Informing City Resilience

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ABSTRACT

In 2015 Wellington joined the 100 Resilient Cities Organization and began a new chapter in its resilience journey. This journey has seen a strategic focus on the use of data to enable better emergency response and to integrate and inform decision making at all levels. A resilience strategy of integrating data into governance, adaptation, recovery and community engagement has helped Wellington manage the effects of the 2016 Kaikōura Earthquake, lead engagement on sea level rise and integrate resilience building measures into the city's built environment and communities. This strategy has driven the renewal of a city data capability to provision the Risk Reduction, Readiness, Response and Recovery of the city.

Keywords

City Resilience, Open Data, GIS, Geospatial, Community Engagement.

INTRODUCTION

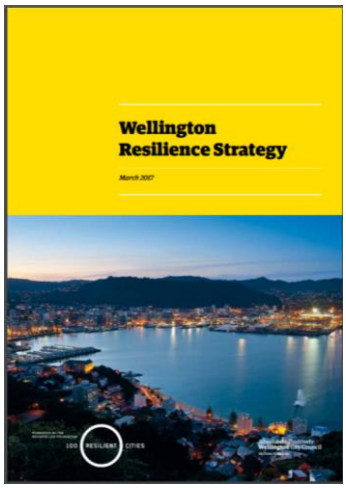
In 2015 Wellington joined the 100 Resilient Cities Organisation and began a new chapter in its long journey of improved resilience. Wellington's Resilience Story over the past three years has seen the production of a resilience strategy, the response and ongoing recovery from the Kaikōura Earthquake, renewed engagement on preparing the city for further seismic events, and progress on a number of longer term stresses in the city, such as climate change and affordable housing

As this busy programme of resilience building has continued it has been underpinned by the development of a data capability within Wellington City Council. This paper details how this capability has developed, the advantages it gives the city and how it is helping build resilience by increasing the city's emergency response, recovery, risk reduction and readiness capabilities.

Resilience Strategy

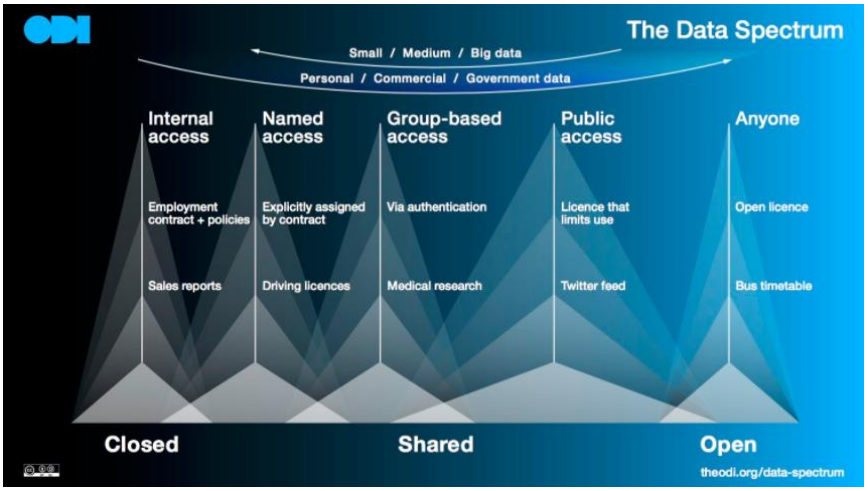
Set up by the Rockefeller Foundation, the 100 Resilient Cities Organisation has brought together 100 cities into a global network to share knowledge, resources and solutions, and ultimately to become more resilient. Membership of the network required the establishment of a Chief Resilience Officer role and the commitment that the city would produce a Resilience Strategy – a document that would lay out a vision, goals and programmes to make the city more resilient. In Wellington's case this strategy was co-created with city communities, businesses, infrastructure partners, central government and surrounding local governments. The strategy has the vision of "As Wellington changes everyone here will survive and thrive". This vision is driven through three resilience goals into a number of programmes designed to increase the many aspects of city resilience. Key to the city's success in delivering on the commitments in this strategy has been the recognition that the City Council needs to take an active role in a data ecosystem. This approach mandates the opening and

sharing of data to engage citizens and organisations in making the city more resilient.



Wellington City Council has taken the mandate of open and shared data for resilience of the city to hazards and translated that through the Open Data Institutes Open Shared Closed data framework (Open Data Institute). This framework divides data into spectrum of:

- **Open**: Data which is freely available, without restriction on user identity or intent.
- **Shared**: Data which is shared between known users based on understandings of use.
- **Closed**: Data which is only accessible by its creator or holder agency – usually data which has privacy or other concerns.



