QuakeCoRE

NZ Centre for Earthquake Resilience

2016 Annual Meeting

31 August - 2 September

QuakeCoRE
NZ Centre for Earthquake Resilience

QuakeCoRE is transforming the earthquake resilience of communities and societies.
We do this though innovative world-class research, human capability development, and deep national and international collaborations.

Our Flagship Programmes address six areas of multi-disciplinary research, interconnected to understand and improve how our communities recover and thrive after major earthquakes.

Our Technology Platforms are advancing the underpinning infrastructure needed for our research, from lab and field experimentation to complex community datasets and high-performance computing.

Translation of our research outputs into policy and practice is achieved through active participation with our stakeholders and end users in our research programme and education of the next-generation leaders in earthquake resilience.

Annual Meeting Supported by

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TP4: Computational Simulation and Visualisation
Leader: Brendon Bradley
Deputy: Christopher McGann

Flagship Programme Leaders

FP1: Ground Motion Simulation & Validation
Leader: Brendon Bradley
Deputy: Didier Pettinga

FP2: Liquefaction Impacts on Infrastructure
Leader: Misko Cubrinovski
Deputy: Sjoerd van Ballegooy

FP3: Heritage, Safety and Economics: Addressing Earthquake-prone Buildings
Leader: Jason Ingham
Deputy: David Johnston

FP4: Next-generation Infrastructure: Low-damage and Repairable Solutions
Leaders: Ken Elwood & Stefano Pampanin

FP5: Pathways to Improved Resilience
Leader: Erica Seville
Deputy: Tracy Hatton

FP6: Spatially-distributed Infrastructure
Leader: Liam Wotherspoon
Deputy: Roger Fairclough

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BRANZ

Welcome to the 2016 QuakeCoRE Annual Meeting!

QuakeCoRE Directors

Welcome to the first QuakeCoRE Annual Meeting! With approximately 180 registered attendees, including over 30 from overseas, this Annual Meeting provides a unique first opportunity for the QuakeCoRE community to come together to share ideas and experiences; an important first step toward our collective vision of an earthquake-resilient New Zealand, realised through innovative world-class research, human capability development, and deep national and international collaborations.

The QuakeCoRE Leadership Team has developed a programme that will keep you very busy and engaged during your stay in Wairakei. Five workshops will be held on Wednesday exploring the future directions of our Flagship Programmes. Wednesday evening, Professor Tom Jordan from the University of Southern California, and Director of the Southern California Earthquake Centre, will kick off the main meeting as our Distinguished Speaker with a talk on "Earthquake System Science in California."

The agenda features plenary speakers on thought-provoking subjects that feed into discussions of future research directions for QuakeCoRE and the New Zealand earthquake resilience community, poster sessions on ongoing research, and some lively social gatherings. The overall goal of the meeting is to share recent research accomplishments, enhance our national and international collaborations, and discuss plans for the year ahead including the 2017 QuakeCoRE Request for Proposals (RfP).

The organisation of the Annual Meeting may be a little different than what you are used to from conferences. The action is centred around the poster sessions. The posters will stay up for the entire meeting to allow more face-to-face interactions on the important nuances of on-going QuakeCoRE research. As always, we will be looking for ways to improve the meeting, so give us your feedback on any and all aspects of the meeting. Just grab any member of the Leadership Team during the Annual Meeting and tell them what you think.

We hope you are inspired by the research, and social activities and connections you make, and that you take a moment to contemplate the beautiful landscape of Wairakei.

Thank you for your collaboration!

Ken Elwood, Director

Brendon Bradley, Deputy Director

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Programme

Wednesday, 31 August

17:00-18:00	Welcome Reception	*Geyser House Bar*
18:00-19:30	Opening Session Welcome Distinguished Lecture: Earthquake System Science in California *Tom Jordan (USC, Director of Southern California Earthquake Center)*	*Waikato Room*
19:30-22:30	Dinner Poster Session and socialising	*Graham Room*

Thursday, 1 September

09:00-10:00	Welcome and State of QuakeCoRE	*Waikato Room*
10:00-10:30	Morning Tea	
10:30-12:00	Plenary Session 1: Community Datasets and Community Models Moderators: *Nick Horspool (GNS), Anna de Raadt (LINZ/ CRCSI)* Speaker 1: *Sjoerd van Ballegooy (Tonkin & Taylor)* *The NZ Geotechnical Database and Internationally Relevant Research it has enabled.* Speaker 2: *Ellen Rathje (University of Texas, Austin)* *DesignSafe- A Cloud-Based Environment for Research in Natural Hazards Engineering.*	*Waikato Room*
12:00-13:30	Lunch	
13:30-15:00	Plenary Session 2: Transforming Earthquake Resilience through Advanced Computation Moderators: *Brendon Bradley (University of Canterbury), Ricardo Taborda (University of Memphis)* Speaker 1: *Christopher McGann (University of Canterbury)* *Opportunities and Challenges for Increased Understanding and Resilience through Advanced Computational Models.* Speaker 2: *Abie Liel (University of Colorado, Boulder)* *Waiting For the Big One: Simulations of Infrastructure Performance to Inform Seismic Risk Decision-making before the Next Earthquake.*	*Waikato Room*
15:00-15:30	Afternoon Tea	

15:30-17:00	Plenary Session 3: System-level Resilience – Challenges and Opportunities Moderators: *David Johnston (GNS Science/Massey University), Mary Comerio (University of California, Berkeley)* Speaker 1: *David Lallemant (Stanford University)* *From Building-level Risk to Human and Infrastructure Systems Resilience.* Speaker 2: *Tom Wilson (University of Canterbury)* *Bridging Gaps: Challenges and Opportunities for System-level Resilience.*	*Waikato Room*
19:00-22:30	QuakeCoRE Dinner Poster Session and socialising	*Karapiti Room* *Graham Room*

