SUMMARY

A Decade of Dynamic Adaptive Decision-making tools in New Zealand - Practice applications, lessons learned and next steps.

Mini Symposium 9 March 2023

Purpose

A mini symposium was held in Wellington 9 March 2023 to mark 10 years since New Zealand introduced dynamic adaptive pathways planning (DAPP) approaches for addressing the new climate reality and to share research and practice experience and to discuss where to next. This builds on a 10-year collaboration between Deltares, The Netherlands and the Climate Change Research Institute at Te Herenga Waka Victoria University of New Zealand, with support from the Deep South Science Challenge, the Resilience to Nature's Challenges Science Challenge and Ministry for the Environment.

The mini-symposium was broken into four sessions—setting the context (why and how); sharing applications from New Zealand and elsewhere (what); discussing lessons learned (experience) ; advancing methods, assessment, engagement and implementation (where to).

The sixty-four participants (including fourteen online) were from research institutions and universities, local and regional government, consultant companies, crown and government agencies with experience in developing decision making under deep uncertainty (DMDU) methods, using the methods and implementing the outputs from using them. Four international researchers also attended including the developers of the DAPP and other DMDU methods from the Netherlands, a researcher and user from Boston USA applying DAPP in a cities context, and a researcher from Denmark applying DAPP at different scales for infrastructure planning under a changing climate (the full attendee list attached).

Session 1 Background and context

Two presentations set the scene. One discussed the role that deep uncertainty tools can play for decision making in a changing climate reality and why we use them, and the other covered the New Zealand context and how the decision tools were socialised into New Zealand and what enabled this to happen. A slide set from the mini symposium follows below.

A changing reality--the role of deep uncertainty tools and why do we use them? Assoc Prof. Dr Marjolijn Haasnoot Deltares and Utrecht University, The Netherlands [slides available at.]

Key messages:

- Avoid investments that lock in problems for the future in the same exposed places where damage has been or will be experienced.
- Stepwise decisions for timely investment can make finance more attractive and have reinsurance benefits for assets through better understanding of asset condition.
- Embed risk assessment and uncertainty into design standards and guidance for decision making on adaptation, mitigation and development.

- Use water and soil characteristics to determine spatial planning and enable just land use choices that reduce rather than embed risk, for example, by allowing more room for rivers and flood ways.
- Use decision tools that are fit for purpose, and which consider increasing damage from ongoing climate changes that are costed appropriately.
- Can appear to be a lot to consider but can be broken down into accessible parts and scaled for audience and purpose.

All over the world we are seeing the human footprint in our extreme events and rising seas—extreme heatwaves in USA, multiyear drought in Europe, wildfires in Australia, California and Chile, heavy rainfall events in Australia, California and Europe. The recent Auckland heavy rainfall event and Cyclone Gabrielle confirms we are in a new climate reality. A pathways-approach can help to break adaptation into manageable steps and to move onto the right track while navigating as the future unfolds. This will help to accelerate the most effective climate action. This means that decisions are flexible and can avoid detrimental dependencies that create barriers to adjusting to the new climate reality because they lock us into large transition costs that fall on future generations disproportionately and result in irreversible impacts for nature and people.

How did we get here? A timeline of 10 years from Serious Games to DAPP / DMDU uptake in New Zealand Dr Judy Lawrence Victoria University of Wellington (VUW)

A collaboration between Deltares and VUW, with support from number of councils, led to the modification of the Dutch 'Sustainable Delta Game" (a serious game). The two games developed (NZ River Game and NZ Coastal Game) used New Zealand rainfall and sea-level rise data. The game was then applied with local councils across New Zealand for flood risk management and in coastal settings. This followed the 5th IPCC Assessment Report in 2014 that highlighted the use of tools decision making under deep uncertainty (DMDU) to enable anticipatory planning to reduce the impacts of climate change through adaptation action. The DAPP process and other DMDU tools (e.g., robust decision making, scenario analysis) were subsequently incorporated into the 2017 Coastal Hazards and Climate Change Guidance for local government (MfE 2017).