This method of governing data as applied\by the city to hazards data and research aligns with the more usual methods of city management, allowing it to be used in day to day processes within the city. The conversion of data so that it is spatially formatted and machine-readable allows meaningful insights to be generated from traditionally siloed datasets such as geotechnical and social data. This interactability and use data in day to day city management means that city staff are used to dealing with these data and tools, meaning they can quickly adapt them to be useful during an emergency. This interactability also allows resilience data to be brought into wider city systems such as web GIS, the Virtual Reality Digital City Model and other engagement systems to make these concerns relatable for citizens and multidisciplinary teams of professionals.

Response

Just after midnight on 14 November 2016 residents of Wellington city were shaken awake by the 7.8 magnitude Kaikōura earthquake, centered in the upper South Island of New Zealand. This earthquake event quickly became a test of the cities data platform and the ability to transition from resilience building processes to active response. The Kaikōura Earthquake is one of the most complex ever recorded, with 21 faults rupturing over

180km. As the energy propagated northwards, it shook Wellington, damaging buildings, but thankfully sparing the city any fatalities. The following days to weeks would involve the assessment of over 1600 multilevel commercial and residential buildings, the cordoning of streets, the evacuation of residents from affected properties and the demolition of the more severely damaged buildings. There was also damage and disruption at the city's port and other critical infrastructure sites, and coincident severe weather presented many additional challenges.

In this dynamic and very complex event the geospatial capability which was developing for the city was put to the test. From the beginning of the event the ability to convey a single, unifying picture of the city in an Emergency Operations Centre (EOC) became key. This immediately helped unify the response.

The agility of our geospatial approach was enabled by a series of decisions taken early on to manage the spatial outputs of this emergency in ArcGIS Online. Migrating the majority of our geospatial functions online was a simple task to achieve, but proved transformative in supporting our officials to assist the city's response by:

•Creating a core spatial dataset that was accessible across our organisation.

•Allowing the deployment of web maps and web scenes as common operating pictures tailored to particular teams.

•Improving the speed of delivery of products by using inbuilt base maps.

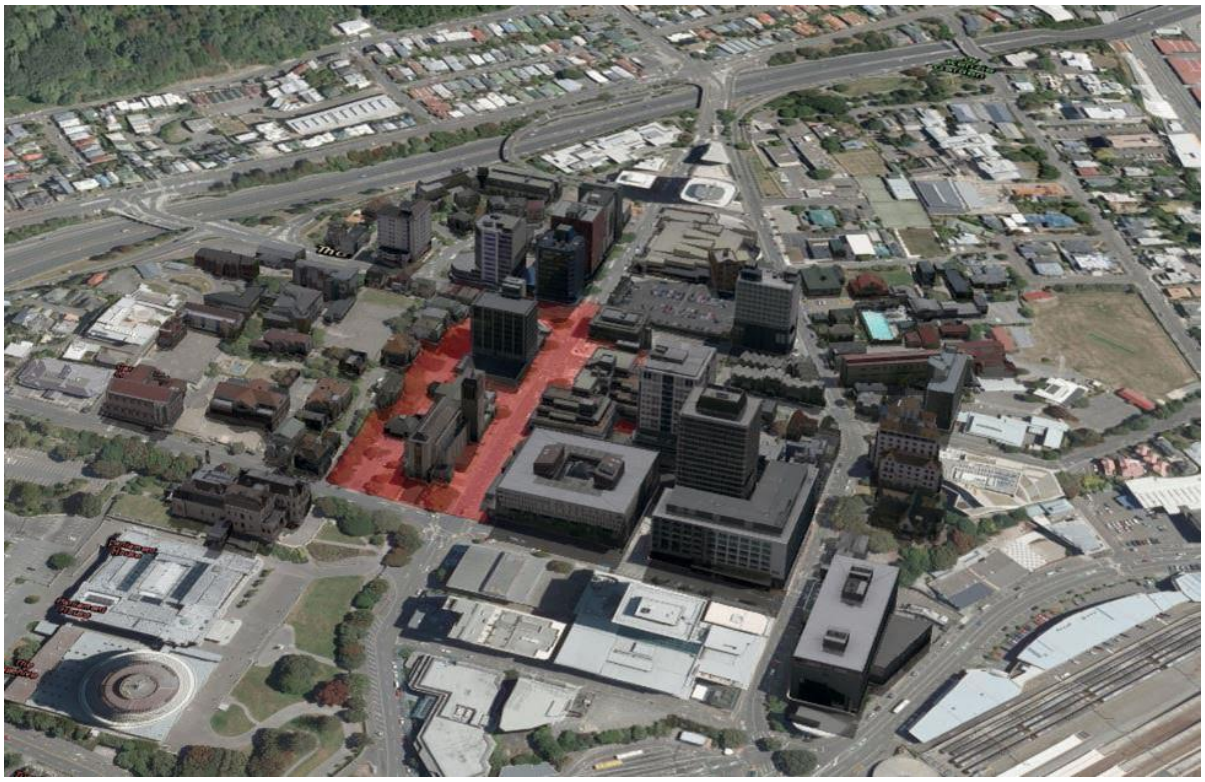
•Allowing us to project information out of our Emergency Operations Centre to specialist council teams and other organisations.