Friday, 2 September

08:30-10:00	Plenary Session 4: Cross-disciplinary Case Studies Moderators: *Erica Seville (Resilient Organisations), John Hare (Holmes Consulting Group)* Speaker 1: *Russ van Dissen (GNS Science)* *It's Our Fault - a Decade of Co-generated Research Aimed at Better Defining Earthquake Risk in the Wellington Region.* Speaker 2: *Laurie Johnson (Laurie Johnson Consulting)* *Insights from a Career of Cross-disciplinary Collaboration.*	*Waikato Room*
10:00-10:30	Morning Tea	
10:30-12:00	Lightning Talks: Celebrating Emerging Researchers Conrad Zorn: *Interdependent Infrastructure.* Gye Simkin: *Vibration Based Monitoring of Instrumented Buildings in New Zealand.* Alex Shegay: *Seismic Performance of Reinforced Concrete Walls Designed for Ductility.* Khiam Lee: *The Dynamics of Inter-organisational Collaboration in Disaster Management.* Nick Mellsop: *Whakatane CBD and why it didn't liquefy in the 1897 Edgecumbe Earthquake* Nikolaos Ntritsos: *Developing State-dependent Seismic Fragility Functions for Pile-supported Wharves.* Xavier Bellagamba: *Seismic Resilience of Underground Lifelines.* Robin Lee: *Development of a 3D Canterbury Velocity Model for Broadband Ground Motion Simulations.*	*Waikato Room*
12:00-13:30	Lunch	
13:30-15:00	Where to go from here? – Future QuakeCoRE Research Directions *QuakeCoRE Leadership Team*	*Waikato Room*
15:00-15:30	Closing Remarks	*Waikato Room*

18:00 - 19:30, 31 August

Distinguished Lecture:

The Prediction Problems of Earthquake System Science

Prof. Thomas H. Jordan

System science seeks to explain emergent phenomena at the system scale, such as global climate change or earthquake activity in California or Japan. The "system" is not a physical reality, but a hypothetical representation of nature, typically a numerical model or ensemble of models that replicates an emergent behavior and predicts its future course. This presentation will describe how earthquake system science is improving predictive models of fault rupture and seismic wave propagation through a cyclical process of model formulation and verification, simulation-based prediction, validation against observations, and data assimilation. As we work models around and outward on this "spiral of inference", we alternate between constructionistic synthesis and reductionistic analysis, addressing model inadequacies with more data and better physics. Over the last decade, this development cycle has increased the computational demands of earthquake system science more rapidly than Moore's law, and current research to improve the system-level models is now taxing the capabilities of the largest supercomputers. I will discuss efforts by the Southern California Earthquake Center (SCEC) to develop and validate earthquake forecasting models based on the coupling of rupture simulators with ground-motion simulators, focusing on how we can use this modeling framework to pose interesting problems of contingent predictability as physics questions in a system-specific context. Solving such problems is leading to probability gains that will enhance the capabilities of both long-term and short-term earthquake forecasting. For example, more accurate earthquake simulations using realistic three-dimensional crustal models can reduce the aleatory variance of the strong-motion predictions by a factor of two relative to the empirical ground motion prediction equations in current use, which would improve the estimation of exceedance probabilities at high hazard levels by an order of magnitude. Realizing this gain in forecasting probability could have a broad impact on the prioritization and economic costs of risk-reduction strategies, especially for critical facilities and transportation infrastructure.

Thomas H. Jordan is a University Professor and the W. M. Keck Foundation Professor of Earth Sciences at the University of Southern California. His research is focused on system-level models of earthquake processes, earthquake forecasting, continental structure and dynamics, and full-3D waveform tomography. As SCEC director, he coordinates an international research program in earthquake system science that involves over 1000 scientists at more than 70 universities and research organizations. He has authored 240 scientific publications, including two popular textbooks. Jordan received his Ph.D. from the California Institute of Technology in 1972 and taught at Princeton University and the Scripps Institution of Oceanography before joining the Massachusetts Institute of Technology in 1984. He served as head of MIT's Department of Earth, Atmospheric and Planetary Sciences from 1988 to 1998. He received the Macelwane and Lehmann Medals of the American Geophysical Union and the Woollard Award and President's Medal of the Geological Society of America. He is a member of the National Academy of Sciences, the American Academy of Arts and Sciences, and the American Philosophical Society.

10:30 - 12:00, 1 September

Plenary Session 1:

The NZ Geotechnical Database and Internationally Relevant Research it has enabled

Dr. Sjoerd van Ballegooy

Community data and models are the basis of large research efforts that can transcend disciplinary boundaries and enable far deeper and broader understanding and insights than what can be gained compared to when community access to datasets and models have restricted accessibility. The development of the Canterbury Geotechnical Database (CGD), which has now been expanded into the New Zealand Geotechnical Database (NZGD), provides a good example where the pooling of geotechnical data into a shared database system has resulted in unprecedented collation of geotechnical data. This pooling of data has enabled the building of large scale models in the Christchurch area for a diverse range of applications and enabled extensive and collaborative research and insight to be made in the field of liquefaction. This pooled data has also been utilised by many other disciplines resulting in large cross disciplinary research studies. This presentation will first discuss the philosophies that underpinned the successful development of the CGD and provide examples of projects that have been undertaken as a result and some of the exciting opportunities that could still be explored. The presentation will then go on to explore other areas in earthquake engineering where community based datasets and models could be implemented which could radically change the way research is undertaken and the advancements that could be made in the field of earthquake engineering.