In parallel with guidance development, DAPP and DMDU were also being applied to flood risk and in coastal settings and several other domains (see slide set). The development and use of these tools in diverse settings has helped raise and address methodological issues; contribute to assessment processes and inform strategic planning; and provides a basis for community engagement. Pathways have also been used to guide decision making, and explore the significance of signals, triggers and system-critical thresholds. To varying degrees, pathways have been implemented, and are now the focus of monitoring and review.

While originally used for flood risk and in coastal settings, DAPP and DMDU tools are now being more widely applied. They have the potential to assist with a range of place- and problem-based analyses, including recovery and rebuild processes following the Auckland and Northland extreme rainfall event and Cyclone Gabrielle in Hawke's Bay and Tairawhiti. There is an urgent opportunity to identify sustainable recovery pathways, that do not lock in undesirable future outcomes, but maintain flexibility in the face of worsening and changing climate change risks.

Panel reflections Jan Kwakkel (TU Delft), Rob Bell (Bell Adapt), Anita Wreford (Lincoln University), Marjolijn Haasnoot (Deltares)

The panel reflected on the last 10 years of DMDU and DAPP applications as follows:

- Decisions need to be made despite uncertainty.
- Use of up-to-date risk projections are essential.
- A shift is required; we have to get used to change and redesign our risk assessment tools from static to dynamic methods. We are good at assessing existing risk but not at assessing risks associated with risk that is changing (e.g. is there going to be maladaptation, how does the implementation of different options change the risks).
- There is an impasse with implementation; sectors are at different stages of thinking about risk, and many have difficulty articulating the benefits of dynamically adapting.
- Current governance mechanisms are a major impediment to embedding DAPP in practice; we make policy and legislation for now – they are static – and we need to move to more adaptive modes of governance and decision-making. There are opportunities to get emergency management and adaptation better aligned.
- There is an opportunity to conduct a hackathon to envisage how an area could plan for an extreme event like Gabrielle. This was done for the Netherlands following the 2021 European pluvial event by shifting the rainfall that fell in Germany to the Netherlands and envisaging what would happen as a result[1].
- Where 'Room for the River' was used in the Netherlands it also included small incremental measures suggested by communities which empowered communities enabling ongoing engagement in its implementation[2]
- Making opportunities and creating catalysts for change is important. Pathways can be agnostic; the process can be used at any level, i.e., for scoping and prioritising and then scaled for a particular locality or purpose. DAPP can apply to any situation where there is a degree of uncertainty. The process can be entered at any point in an iterative manner.
- Using DAPP/DMDU tools with communities can enhance understanding of changing risk and enhance learning. So long as key principles are maintained— i.e., stress testing across different futures (e.g. scenarios or SLR increment consequences), signals and triggers designed and monitored, lock-in of actions considered, alternative pathways developed, short term actions and long-term options—the process can be modified to suit the context.

Session 2 Applications of DMDU/DAPP

Participants at the workshops were asked to describe the steps/actions they took to create a DAPP or use DMDU tools and then grouped their results and reported them back to the plenary. The following is a summary of these applications of DMDU methods and DAPP applications. (see the examples in the slides).

In recent years, the applications of DMDU methods and DAPP in New Zealand have become increasingly diverse. Place- and problem-based analyses have been completed for flood risk reduction, coastal hazard risk, Māori land strategy and marae infrastructure, urban and rural water supply, stormwater management, wastewater treatment, primary sector management, defence force infrastructure planning, translocation of species at risk, alpine infrastructure management, and transport developments.

Few, however, have advanced to implementation through decision-making processes on the ground; only flood risk reduction, Māori marae planning, transport and threatened species conservation.

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[1] https://www.preventionweb.net/news/netherlands-can-prepare-even-better-extreme-weather-seven-recommendations-response-floods-july

[2] https://doi.org/10.1080/09640568.2016.1168288

The DMDU tools have been developed through MBIE investments over the last decade and in association with users at regional, local and central government, including water and transport agencies and with rural and urban communities. The tools include DAPP Real Options Analysis (ROA), Robust Decision Making (RDM), Many Objective Robust Decision Making (MORDM), Serious Games and many regionally applicable tools. e.g., NZSeaRise, (Takiwā website)[3].

