understand, plan and prioritise resilience improvements.*

Measuring resilience – 'all-hazards'



Measuring resilience – 'specific-hazard'



Next steps:

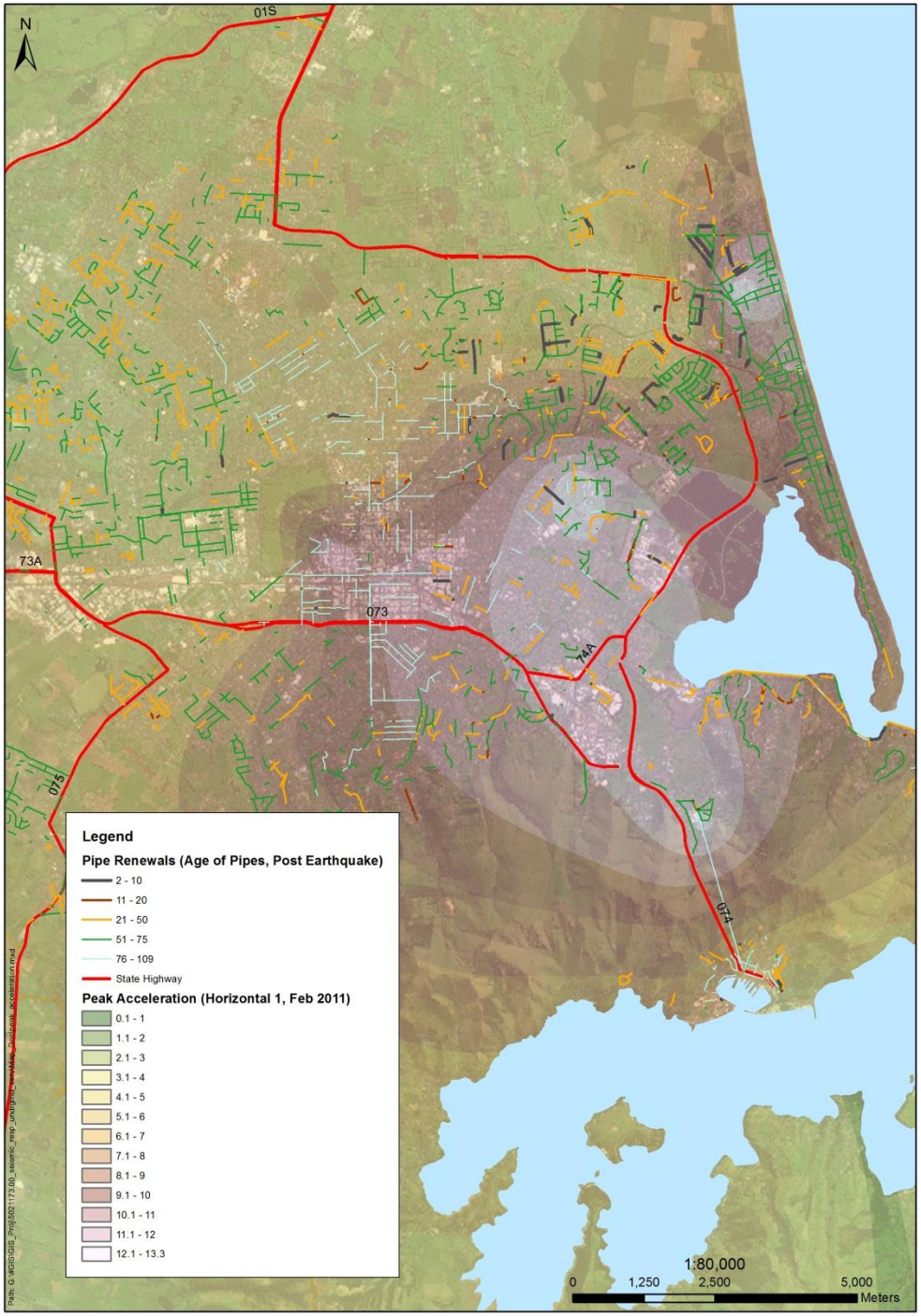
- NZTA project in final stages
- Assessment tool which can be applied to understand and prioritise resilience efforts and investment
- But there are gaps:
  - How do we design for resilience?
  - How much do we spend on resilience?
  - Which pieces of infrastructure should be resilient? (link to criticality)
  - Understanding relationship between resilience and sustainability

Seismic Response of Underground Services (& National Implications)