Sjoerd van Ballegooy is a senior geotechnical engineer and technical director at Tonkin + Taylor Ltd, a specialist geotechnical consultancy company in New Zealand. He received his undergraduate and graduate degrees from the University of Auckland, New Zealand. Since September 2010, Sjoerd has been involved in leading the geotechnical response to the damage caused by the 2010-2011 Canterbury earthquake sequence and in 2013 received the Queen's Service Order, Honorary Companion for his services to geotechnical science. His main roles involved overseeing the mapping of the land damage and building damage and the ground surface subsidence, helping the New Zealand Government to evaluate which land would be suitable for rebuilding and the New Zealand Earthquake Commission understand its land liabilities and identify which land is vulnerable to liquefaction and where the vulnerability has increased as a result of the physical changes caused by the earthquake sequence. Sjoerd has also architected the online geotechnical database system to manage, gather and disseminate the land damage data and geotechnical investigation data to the wider engineering community, as well as lead a large ground improvement trial programme to evaluate the effectiveness of different ground improvement methods to enable the residential areas of Christchurch to be rebuilt with greater resilience to future damage using affordable solutions.

10:30 - 12:00, 1 September

Plenary Session 1:

DesignSafe- A Cloud-Based Environment for Research in Natural Hazards Engineering

Dr. Ellen Rathje

DesignSafe (www.designsafe-ci.org) is the cyberinfrastructure (CI) platform being developed as part of the Natural Hazards Engineering Research Infrastructure (NHERI) to support natural hazards engineering research. DesignSafe allows researchers to more effectively share, publish, and find data; perform numerical simulations using high performance computing; and integrate diverse datasets. DesignSafe

embraces a cloud strategy, with all data, simulation, and analysis taking place on the server-side resources of the CI, accessible and viewable from the desktop. Two important DesignSafe components for researchers are the Data Depot and the Discovery Workspace. The Data Depot is the central shared data repository that supports the full research lifecycle, from data creation to analysis to curation and publication. The Discovery Workspace is the place for researchers to perform simulations using the most sophisticated computational tools (including OpenSees), as well as analyze, visualize, and transform their data using cloud-based tools such as MATLAB or Jupyter notebooks. This presentation will describe the DesignSafe functionalities and provide examples of how DesignSafe can be used today to enhance earthquake engineering research.

Dr. Ellen M. Rathje is the Warren S. Bellows Centennial Professor in the Department of Civil, Architectural, and Environmental Engineering at the University of Texas at Austin. She has expertise in the areas of seismic site response analysis, seismic slope stability, field reconnaissance after earthquakes, and remote sensing of geotechnical phenomena. Dr. Rathje is a founding member and current Co-Chair of the Geotechnical Extreme Events Reconnaissance (GEER) Association and she was a member of the Board of Directors of the Earthquake Engineering Research Institute (EERI) from 2010-2013. She is the Principal Investigator for the DesignSafe-ci.org cyberinfrastructure for the NSF-funded Natural Hazards Engineering Research Infrastructure (NHERI). She has been honored with various research awards, including the Huber Research Prize from the American Society of Civil Engineers (ASCE) in 2010, the Hogentogler Award for outstanding paper from ASTM Committee D18 in 2010, the Shamsher Prakash Research Award in 2007, and the Shah Innovation Prize from EERI in 2006.

13:30 - 15:00, 1 September

Plenary Session 2:

Opportunities and Challenges for Increased Understanding and Resilience through Advanced Computational Models

Dr. Christopher McGann

Numerical simulation and computational modelling are critical tools for earthquake resilience. Such computational approaches allow for the consideration of a much broader range of hazard scenarios than is feasible by other means, facilitating comprehensive examination of seismic hazards, seismic response of infrastructure, and assessment of the loss associated with seismic damage. While there are many advantages and opportunities for gain in current and near-future computational approaches, there are also challenges that must be overcome in order to fully realise the potential of advanced computational methods in performance-based earthquake engineering design and analysis.

As the community moves forward, it is critical to take full advantage of computational resources such as parallel and grid computing to answer new questions that can only be addressed through the consideration of very large and complex models, which facilitate the study of the response of a single infrastructure component in great detail, or large parameter/sensitivity studies that allow for an assessment of the uncertainty in the response of infrastructure to a large range of hazard levels, load cases, or model conditions. Other critical numerical approaches include utilising advanced constitutive models and other numerical simulation tools to better consider the effects of complex nonlinear material behaviour on infrastructure response, and advancing the consideration of coupled system response (e.g., soil-foundation-structure response analysis) and multi-hazard load scenarios (e.g., earthquake, tsunami, landslides and debris flows). Specific examples of advanced geotechnical and structural modelling approaches are given to demonstrate these ideas and facilitate group discussion, and a comparison is made between computational approaches in ground motion simulation, where sophisticated models are commonplace but the expectation of validation is much greater, and geotechnical ground response analysis, where simple 1D equivalent linear models are the benchmark analysis.

Dr Christopher McGann is a lecturer in earthquake engineering in the Department of Civil and Natural Resources Engineering at the University of Canterbury in Christchurch, New Zealand. Chris received his BS from Montana State University in 2004, then from 2004 to 2007 he worked as a naval architect at the Puget Sound Naval Shipyard and Intermediate Maintenance Facility in Bremerton, Washington. He returned to school in 2007 and received his MS and PhD in structural engineering from the University of Washington in 2009 and 2013, respectively. From 2014 to 2016, Chris was an assistant professor at Washington State University in Pullman, Washington. His research activities have focused on seismic response analysis of soil-foundation-structure systems, finite element technology and constitutive modelling, and regional geotechnical site characterization.