Examples of how they have been used, include:

The first application was via the Hutt River Flood Risk Management Plan completion project to assess adaptation options through a comprehensive Multi-Criteria Analysis (MCA) and DAPP assessment and pathways development through community engagement (workshops, consultation, community surveys) which resulted in decisions to make room for the river. This is now being implemented via a wider city redevelopment project, the Hutt City RiverLink project.

The second application formed part of the Clifton to Tangoio Coastal Hazards Strategy 2120. The DAPP approach was able to be used alongside MCA through a clear governance mandate reflecting mana whenua, regional and district councils and decision-making framework, community panels and long-term plans for coastal units. Adaptation thresholds have been developed and the project is currently at the implementation planning stage.

The Department of Conservation has used DAPP to evaluate options and build pathways for relocating and replacing huts in alpine areas and for translocating species at risk to safer places away from predators and human influences.

In the rail transport sector DAPP has been used for evaluating the effectiveness of different climate change adaptation planning approaches and for the development of a detailed adaptation planning framework for Auckland Transport.

The NZ Defence Force has used DAPP alongside MCA to evaluate risks and co-design with a range of Defence Alliance stakeholders alternative adaptation pathways for their infrastructure procurement.

Manaaki Whenua –Landcare Research with support from the Ministry for Primary Industries has used DAPP to help identify risks and opportunities for agriculture sector users through stakeholder workshops, expert interviews, alongside crop modelling and local climate projections.

Several coastal applications of DAPP have been undertaken including for the Hawke's Bay Coast (noted above) and at Wellington City's Mākara Beach through community workshops. A detailed DAPP assessment and pathways has been developed for Amberley Beach at Hurunui district which includes a detailed implementation plan with funding options. Thames Coromandel District Council has developed coastal compartment pathways with signals and triggers for monitoring them over time. Hauraki District Council and Waikato Regional Council have undertaken a DAPP process, via a community/stakeholder panel, for Wharekawa (Kaiaua) 2120 adaptation project.

Water supply and wastewater examples have been developed, in part through research projects and using real-life examples where the methods are being applied in agencies. The stormwater example is part of post-graduate research based on a real-life location in Petone with close links to the agency responsible and includes a spatial component to option development. The components of managed retreat and the design of a DAPP monitoring framework have been completed as part of post

[3] https://www.searise.nz/maps-2

graduate research and exploration of the role that serious games can play in motivating dynamic adaptive behaviour change is currently underway.

Session 3 Lessons learned.

Participants were asked to discuss lessons learned from their applications and reported back to the plenary, These lessons have grouped across a number of themes as follows:

Strategic

- Start by considering how will the actions and pathways implemented and by whom? e.g., what are the roles within and between agencies and the governance structure including mana whenua, collaboration with the community, time/cost/resources, respectful processes.
- DMDU tools and DAPP can lift focus on short-term, "nowism" to more strategic considerations over the long-term.
- Participants were motivated to build a shared future in addressing climate change impacts and implications.

Process

- Creating a safe space for community views has proven helpful to open up productive community conversations.
- Transparency is important for technical and community processes to maintain legitimacy.
- Break the DAPP process down into manageable steps. Start with the familiar, discuss understandable thresholds, group options into portfolios of actions to reduce complexity. Give participants an initial set of options to discuss. Use visuals and be spatially specific.
- DAPP is more than a planning tool—pathways can be simulated to test the longevity of actions and the conditions under which they can fail in a multi-hazard environment.
- The DMDU tools and DAPP approach is versatile, and adaptable to specific community contexts.
- Community panels keep help maintain engagement and build ownership.

Managing change and uncertainties

- It is important to acknowledge uncertainties in climate change and coastal hazard models, exploring different pathways early and testing the consequences.
- Applying cultural considerations and inputs into a DAPP approach is highly complex, especially when seeking to reconcile the needs of 19 iwi entities in a single region.
- The need for timely and early detection of signals and thresholds in situations with large natural
  variability, and to consider multiple perspectives and trade-offs when developing thresholds and triggers.

Organisational

- It is possible to integrate DAPP and the MfE decision cycle into organisational protocols.
- Build capability and capacity internally, and across the organisation, and have robust engagement internally before working externally with stakeholders.
- Leadership support is essential as the approach challenges status quo thinking and requires leadership and courage.