•Enabling more experimental and innovative approaches like producing 3D common operating pictures.

By migrating functions online, geospatial capability could be deployed directly to teams looking after welfare, building inspections and infrastructure and assist in ensuring information flows continued as these teams became larger and more involved in their tasks.

The online environment also proved invaluable when it came to placing damage into context- with the ability to draw on the ARCGIS-Online community of datasets and begin to understand and anticipate the impacts of cordoning off buildings and streets. In this regard, geospatial information helped us change stance from being responsive to proactive in the management of the event.

The online first model also allowed a unified approach to public information – with traditional cordon maps being produced, and Common Operating Pictures and public information web maps being updated. This is not to say that all geospatial data could be provisioned online, there was still a need for desktop backups of online data and more in depth offline analysis of aspects like economic impact. In a stressful 24 hour operation, this ability to unify systems and flows, deploy every day tools and gain the efficiencies needed to allow time to become proactive is invaluable.



One key thing that we achieved in this event was to deploy Wellington's 3D geospatial capability to communicate what was happening to our city to citizens, government decision makers and other city stakeholders. The use of 3D data and scenes became a vital capability to calculate safety zones surrounding buildings, place these zones in context and assess the surrounding streets to make logical cordoning decisions. The place in which 3D technology really delivered dividends was in the creation of web scenes. These web scenes allowed fast, intuitive briefing of leaders. Rather than seeing the abstracted cartography of a map they saw a representation of the world they were familiar with – allowing them to orient quickly, concentrate and understand what expert staff were talking about and engage effectively to make the decisions needed with confidence. The true value of 3D images in this instance was to show decision-makers that the operating scale was at a street-by-street level, and that the cordoning and closure of our entire central business district was not

necessary. This saved potentially enormous disruption to lives, loss of economic activity, logistical issues and more importantly loss of community ownership of the places people live from occurring.