13:30 - 15:00, 1 September

Plenary Session 2:

Waiting for the Big One: Simulations of Infrastructure Performance to Inform Seismic Risk Decision-making before the next Earthquake

Assoc. Prof. Abbie Liel

In recent decades, advances in computational power, together with probabilistic methods for assessing performance of building and other infrastructures, have significantly changed the nature of earthquake engineering simulations and their usefulness for decision making. This talk will describe three examples of decision making for seismic design and mitigation that have been informed by nonlinear dynamic analysis and probabilistic methods. The first example examines design provisions in building codes. In the U.S., the FEMA P-695 method has essentially benchmarked modern codes as targeting a risk of collapse that corresponds to 10% probability of simulated collapse under the maximum considered earthquake motion. This benchmark enables us to test the addition or deletion of code provisions as it impacts this goal. Here, we will investigate how collapse risk can be used to investigate accidental torsion provisions used in design. The second example focuses on the risk posed by existing potentially non-ductile reinforced concrete buildings. Los Angeles has recently led the way among U.S. cities in mandating retrofit of vulnerable pre 1980 concrete buildings. However, there is an urgent political and pragmatic need to develop procedures to quickly identify the most vulnerable "killer" buildings as priorities for retrofit. We are using nonlinear dynamic simulation of buildings of this type to quantitatively identify very weak buildings and very torsionally irregular buildings as high risk candidates for retrofit. Finally, we will examine regional level seismic risk simulations and probabilistic (Monte Carlo based risk assessments), investigating the additional challenges and opportunities presented by regional scale simulations. The example will examine the distribution and characteristics of seismic risk of concrete buildings in southern California.

Abbie is an Associate Professor of Civil, Environmental and Architectural Engineering at the University of Colorado, Boulder. She earned undergraduate degrees in Civil Engineering, and the Woodrow Wilson School of Public Policy, at Princeton University. She started her graduate studies in the United Kingdom on a Marshall Scholarship, where she received a M.Sc. in Civil Engineering and a M.Sc. in Building and Urban Design and Development. Abbie did her Ph.D. at Stanford University, under the

guidance of Professor Gregory Deierlein, focusing on collapse risk of older non-ductile concrete frame structures. At CU, Abbie has worked on problems related to performance of concrete buildings, snow loads on structures, and flood damage in the 2013 Boulder, CO floods. She recently received the Shah Family Innovation Prize from the Earthquake Engineering Research Institute.

15:30 - 17:00, 1 September

Plenary Session 3:

From Building-Level Risk to Human and Infrastructure Systems Resilience

Dr. David Lallemant

Today we have the ability to predict the probability of collapse of a building due to an earthquake in the next 100 years, and can design the building to a level of risk that society deems acceptable. It is a real testament to the work of geo-scientists, engineers and policy makers that today earthquake risk is something we can calculate and design for. It is easy to forget that the theory of plate tectonics was widely accepted only in the late 1950s and early 1960s, the theory upon which all earthquake science is premised. Yet our recent advancements also make clear the limitations of risk science as a tool to understand and manage the impact of disasters on our communities. These limitations herald the beginnings of a new research frontier: human and engineering systems resilience. This presentation advocates for a shift in scale and focus of research in earthquake risk science, from the analysis of individual buildings to that of interconnected human and infrastructural systems, the need to include time as another dimension of analysis (i.e. risk creation as a dynamic process, and resilience having time as one of its dimensional units), and the need to develop new metrics to properly capture the human impact of disasters. Promising analytical methods, technologies and data will be presented. Finally, this presentation is premised on a belief that disasters are not exogenous to politics and history. This presentation therefore looks at new potential metrics of disaster impact which would provide avenues to better integrate the many important tools from social-science research within an integrated framework. These could shed light on some of the historical and political processes that create extreme vulnerability, and therefore provide means to address them.

Dr. David Lallemant is a research scientist at Stanford University and an upcoming assistant professor at Nanyang Technological University in Singapore (Jan 2017). His research focuses on understanding and quantifying the evolution of extreme risk in today's growing cities. He uses hazard modeling, engineering analysis, urban analytics and spatial statistics for application in large-scale natural disaster risk analysis. The transdisciplinary and policy-oriented nature of his work has led him to build collaborations with the World Bank, Google, the Red Cross, GFDRR, the United States Geological Survey and others. He holds a PhD from Stanford University (2015), a master's degree from UC Berkeley (2010) and bachelor's degree from MIT (2007). David is part of the teaching faculty at the Understanding and Managing Extremes Graduate School in Pavia, Italy, and has also taught courses at Stanford, Berkeley and the Pratt Institute. David co-founded the Stanford Urban Resilience Initiative, the ResilientUrbanism.org collaborative and the Co-Risk Labs consultancy group.
David is also active in post-disaster response and recovery, which forms the basis for his research on post-disaster assessment and community resilience. He worked for two years in Haiti following the 2010 earthquake and has been involved in the earthquake recovery in Nepal and recovery lessons learned following the Christchurch earthquake.

15:30 - 17:00, 1 September

Plenary Session 3:

Bridging Gaps: Challenges and Opportunities for System-level Resilience

Dr. Tom Wilson

Disasters are interdisciplinary, complex challenges for society. Societal expectations of how our built, economic, social, cultural and natural environment will function during and after disaster events continues to dynamically evolve and increase, all within the complex hazardscape of New Zealand. In the backdrop of the Canterbury Earthquake Sequence (New Zealand) we remain in a window where opportunities to enhance system-level resilience exist. Seizing this is a priority for researchers, decision-makers and communities.

For researchers, building and maintaining credibility is essential. Continuing to support and foster fundamental research is critical for underpinning resilience to earthquake and other hazards. But this must be balanced to ensure our applied work meets society's increasing demands that research be relevant for practitioner- and policy-decision makers. Identifying what is relevant and useful for these decision makers is not easy. Recent experiences suggest we need to effectively incentivise resilience decisions and broaden the cultural appetite for resilience – all within the context of growing and changing populations and our challenging hazardscape, in New Zealand and abroad. Science-practitioner-policy co-creation partnerships seem to be yielding fruitful and lasting impact in other fields facing equally wicked problems. This talk will explore these challenges and recent initiatives in New Zealand which are attempting to address them.