- Embedding DAPP/DMDU into decision frameworks within organisations enhances implementation.
- There are challenges with community and staff "turnover" throughout a DAPP process.

Multiple hazards

- Focused adaptation objectives can help when addressing a range of climate hazards and potential responses.
- Consideration of multiple hazards creates complexity and increases the time and cost required for analysis in an iterative process.

Communication of the risk through DAPP

- Useful if the spatial application of DAPP could be used for communicating the risk.
- Outputs from the DAPP and DMDU analyses should be tailored for the different audiences.

Identifying and enabling adaptation options

- DAPP may helpfully address the tendency to limit adaptation options to hard engineering structures and to not consider planning rules, managed retreat, nature-based or behavioural options, especially in coastal settings.
- It is necessary to help stakeholders and users of DMDU tools to think beyond just adaptability, to consider transformational adaptations by envisioning a wide range of options and pathways.
- Serious games have proven useful in creating a "safe space" for considering more transformational options that challenge 'business as usual' responses.

Scale

- Proactively managing risks and opportunities using DMDU tools and DAPP enables in-depth catchment scale case studies to inform sector adaptation pathways at a regional scale.
- DAPP can be used as an initial screening process to help prioritise spatial areas of highest risk.

DMDU tools

- Real Options Analysis can complement the DAPP approach and does not require probabilities of different pathways to be determined; stress test of options using sensitivity analysis can be used.
- Using lower discount rates for analysis can more accurately reflect the costs and benefits of long-term adaptation options e.g., managed retreat.

Research and input gaps

- Multi-agency and cross-sectoral research teams and adequate research funding working alongside practitioners have proven useful and needs to continue.
- Good data is lacking e.g. Annual Exceedance Probability (AEP), risk distribution, costs of adaptation and more attention is needed for both economic and non-economic benefits and costs.

Signals and triggers

- Signals have arrived already, triggers to act are upon us and adaptation thresholds have occurred for some communities. Quantitative methods provide an essential element, but social, economic and cultural signals and triggers are needed.
- A range of indicators will enable adaptation signals and triggers to be monitored over time including option cost profiles, consenting feasibility and policy.
- Consider that changes to new pathways may occur over time and not just at a point in time.

Implementation

- Think carefully and develop evidence before committing resources to expensive and/or inflexible protection pathways.
- Implementation of the DAPP approach has been hindered by tensions in agencies between strategic work and outdated planning rules and compounded by immediate local issues such as pressure for hard protection and resource pressures.
- Have a plan to manage the risk of the immediate taking over when climate events occur and use the pre-prepared DAPP to form the basis of review post event.

Session 4 Advancing methodology, assessment, engagement, and implementation

Participants discussed what were the further knowledge, policy and practice needs and what went well, what was challenging, what would they do differently and what surprised them when using and apply the DMDU methods and developing DAPPs across the different stages in the application process.

	Methods	**Assessment process**	**Engagement**	**Implementation**	**Other**
What went well?	-Used Guidance -Community Adaptation Framework -Reveals new issues and across several hazards -Enables systems thinking and visualisation of the future -Can bolt several tools together e.g. DAPP and ROA are a good match - Enabled multidisciplinary approach	-Community Panels took ownership of risk and vulnerability assessment - Mātauranga Māori integrated - Having the underpinning science helped communicate 'the why' - Internal asset managers understood hazards and asset tolerances - Q whether should get consultants to do the assessment	- Guidance helped - Panels empowered people to understand the science aided with use of visuals - Effective engagement with decision-makers - 'Coastal Explorer' tool useful	- Easier when staff signed up across domains - Having mana whenua involved was essential in the process - Not there yet	- Shared governance necessary between regional and local councils - Council collaboration enhanced as Aotearoa Climate Adaptation Network (ACAN) developed

