USING AN AGENT-BASED MODEL TO SIMULATE THE IMPACTS OF AN APPLIED DYNAMIC ADAPTIVE PATHWAYS PLAN

Andrew Allison, National Institute of Water and Atmospheric Research (NIWA), Hamilton, New Zealand, andrew.allison@niwa.co.nz
Scott Stephens, NIWA Hamilton, scott.stephens@niwa.co.nz
Paula Blackett, NIWA Hamilton, paula.blackett@niwa.co.nz
Yvonne Matthews, NIWA Hamilton, yvonne.matthews@niwa.co.nz
Mark Dickson, School of Environment, University of Auckland, New Zealand, m.dickson@auckland.ac.nz
Judy Lawrence, School of Geography, Environmental and Earth Science, Victoria University Wellington, New Zealand judy.lawrence@vuw.ac.nz

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CONTEXT
Coastal cities and towns are at risk from climate change and relative sea level rise (RSLR). There is uncertainty in how and when these will impact and how to adapt, meaning there is a need for flexible tools to help decision-making and decision-makers. Decision-makers have many available actions to respond to sea level rise and other coastal hazards, but there is uncertainty around which action to take in different situations and when is the best time to act.

METHODS
We use agent-based modelling (ABM) to investigate multi-hazard interaction and Dynamic Adaptive Pathways Planning (DAPP) to explore the impact of an applied DAPP to work with the deep uncertainty around urban coastal systems. We developed an ABM, which included five physical hazards, whose occurrence in time was influenced by six plausible future shared socio-economic pathway / representative concentration pathway (SSP/RCP) scenarios.
We developed a DAPP using a set of rules and coded it into the model as an integrated submodel. The intent of the DAPP is to allow the simulated society to make timely adaptation decisions in response to hazards, which minimises their socio-economic impacts. The integrated DAPP includes seven indicators that have associated 'trigger' values that instigate a change in adaptation behaviour, and it includes five adaptation actions. We established a set of adaptation thresholds for each indicator, which should be avoided, and a set of signals and triggers to initiate a change in adaptive action.
The integrated DAPP chooses an action based on what trigger became active and what an appropriate action would be to respond to it. Activation of a trigger will instigate a choice of options, an action is chosen with an associated lead time, then lead time elapses and the chosen action becomes the new management strategy, causing a change of pathway.
The model explores the timing of trigger activation under six SSP-RCP scenarios and highlights the most likely pathway society will choose under the different scenarios.

RESULTS
Several important drivers of system change were suggested by the model. The model suggests that RSLR combined with episodic storm events is the main driver of pathway changes and actions selected. Four of the six SSP-RCP scenarios have the same most common pathway; these scenarios are all SSP1 or SSP5. The DAPP will unfold the same way under each of these four scenarios. The changes in adaptive action are instigated at the same increments of RSLR in all four of these scenarios, evidenced by the same pathway across the scenarios.
The other two scenarios are different; these two scenarios are SSP3. There is more variability in these two scenarios; the DAPP will unfold differently in these two scenarios from the other four, and it will unfold differently in each of these two scenarios. Adaptive actions are not triggered at the same level of RSLR in these two scenarios as in the other four.

CONCLUSIONS
We find that RCP-induced RSLR is the main driver of adaptation timing. The model shows that adaptation actions have limited lifespans in relation to RSLR. This is not because adaptation thresholds or triggers had a hard-coded RSLR value attached; it is because actions triggered at lower levels of RSLR have a limited effectiveness with rising RSLR and become insufficient to prevent other actions being triggered.
The model suggests that the limits for soft and hard protection will occur around 25cm RSLR, three waters upgrades last to around 35cm RSLR, infrastructure improvements and policy mechanisms are feasible until 70cm RSLR, after which managed retreat is the only remaining pathway.