MBIE Research Project 2012 -2016
Opus Research & GNS

Project leader Rosslyn McLachlan
(rosslyn.mclachlan@opus.co.nz)

Team member Mostafa Nayyerloo
(mostafa.nayyerloo@opus.co.nz)



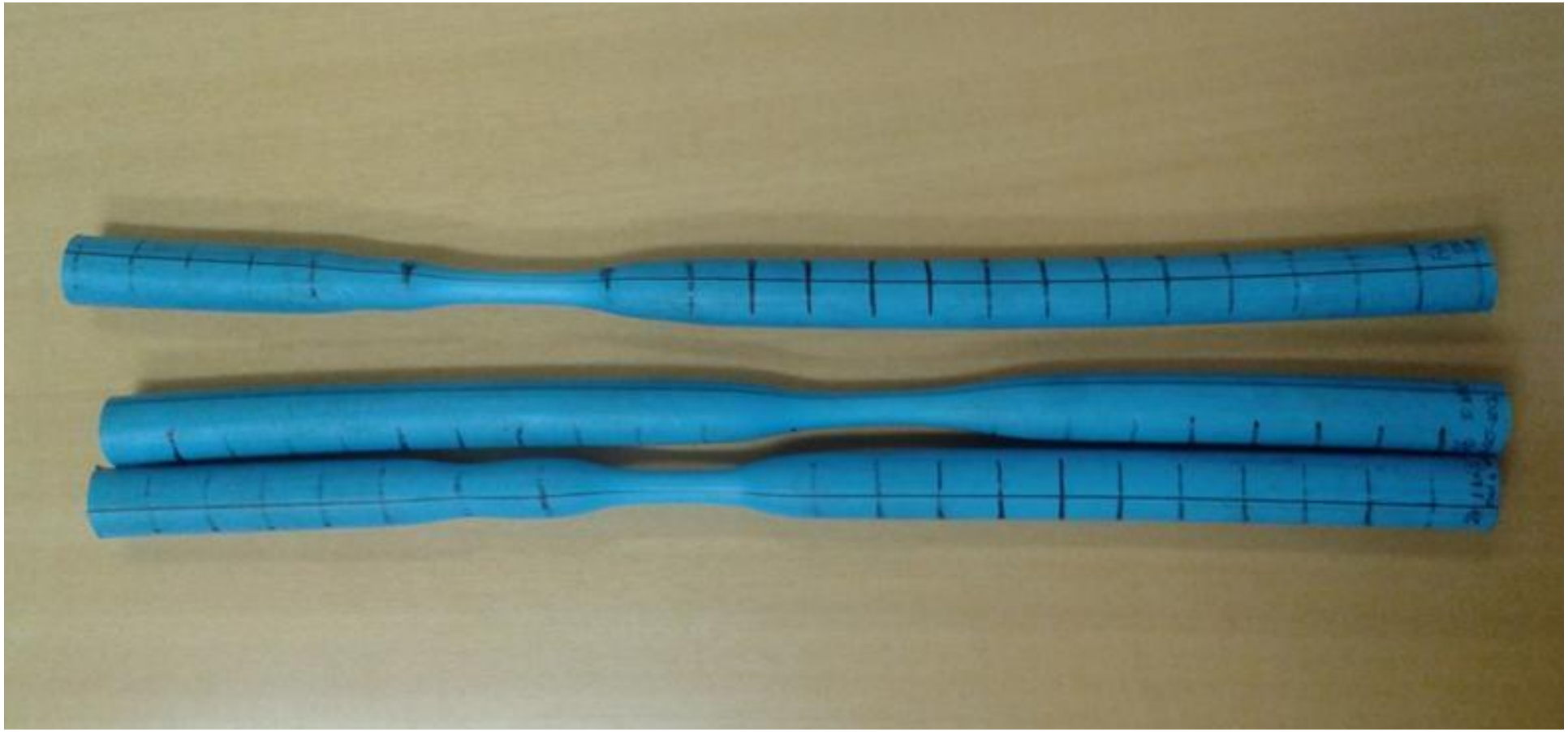
GIS: Pipe Renewals post earthquake and Peak Acceleration

Findings:

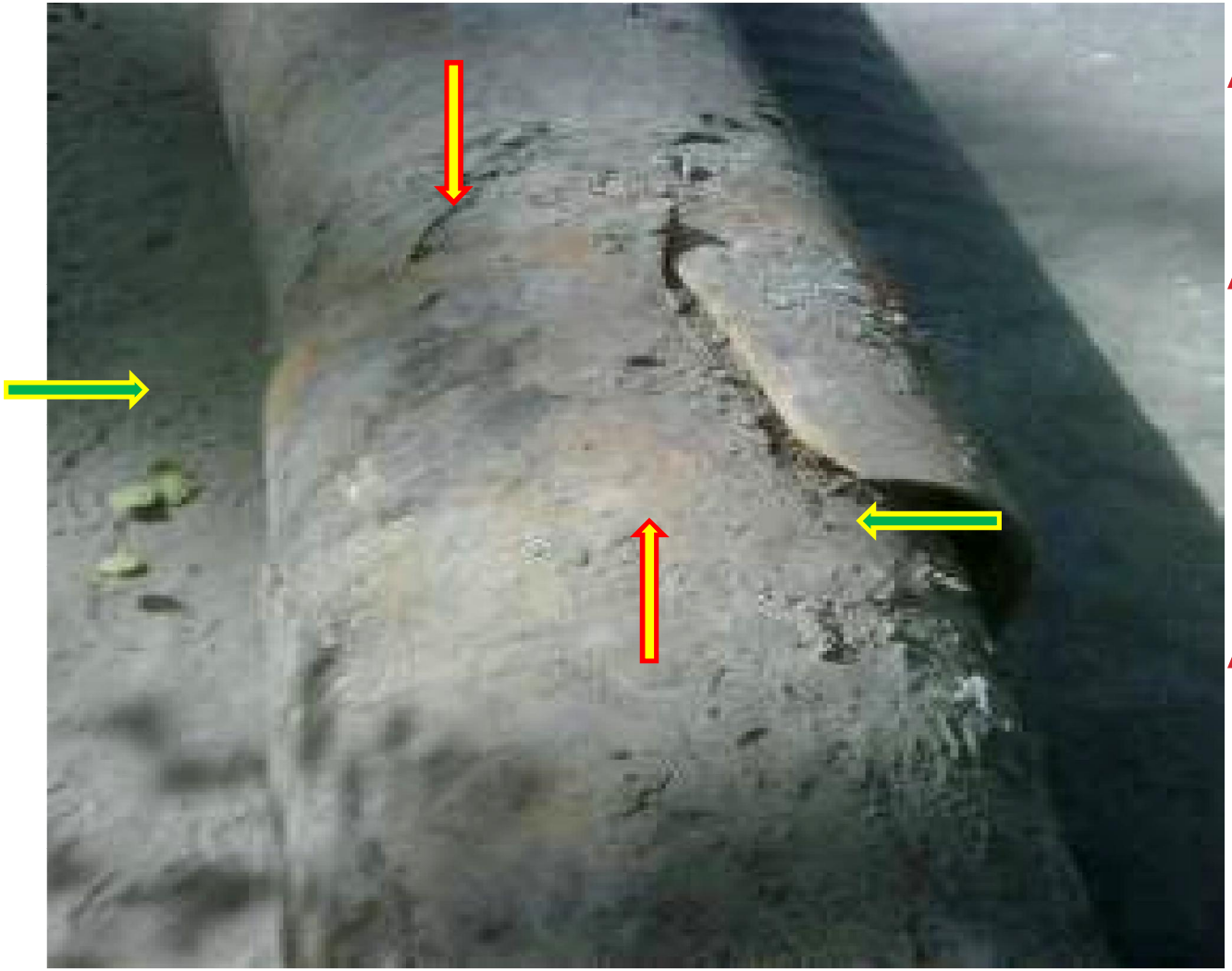
- Pipe renewals have been required both in and out of areas of high peak accelerations
- Suggests that factors other than seismic shaking are causing pipes to fail

PE80 tested in tension

- Under quite large extensions the pipe is still serviceable
- Service level reduced as is asset life