What was challenging?	-Working with long timeframes e.g. 50 or 100 years - Data scarcity - Time required; how to speed up process? - Differing levels of capacity -Learning by doing and building in values	-Different perspectives to reconcile - Different agency mandates -Resources lacking and competition for resources - Capturing local nuances in the Multi Criteria Assessment (MCA) scoring process -	-Managing expectations - Managing vested interests - Different values - Wider issues arise out of scope - Getting cross section of community involved e.g. Rangatahi. - ongoing updates	- Many small things being implemented - Multiple stakeholders - Costing of managed retreat - Difficult to implement managed retreat where hazards not already experienced - Public disengagement -Elected members forget about plan mandates / respond to immediate local pressures	-Aligning many processes - Complexity of how all plans come together -Long lead time for council budgeting - Costly in time and dollars
What would be done differently?	-Establish a clear Adaptation Planning Program -Working with iwi/ hapū is a partnership, not a project - Explore who pays - Develop signals and triggers earlier	-Identify resourcing - More sensitivity analysis	- Include natural systems - Involve iwi/hapū at the outset - Capacity broader than a project - Line up stakeholders -Include managed retreat as an options at the outset -Manage political expectations	- Identify monitoring capacity to support implementation	- More Māori knowledge needed - Update new staff - Setting objectives across and within agency groups
What was a surprise?	- Compounding uncertainties - Not just people but services affected - Wide range of options especially managed retreat	- Lack of understanding of natural systems response to climate change - How to do managed retreat not "if" managed retreat	- Council pulled funding for engagement	- Pressure from media - How to do all the work as it is a lot	- Impact of climate change on daily lives - Non climate indirect risks that cascade

Next steps

The final session discussed next steps going forward with DMDU and DAPP methods including opportunities to strengthen the tools and processes that enable them to be streamlined and used effectively at different scales and by different practitioners. A summary of the key areas for further development and application follows.

- How can these processes be more focussed and efficient and understand what the implications of this might be.
- Extend applications across all hazard drivers, functional domains and sectors in which climate change and deep uncertainty are an issue.
- Shared lessons more widely through networks such as ACAN (Aotearoa Climate Adaptation Network) for local government practitioners.
- Improve training of all relevant practitioners across the relevant professions and at different management levels e.g., CEOs, accountants and auditors, engineers, strategic planners, land use planners, hazard planners, emergency managers, ecologists, management and consultants.
- Explore how Te Ao Māori and mātauranga Māori can enhance DAPP methodological developments through research and policy support.
- Address the legislative and policy barriers implementation (e.g., via the Strategic Planning and Built Environment Bills and the proposed Climate Change Adaptation Act).

Anita Wreford (Lincoln University), Judy Lawrence (VUW), Iain Dawe (GWRC) and Emma Corbett(MfE) concluded the session with reflections across research, and local and central government implementation.

- Future research projects under Deep South could build on the capability the programme has developed on DMDU and DAPP including methods and simple models for compound and cascading impacts and risks, mātauranga Māori, development and transfer of usable science for practice guidance.
- The Resilience Science Challenge has focused on coastal adaptation and enablers including coastal processes, modelling, compound hazards, enhancing coastal adaptation including economic and planning tools, governance enablers and vulnerability assessment.
- Gaps in adaptation research are set out in the IPCC AR6 Chapter 11 covering Australia and New Zealand. There is significant demand – not all of which can be funded. Deep South and Resilience Science Challenges end mid-2024 and there is no clear mechanism as yet, for future funding under the National Research Priorities framework.
- Priorities for local government include:
    - Standardisation of methods and processes that were streamlined and efficient to avoid each council reinventing the wheel.
    - Guidance on how to implement the outputs of the DAPP process as a step-by-step guide so councils can be prepared and stop just responding to extreme events without a long-term plan.
    - Guidance is needed on how best to facilitate difficult conversations with communities with empathy and understanding.
    - How to translate hazards and impacts using online tools, serious games that include the psycho-social elements and the social landscape affected by the impacts and the responses to them.

    - A lot of direction is needed for councils on use of the RMA to trigger effective responses to climate change in conjunction with other environmental issues.
- The central government response is through the NAP with a number of actions over the next six years and post recent extreme rainfall events looking at what needs to be accelerated. The Climate Change Adaptation Bill is being worked on to provide a framework for managed retreat. Tools are being strengthened including a generic DAPP Guidance that can be applied anywhere and developed by the end of 2023.