Unleashing the potential of interdisciplinary collaborations to address decision-makers needs is an exciting and potentially high value direction for future QuakeCoRE research. This talk will explore some of the priorities which must be addressed to meet these needs, including:

- Assessing and evaluating impacts and risk in a multi-hazard – particularly as risk management organisations take all-hazards approaches.
- Effective integration of social sciences into traditional earthquake engineering domains should be and is yielding considerable value – but it requires both disciplines to upskill and develop appropriate methodologies and decision-support tools that meet decision maker's needs.
- Greater partnership with decision makers to address the root causes of disaster vulnerability and risk, particularly for risk reduction strategies such as land-use planning.
- And finally, being able to communicate our knowledge and decision-support tools effectively with appropriate audiences as a two-way conversation remains one of the most important, enduring and unifying challenges.

Earthquake engineering can, has and should continue to lead efforts in this area.

Dr Thomas (Tom) Wilson is a Senior Lecturer in Disaster Risk and Resilience at the University of Canterbury. His expertise centres on natural hazard risk assessment with a focus on impacts, disaster risk reduction, and aspects of disaster resilience. While many of Tom's activities relate to the volcanology domain, he has contributed to earthquake and tsunami impact/risk assessment and risk reduction initiatives in the South Island and disaster impact lessons from the Canterbury Earthquake Sequence. Tom also has a strong interest in disaster and risk science communication and is part of a multi-institutional team which has developed teaching simulation resources to enhance communication effectiveness and confidence – which currently receives some QuakeCoRE support. Tom co-leads the Rural Priority Co-Production Laboratory of 'Resilience to Natures Challenge' (Natural Science Challenge 10). He also co-leads the Master of Disaster Risk and Resilience professional master's programme, co-hosted by Lincoln University and University of Canterbury.

8:30 - 10:00, 2 September

Plenary Session 4:

It's Our Fault- a Decade of Co-generated Research aimed at Better Defining Earthquake Risk in the Wellington Region

Russ van Dissen

Since 2006, It's Our Fault has been a highly successful applied research programme investigating the likelihood of large earthquakes in the Wellington region, and the effects and consequences of those earthquakes on both the social and built environments. The project has collaboratively engaged the efforts and expertise of scientists, engineers and planners from New Zealand's Crown Research Institutes and Universities to deliver high quality earthquake hazard and risk research that has been applicable to the insurance, engineering, geotechnical and civil defence and emergency management communities, as well as local government.

It's Our Fault is governed by a steering committee that currently comprises senior representatives from the Earthquake Commission, Wellington City Council, Wellington Region Emergency Management Office, Natural Hazards Research Platform, and GNS Science. Research objectives within It's Our Fault have been guided and refined via input from the steering committee. Over the years, the programme has been jointly funded by EQC, ACC, Wellington City Council, Greater Wellington Regional Council, the territorial authorities within the region, and the Natural Hazards Research Platform.

Examples of achievements to date include, but certainly are not limited to:

- Estimation of the likelihood of rupture of the major fault lines in the region;
- Discovery of the timing of the two most recent megathrust earthquakes on the subduction zone beneath Wellington;
- Compilation, for the first time, of earthquake ground shaking subsoil class maps that are directly usable within the NZ Standard for Structural Design Actions;
- Review and assessment of earthquake hazard provisions within the District Plans throughout the region, and guidance on how to introduce a risk-based land use planning approach into those plans;
- The quantification of water restoration times in Wellington City following a Wellington Fault earthquake;
- Evaluation of post-earthquake and post-tsunami sheltering needs;
- Appraisal of building damage, repair costs, and casualties for a range of major earthquakes that could impact the region.

The earthquake resilience landscape in Wellington has expanded and changed since the initiation of It's Our Fault ten years ago, and so too has the need increased for high-quality, accessible, research-based, end-user focused earthquake hazard and risk information, guidance and standards. The It's Our Fault steering committee have, in principle, agreed to fund the programme for an additional five years. Over this time, it is envisioned that programme's research objectives will increasingly focus on facilitating the implementation of, and taking direction from:

- Lessons for Wellington from the Canterbury Earthquake Sequence
- Wellington's Regional Natural Hazards Management Strategy
- A Pre-Disaster Recover Planning Framework
- Relevant existing and new research initiatives, such as those supported by the Natural Hazards Research Platform, National Science Challenge and QuakeCoRE.

Born, raised and educated (Humboldt State University and Oregon State University) in the western USA. Moved to New Zealand about 25 years ago to take up a position with the then Earth Deformation Section of the New Zealand Geological Survey. Fellow of the New Zealand Society for Earthquake Engineering. Research specialties include earthquake geology and seismic hazard assessment. Significant involvement in the development of the Ministry for the Environment's "Active Fault Guidelines"; characterisation of the surface fault rupture along the Greendale Fault during the September 2010 Darfield earthquake and its impacts on man-made structures; and currently leading the "It's Our Fault" project that aims to better define earthquake risk in the Wellington Region.

8:30 - 10:00, 2 September

Plenary Session 4:

Insights from a Career of Cross-Disciplinary Collaboration

Dr. Laurie Johnson

Earthquake hazard reduction is a "wicked problem"—a social or cultural problem that is difficult to solve due to incomplete or contradictory knowledge, the number of people and opinions involved, the large economic burden, and/or the interconnected nature of these problems with other problems. As such, it also can be seen as a "collective action problem" in which there is both a shared benefit and burden for cross-disciplinary cooperation, integration, and collaboration. However, for collective action to be effective, there are a number of barriers and adaptations in knowledge and data sharing, communication, institutional and professional valuation, and other issues of project management and implementation that must be addressed.