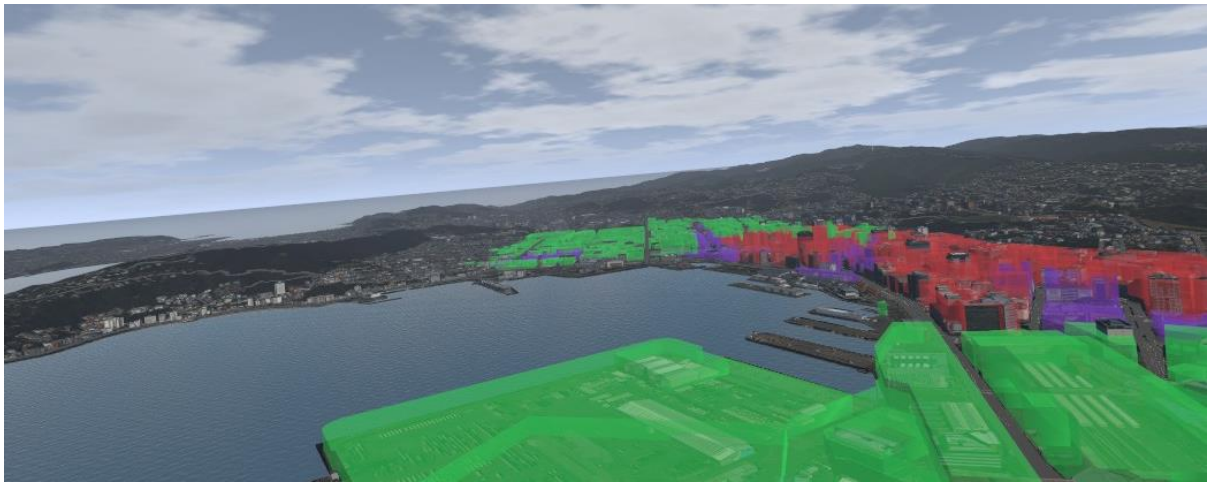
From Response to Recovery

One of the most challenging parts of dealing with an event like an earthquake is transitioning from event response to recovery. As people change from managing the emergency to a more day to day dealing with what has changed, there are challenges in how we take what we learnt forward. In this event, geospatial data has been our way of communicating across time and space. As we transitioned the online data core built during response to our teams leading the recovery, we have been able to build up layers of information looking at the patterns of damage. We have been able to draw on information looking at how the city came to have the shape it has, how the different businesses, homes and infrastructures are connected, and how it is changing, both immediately with real time traffic, but also over longer time periods. This has allowed continuity between response and recovery. The transition from response to recovery is a difficult transition for a local authority as staff are stood down and rested from their emergency roles and ongoing work is tasked back into operational units within council. This transition was made somewhat easier in the case of the Kaikōura Earthquake by having the Resilience Officer to take charge of ongoing work, and a cloud-based system made geospatial data simple to access and use.

With the shift from response to recovery, the needs of the information systems supporting operational efforts changed. The system needed to support a culture of continual improvement and ongoing management as new legislation placed new demands on city property owners and the council to manage earthquake-prone buildings. Ongoing demolition processes required welfare support for displaced residents and businesses, and the lessons learnt transferred into different parts of council to be implemented in ongoing processes. During this phase, our geospatial tools were frequently used to automate data input and transfer, and to train staff. This resulted in the creation of collector apps which are used by building inspectors to record building inspections, shortening the time needed to process this data and allowing the quick production of damage maps for the city. A side benefit of this continuity between Response and Recovery is to embed geospatial data into Council functions focused on recovery efforts and buildings. This has seen the rapid deployment of digital first information collectors with Survey 123, visualisations of data being produced in conjunction with the people collecting it and a general embrace of geospatial data and how it can improve both our city and our effectiveness as a local government.

Risk Reduction

The insights being generated during the recovery phase have been translated through councils continued operations into risk reduction. In terms of information systems, this has taken the form of combining hazard and building data with wider datasets used to plan and operate the city. A key part of this process has been the conversion of these datasets into interactable and engageable forms. This work has seen resilience data used to create a range of webmaps to support public engagement. These webmaps have been supporting efforts to engage on what climate change and sea level rise might mean for the city. They are also a step towards helping communicate what changes in hazard exposure mean for citizens daily lives and city infrastructure. This data has also been inserted into the City's Digital City Model – a metropolitan scale Virtual Reality system allowing users to see the effects of various factors in the city, including ground shaking indices, planning rules, or sea level rise. Game technology that adopts the geospatial data has been used as an engagement/planning tool - a collaboration medium between adjoining local authorities and a way of understanding how actions can affect a variety of disciplines and systems.



Key to the city's risk reduction is the ongoing engagement of communities. The city council has many processes which require public input, and officers have actively added a resilience dividend to these conversations to find ways of informing, reminding and working with people to reduce their risk. These efforts have been backed by additional information infrastructure investment such as the creation of a pedestrian flow measurement system, a way of understanding how streets are being used by pedestrians which aids both their design, but also the city's tactical situational awareness in an emergency. The City Council has also worked with communities to develop an evacuation checklist – helping guide people what they should and should not take should they have to leave their homes. These tools have helped support ongoing resilience conversations and have informed new feedback loops in the city council's data systems for use during emergencies.

Readiness

A key component of risk reduction is the understanding of which vulnerabilities cannot be reduced and instead addressed through a capability. Much of readiness in the city council's data systems is created by their ongoing use. By using our emergency management tools every day in the course of planning and administering the city, staff retain competency in using the tools. By continuing to design with both an everyday value and hazard insurance mindset the city has been able to grow an ecosystem of data which, if functioning, delivers value throughout the lifecycle of an event.

Further development

By adopting city management techniques into emergency management and resilience practices, Wellington City Council has developed a number of capabilities. We proved the advantages of working online, but there is work to do on developing standard operating procedures and data schema if we are to realise the full benefits as a city and as a country. These benefits come from being able to take map services and layers from a number of jurisdictions to build regional and national profiles with limited resources.

There is work to do on operationalising collector and Survey 123 methods across a number of groups. Now that officials have seen such technology first-hand and how they can improve lives, we are in a stronger position for the next emergency event. This will deliver dividends by speeding the information flow, reducing paper waste and improving auditability.

There is also a question of open data in emergencies; if data flows can be standardised and stabilised, can they also be made open to better engage with our community? There is significant of potential in this area to improve engagement with communities, grow resilience and empower citizens.

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