Concluding comment

In closing, based on the learning from this mini-symposium researchers' and practitioners' experience with DAPP/DMDU approaches, it is clear that adaptation is a journey we need to take together, and we all have a role to play. Government can enable action through the National Adaptation Plan, but we will not achieve what is needed without the support from the NAP and all actors playing their part as we have different and complementary roles in the system. The opportunity provided by having our DAPP plans prepared when extreme events confront us empowers decision makers with options pre-tested for implementation however the future unfolds.

Participants

Infometrics	Adolf	Stroombergen
Waikato Regional Council	Alejandro	Cifuentes
Thames Coromandel District Council	Amon	Martin
NIWA	Andrew	Allison
Porirua City Council	Angela	Sutherland
Lincoln University	Anita	Wreford
GNS Science	Annet	Forkink
Auckland Transport	Ashishika	Sharma
Auckland Council	Azin	Fathianpour
Porirua City Council	Ben	Fountain
Auckland Council	Bonnie	Apps
Beca	Cushla	Loomb
Jacobs	Derek	Todd
Tasman District Council	Diana	Worthy
Te Herenga Waka - Victoria University of Wellington	Eleanor	Chaos
Ministry for the Environment	Emma	Lemire
Ministry for the Environment	Emma	Corbett
Ministry for the Environment	Erin	Stieler
Wellington Water	Geoff	Williams
Te Herenga Waka - Victoria University of Wellington	Graeme	Guthrie
Otago Regional Council	Hugo	Bloor
Greater Wellington Regional Council	Iain	Dawe
Wellington City Council	Jamuna	Rotstein

Delft University of Technology (TU Delft)	Jan	Kwakkel
Tauranga City Council	Jane	Groves
Waka Kotahi - NZTA	Janet	Petersen
Otago Regional Council	Jean-Luc	Payan
Department of Conservation	Jenny	Christie
Ministry of Housing and Urban Development (HUD)	Jerren	Tweedie
Tonkin + Taylor	Jon	Clarke
Ministry for the Environment	Joseph	Hägg
Market Economics	Juan	Monge
Te Herenga Waka - Victoria University of Wellington	Judy	Lawrence
Jacobs	Kate	MacDonald
Beca	Laura	Robichaux
Waka Kotahi - NZTA	Leah	Coghill
Nelson City Council	Maggie	Fellowes
Ministry of Business, Innovation and Employment	Maj-Britt	Engelhardt
Deltares/ Utrecht University	Marjolijn	Haasnoot
Ministry for the Environment	Mark	Johnson
Hurunui District Council	Monique	Eade
Te Waihanga	Monique	Cornish
Auckland Council	Natasha	Carpenter
GNS Science	Nick	Cradock-Henry
NEMA	Olivia	Quigan
University of Canterbury	Patrick	Curran
Massachusetts University	Paul	Kirshen
NIWA	Paula	Blackett
Auckland Council	Petra	Pearce
Deep South Challenge / NIWA	Phil	Wiles
Far North District Council	Rakesh	Pinao
Technical University of Denmark (DTU) and NIRAS	Rick	Kool
Bell Adapt	Rob	Bell
Defence Force NZ	Rosie	Evans
Auckland Council	Sage	Vernall
NIWA	Scott	Stephens
Traverse Environmental	Simon	Bendall
Otago Regional Council	Tim	van Woerden
Ministry for the Environment	Tim	Denne
Christchurch City Council	Tom	Simons-Smith
University of Canterbury	Tom	Logan
Northland Regional Council	Tom	FitzGerald
NIWA	Yvonne	Matthews

A Decade of Dynamic Adaptive Decision-making Tools in Aotearoa

Practice applications, lessons learned and next steps

9 March 2023

Judy Lawrence

Climate Change Research Institute,

Te Herenga Waka Victoria University of Wellington

VICTORIA UNIVERSITY OF WELLINGTON TE HERENGA WAKA

National SCIENCE Challenges — THE DEEP SOUTH — Te Kōmata o Te Tonga

National SCIENCE Challenges — RESILIENCE TO NATURE'S CHALLENGES — Kia manawaroa – Ngā Ākina o Te Ao Tūroa