This presentation will look across 25+ years of cross-disciplinary collaborations among the fields of geosciences, engineering, urban planning, economics and finance, emergency management, and social and political science to identify insights for building and sustaining effective cross-disciplinary collaborations and outcomes. Instead of a case-by-case litany of reflections, the insights will be derived from the author's three major thrusts of cross-disciplinary collaborations in:

- Urban disaster recovery and resilience planning and research, including leadership of the Unified New Orleans Plan concurrent citywide and district-level recovery planning following Hurricane Katrina
- Large-scale urban hazard scenario development efforts as part of the U.S. Geological Survey Science Application for Risk Reduction (SAFRR) scenario development teams for ShakeOut (M7.8 earthquake on the San Andreas fault in Southern California), ARkStorm (California-wide winter storm and catastrophic flooding), SAFRR Tsunami Scenario (M9.0 Aleutian earthquake-generated tsunami impacting the California coast), and HayWired (M7 earthquake on the Hayward Fault in Northern California)
- Natural hazard loss estimation and risk modeling (Hazus®and RMS™ insurance industry suite of natural catastrophe peril models).

Consideration will be given to the entire project/product management life cycle: start-up (scope, conceptualization and design, teaming and leadership, budgeting and scheduling), development (project/product execution, knowledge, data and information management, internal and external communication and engagement, calibration and validation), and implementation (documentation, training and outreach, knowledge management, impact monitoring, and evaluations and lessons learned).

Laurie Johnson is an urban planner specializing in disaster recovery and catastrophe risk management. She has been active in research and consulting following many of the world's urban disasters, including the 2005 Hurricane Katrina, 2011 Tohoku Japan tsunami, and 2010-2011 Canterbury earthquake sequence. She is a member of the U.S. Geological Survey's HayWired scenario team and a strategic risk advisor to the California Earthquake Authority. Dr. Johnson is also a visiting project scientist at the Pacific Earthquake Engineering Research Center (PEER), University of California-Berkeley, and chairs the U.S. National Advisory Committee for Earthquake Hazards Reduction. She also serves on the steering committee of GEER – Geotechnical Extreme Event Reconnaissance organization and board of directors of SPUR –San Francisco' civic and good governance organization. She is a long-standing member of the Earthquake Engineering Research Institute, American Institute of Certified Planners, and American Planning Association. She holds a Doctor of Informatics degree from Kyoto University and a Master of Urban Planning and Bachelor of Science in Geophysics, both from Texas A&M University.

Poster Presentations

FP1: Ground Motion Simulation and Validation — *Posters 001-016*

001 **Validation of Ground Motion Modelling of the Largest M5.7+ Aftershocks of the Canterbury 2010-2011 Earthquake Sequence**, *Caroline Holden, Anna Kaiser*

002 **Soil Nonlinearity in Physics-Based Ground Motion Simulation**, *Chris de la Torre, Brendon Bradley, Seokho Jeong, Christopher McGann*

003 **Guidance on the Utilization of Ground Motion Simulations in Engineering Practice**, *Didier Pettinga, Brendon Bradley, Jack Baker*

004 **Validations of Ground-Motion Simulations using Precarious Rocks**, *Elliot Bowie, Mark Stirling, Chris Van Houtte*

005 **The South Island Velocity Model (SIVM) - Version 1: Computational Implementation and Integration within the Unified Community Velocity Model (UCVM) Framework**, *Ethan Thomson, Brendon Bradley, Robin Lee*

006 **Effects of Realistic Fault Geometry on Simulated Ground Motions in the 2010 Darfield Earthquake, New Zealand**, *Hoby Razafindrakoto, Brendon Bradley, R.W. Graves*

007 **Dynamic Site Characterisation and Site Response in Auckland, New Zealand**, *Hannah Dawson, Liam Wotherspoon*

008 **Seismic Hazard Analysis and Ground Motion Selection in the Near-Fault Region**, *Karim Tarbali, Brendon Bradley*

009 **A Vs30 Map for New Zealand based on Surficial Geology, Topography and Direct Measurements: Current Progress**, *Kevin Foster, Brendon Bradley, Liam Wotherspoon, Chris McGann*

010 **Dynamic Site Characterisation of Central Auckland Reclamation Zones**, *Liam Wotherspoon, Kuanjin Lee*

011 **Hybrid Broadband Ground Motion Simulations of Porters Pass Fault Earthquakes**, *M Ahsan Nazer, Hoby Razafindrakoto, Brendon Bradley*

012 **Validation of Strong Ground Motion Simulations of two Historical New Zealand Subduction Zone Earthquakes on the SCEC Broadband Strong Ground Motion Simulation Platform**, *Paul Somerville, Jeff Bayless, Mehrdad Hosseini and Andreas Skarlatoudis*

013 **Nelson Tasman Site Classification Study**, *Rebecca McMahon, Liam Wotherspoon*

014 **Model Validation in Ground Motion Simulations for Southern California**, *Ricardo Taborda*

015 **Ground Motion Simulations of Small-to-Moderate Magnitude Events in the Canterbury Region using a Spectral Element Method**, *Robin Lee, Brendon Bradley, Seokho Jeong*

016 **Simulation of Site Amplification Effects at Heathcote Valley during the 2010-2011 Canterbury Earthquakes**, *Seokho Jeong, Brendon Bradley*

FP2: Liquefaction Impacts on Infrastructure — *Posters 017-025*

017 **Liquefaction Evaluation in Stratified Soils**, *Aimee Rhodes, Misko Cubrinovski*

018 **Effects of Partial Saturation on Liquefaction Triggering**, *M.A.L. Baki, Misko Cubrinovski, Mark Stringer*

019 **The Undrained Cyclic Response of Monterey Sand in Direct Simple Shear**, *Claudio Cappellaro, Misko Cubrinovski*

020 **Evaluation of Undisturbed Sampling Techniques for Pumiceous Soils**, *Mark Stringer, Rolando Orense, Misko Cubrinovski, Michael Pender*

021 **Towards a State-Dependent Approach for Seismic Fragility Analysis of Wharves Supported in Liquefiable Soil**, *Nikolaos Ntritsos, Carlo Giovanni Lai*