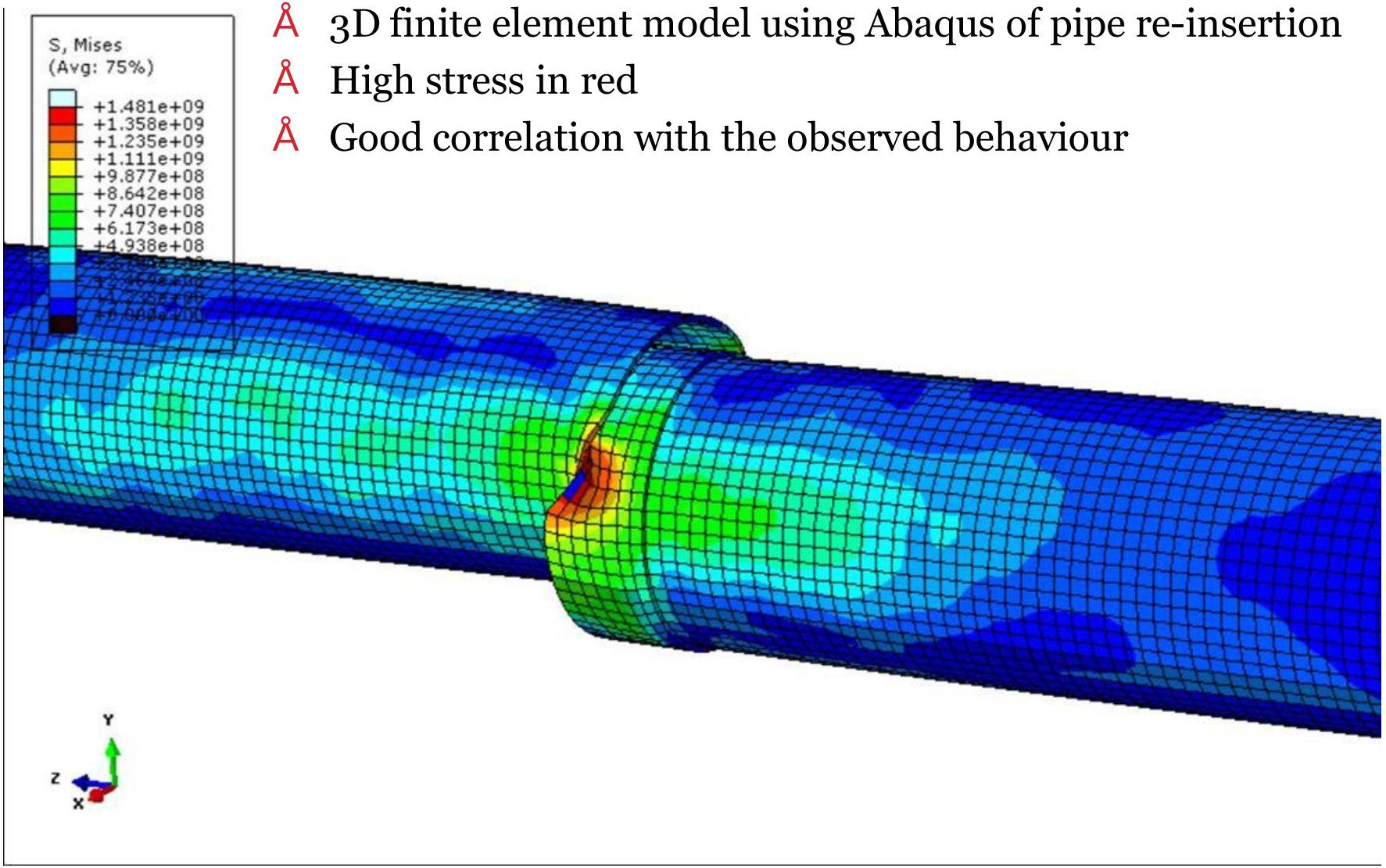
Field Observed Steel interpenetration



- Field observation of steel pipe
- Used to develop finite element model to determine forces for this damage to occur
- Stresses and strains modelled

FE model of field observation

- 3D finite element model using Abaqus of pipe re-insertion
- High stress in red
- Good correlation with the observed behaviour



Research/practitioner clusters

- Interdependencies Cluster
  - Michele Daly, GNS
  - Erica Seville, Res Orgs
  - Tony Fenwick
  - Garry MacDonald, Market Economics
  - Danielle Mieler, GNS
  - Dave Brunsdon
  - ……
  - ……
- Water Networks Cluster
  - Mark Christison, CCC
  - Brian Park, WaterCare
  - Ros McLauchlan, Opus
  - Jim Cousins, GNS
  - Gary O'Meara, Capacity
  - Tim Davin, IPENZ
  - Christopher Munden, Civic Assurance
  - Nick Walmsley, Water NZ
  - Rod Cameron, SCIRT
  - Gerard Cleary, Waimakariri
  - ……..
  - ……
- Economics Cluster
  - Garry MacDonald
  - Tony Fenwick
  - ……
- Resilience into practice Cluster
  - James Hughes
  - Ljubica Mamula-Seadon
  - ……
- Resilient Organisations
  - Erica Seville
  - John Vargo
  - Suzanne Wilkinson
  - ……

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