022 **Evaluation of Liquefaction Potential of Pumiceous Deposits through Field Testing**, *Rolando Orense, Liam Wotherspoon, Michael Pender, Misko Cubrinovski, Sjoerd van Ballegooy*

023 **Whakatane Liquefaction Case History from the 1987 Edgecumbe Earthquake: Examination of an Extensive CPT Dataset Supplemented by Paleo-Liquefaction Investigations**, *Sarah Bastin, Sjoerd van Ballegooy, Liam Wotherspoon, Nick Mellsop, Rolando Orense, Michael Pender*

024 **Geologic and Geomorphic Influence on the Spatial Extent of Lateral Spreading in Christchurch, New Zealand**, *Sjoerd Van Ballegooy, Sarah Bastin, Misko Cubrinovski, James Russell*

025 **Comparisons between Deterministic and Probabilistic Liquefaction Assessment Approaches in the Christchurch Area**, *Virginie Lacrosse*

FP3: Heritage, Safety and Economics: Addressing Earthquake-prone Buildings *Posters 026-034*

026 **Implementing Earthquake-prone Building Legislation: Comparing Earthquake Health Costs with Legislative Priorities for Earthquake Risk Remediation**, *Ann Brower, Danyon Thomas*

027 **Characterising Human Behaviour in Earthquakes: Implications for Improved Health Outcomes, Risk Communication, and Engineering Design**, *David Johnston, Carol MacDonald, Emily Lambie, Emma Doyle, Julia Becker, Michael Ardagh, Joanne Deely, Steven Jensen, Shirley Feldmann-Jensen, Michael Lindell*

028 **Shake Table Testing of Simple and Practical Securing Solutions for Face Loaded Unreinforced Masonry Walls**, *Dmytro Dizhur, Jason Ingham*

029 **Public Perceptions of Small to-Medium Enterprises (SMEs) in New Zealand - Implications for Policy Makers**, *T. Egbelakin, J. Becker, David Johnston, Caroline Orchiston, Jason Ingham*

030 **Seismic Strengthening of Reinforced Concrete Columns with Straight Carbon Fibre Reinforced Polymer (CFRP) Anchors**, *Enrique del Rey Castillo*

031 **Successful Retrofitting System of Masonry Substation using Steel Elements**, *Noor Aina Misnon, Dmytro Dizhur, John Mackenzie, Shannon Abeling, Jason Ingham*

032 **Exemplar Retrofits: Christ's College School House and Dining Hall**, *Shannon Abeling, Dmytro Dizhur, Jason Ingham*

033 **Strengthening our Buildings, Place by Place?** *Vivienne Ivory, Jason Ingham, Chris Bowie*

034 **Public Perception of Earthquake Risks & Retrofitting of Heritage Buildings**, *E. Yakubu, T. Egbelakin, K. Park, R. Phipps,*

FP4: Next-generation Infrastructure: Low-damage and Repairable Solutions *Posters 035-053*

035 **Experimental Investigation of the Seismic Residual Capacity of earthquake-damaged Concrete Buildings: Preliminary Results**, *Alberto Cuevas, Amir Malek, Stefano Pampanin, Allan Scott, Kai Marder, Ken Elwood*

036 **Dynamically Straightening Steel Buildings after Earthquakes**, *Ali Rad, Gregory MacRae*

037 **New Generation of Seismic Resistant Timber Structures with Resilient Slip Friction (RSF) Joints**, *Ashkan Hashemi, Pouyan Zarnani, Pierre Quenneville*

038 **Repair and Re-testing of Lightly-Reinforced Concrete Walls**, *Chris Motter, James Petch, Aaron Clauson, Ken Elwood, Rick Henry*

039 **Experimental Testing of Double Acting Ring Springs Type II**, *Gary Djojo, Charles Clifton, Rick Henry*

040 **Residual Strain Capacity of Earthquake Damaged Reinforcing Bars. Damage Assessment and Remaining Ductility Prediction through Vickers Hardness Testing**, *Giuseppe Loporcaro, Stefano Pampanin, Milo Kral*

041 **Effects of Bolt Grip Length on the Behaviour of Asymmetrical Friction Connections (AFC)**, *Gregory A. MacRae, Jose Chanchi-Golondrino, Geoff Chase, Geoff Rodgers, Charles Clifton*

042 **Improving Seismic Performance, Resilience, Repair, and Assessment of New Zealand Light Framed Houses with a Focus on Post-event Occupation**, *Hugh Morris, David Carradine, Minghao Li, Eric Bird*

043 **Performance of Baseplate Energy Dissipating Mechanisms for Cold-Formed Steel Storage Racking Subjected to Rocking Motion**, *James Maguire, Zhenghao Tang, Charles Clifton, Lip Teh, James Lim*

044 **Case Study of a Gap Damper to Control Extreme Displacement Demands in a Seismically Isolated Building**, *Justin Marshall, Taylor Rawlinson, Hamed Zargar, Keri Ryan*

045 **Evaluating Estimation Performance for Wireless Structural Control**, *Lauren Linderman*

046 **Design and Experimental Test of an Off-diagonal (2-4) Direction Dependent Dissipation (D3) Device**, *N. Hazaveh, Geoff Rodgers, Stefano Pampanin, J. Chase*

047 **High Performance Shape Memory Alloys for Seismic Response Control**, *Osman Ozbulut, Soheil Saedi, Haluk Karaca*

048 **Application of Floor Isolation Systems for Multi-functional Seismic Mitigation: Computational Results**, *P. Scott Harvey Jr., Nisal Halaba Arachchige Senarathna, Skylar Calhoun*

049 **Experimental Modeling and Identification of the Force-Displacement Behavior in Elastic Sliding Bearings of a Base-Isolated Structure**, *Patrick Brewick, Erik Johnson, Richard Christenson*

050 **Influence of Ground Motion Duration on Structural Collapse Risk**, *Reagan Chandramohan, Jack Baker, Gregory Deierlein*

051 **Seismic Design of Lightly Reinforced and Precast Concrete Walls**, *Richard Henry, Yiqiu Lu, Pouya Seifi, Tongyue Zhang, Lucas Hogan, Jason Ingham, Ken Elwood*

052 **Dynamic Characteristics of a PresLam Structure**, *Tobias Smith, Francesco Sarti, Gabriele Granello, Alessandro Palermo, Stefano Pampanin*

053 **Parametric Investigation of Dissipative Rocking Connections for Bridge Superstructures**, *Zeinab Chegini, Alessandro Palermo*

FP5: Pathways to Improved Resilience — *Posters 054-065*

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054 **Public Perceptions of Earthquake Risk: Implications for Policy Makers and Educators**, *J. Becker, David Johnston, T. Egbelakin, Caroline Orchiston, Jason Ingham*

055 **Decision Making for Seismic Resilience**, *Bob Kipp, Erica Seville, Tracy Hatton*

056 **Enabling Earthquake Resilience and Recovery Governance: A NZ Perspective**, *Bruce Glavovic, Iain White*

057 **Tourism and the MERIT Model: Post-quake Impacts,** *Caroline Orchiston, Nicky Smith, Garry McDonald*

058 **Understanding the Risk Information needs for New Zealand's CDEM Sector**, *M. Crawford, K. Crowley, S. Potter, David Johnston, E. Hudson-Doyle, G. Leonard, W. Saunders*

059 **Canterbury Earthquake Recovery Learning and Legacy Programme - Our Learning Infrastructure**, *Elizabeth McNaughton*

060 **Linking Building Properties to Earthquake-induced Damage and Business Downtime using FEMA P-58 and REDi Assessments**, *Gemma Cremen, Jack Baker, Sonia Giovinazzi, Erica Seville*

061 **A Robust Framework for Benchmarking Seismic Performance of Modern New Zealand Code-Conforming Buildings**, *Masoud Moghaddasi, Brendon Bradley, Ken Elwood, Greg Preston*

062 **Are Plans at Fault? How Active Faults are provided for in Territorial Authority Land use Plans**, *J. Mathieson, Wendy Saunders*

063 **Building Employee Resilience,** *Sanna Malinen, Katharina Naswall, Joana Kuntz*

064 **Creating the Business Case for Investment in Organisational Resilience**, *Tracy Hatton, Charlotte Brown, Erica Seville*

065 **A Risk-based Approach to Land use Planning for Natural Hazards**, *Wendy Saunders, James Beban, Margaret Kilvington*

FP6: Spatially-distributed Infrastructure — *Posters 066-068*

066 **Assessing the Seismic Resilience of an Underground Lifeline: Study Case of the Christchurch City Portable Water Network**, *Xavier Bellagamba, Brendon Bradley, Matthew Hughes, Liam Wotherspoon*

067 **The Dependence of National Transportation Infrastructure on Electricity**, *Conrad Zorn*

068 **Physical and Functional Performance of the Telecommunication Infrastructure after the Canterbury Earthquake Sequence**, *Sonia Giovinazzi, Rob Ruiter, Collin Foster, Simona Esposito, Bozidar Stojadinovic, Alex Tang, Adnan Rais, Mostafa Nayyerloo*

TP1: Large-scale Laboratory Facilities — *Posters 069-072*

069 **Loading Protocols for Quasi-Static Laboratory Testing**, *Christopher Motter, Ken Elwood*

070 **Horizontal-Vertical Coupling of a Building Frame System in Shake Table Testing to 3D Motions**, *Keri Ryan, Jean Guzman Pujols*

071 **Collaborative Framework for Large-scale Structural Testing Between New Zealand Research Institutions and Swinburne University of Technology**, *Lucas Hogan*

072 **Real-Time Hybrid Simulation of Base Isolated Structure Using Mixed Force and Displacement Control**, *Narutoshi Nakata, Richard Erb, Matthew Stehman*

TP2: Field-testing and Monitoring — *Posters 073-074*

073 **Earthquake-induced Displacement is Insignificant in the Reactivated Utiku Landslide, New Zealand**, *C Massey, E. Abbott, M. McSaveney, D. Petley, L. Richards*

074 **Seismic Response Analysis of the Christchurch Women's Hospital**, *Henri P Gavin, Boya Yin*

TP3: Multi-disciplinary Community Databases — *Posters 075-076*

075 **Data Integration and Visualisation: Prototyping QuakeCoRE Data Platform for Diverse Needs**, *Charlotte Brown, Joanne Stevenson, John Vargo*

076 **Estimating Real-Time Earthquake Impacts in Urban Environments through Smart Seismic Cities**, *Nick Horspool, Ken Elwood, Max Stephens, S.R. Uma, Mostafa Nayerloo*

TP4: Computational Simulation and Visualisation — *Posters 077-079*

077 **QuakeCoRE and OpenSees (Year 1): Optimisation of Source Code, Pre- and Post-Processing Tools, and Community Development**, *Christopher McGann, Seokho Jeong, Brendon Bradley, Karim Tarbali, Daniel Lagrava, Sung Bae*

078 **OpenSLAT Software for Estimating Seismic Risks**, *Michael Gauland, Brendon Bradley, Masoud Moghaddasi*

079 **QuakeCoRE Ground Motion Simulation Computational Workflow**, *Sung Bae, Viktor Polak, Richard Clare, Brendon Bradley, Hoby Razafindrakoto*

Outreach, Education and Training — *Posters 080-081*

080 **Documenting Natural Hazard Risk Communication Needs, Challenges and Innovations through Participatory Engagement**, *Jacqueline Dohaney, Thomas Wilson, Brendon Bradley, Erik Brogt, Ben Kennedy, Emma Hudson-Doyle, David Johnston*

081 **East Coast LAB (Life at the Boundary)**, *Kate Boersen*

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