Ministry for the Environment — Manatū Mō Te Taiao

Purpose of the day

- 10-years since DMDU tools were introduced to New Zealand for natural hazard and climate change adaptation practice
- To celebrate our enduring New Zealand and The Netherlands collaboration on DMDU
- To share lessons about the development and application of tools to support decision-making under uncertainty
- To discuss, with practitioners and experts, what is needed from research and for practice for the next decade

A Decade of Dynamic Adaptive Decision-making Tools in Aotearoa

Agenda 9 March 2023

Session 1 Background context for the day (Presentations, Panel, Q & A)

Session 2 Applications of DMDU/DAPP (Groups using participant slide 1)

Session 3 Lessons learned (Groups using participant slide 2)

Session 4 Advancing methodology, assessment, engagement, and implementation (Panel reflections, group discussion and plenary)

Session 5 Next steps (Plenary)

VICTORIA UNIVERSITY OF WELLINGTON TE HERENGA WAKA

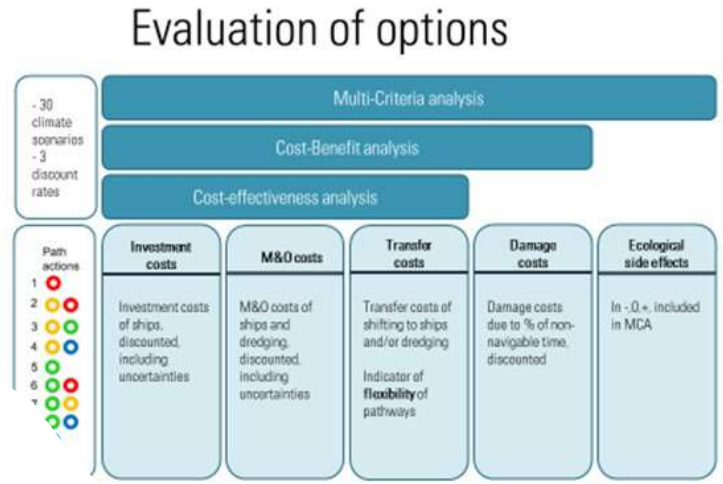
National SCIENCE Challenges THE DEEP SOUTH Te Kōmata o Te Tonga

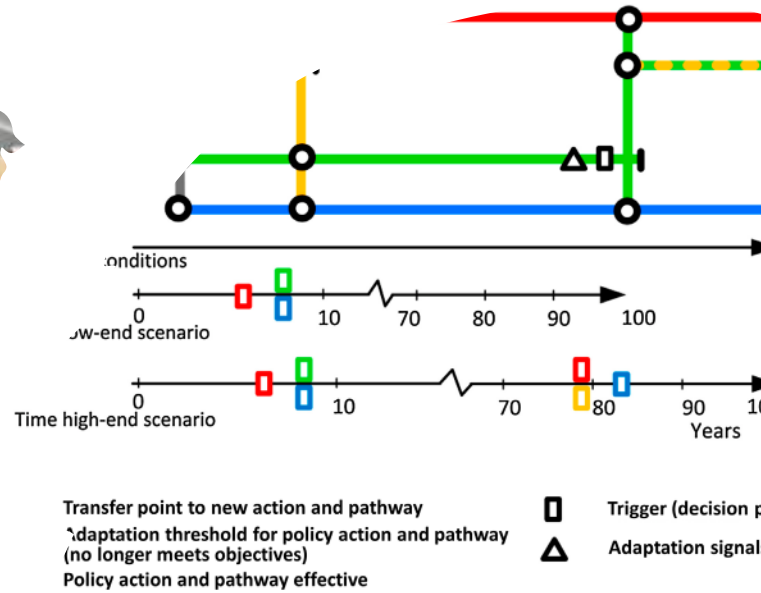
National SCIENCE Challenges RESILIENCE TO NATURE'S CHALLENGES Kia manawaroa – Ngā Ākina o Te Ao Tūroa

Ministry for the Environment Manatū Mō Te Taiao

You have all shared your experiences with DAPP/DMDU

- Methodological issues
- Assessment processes
- Strategy
- Engagement
- Pathways for decision making
- Implementation
- Monitoring and review

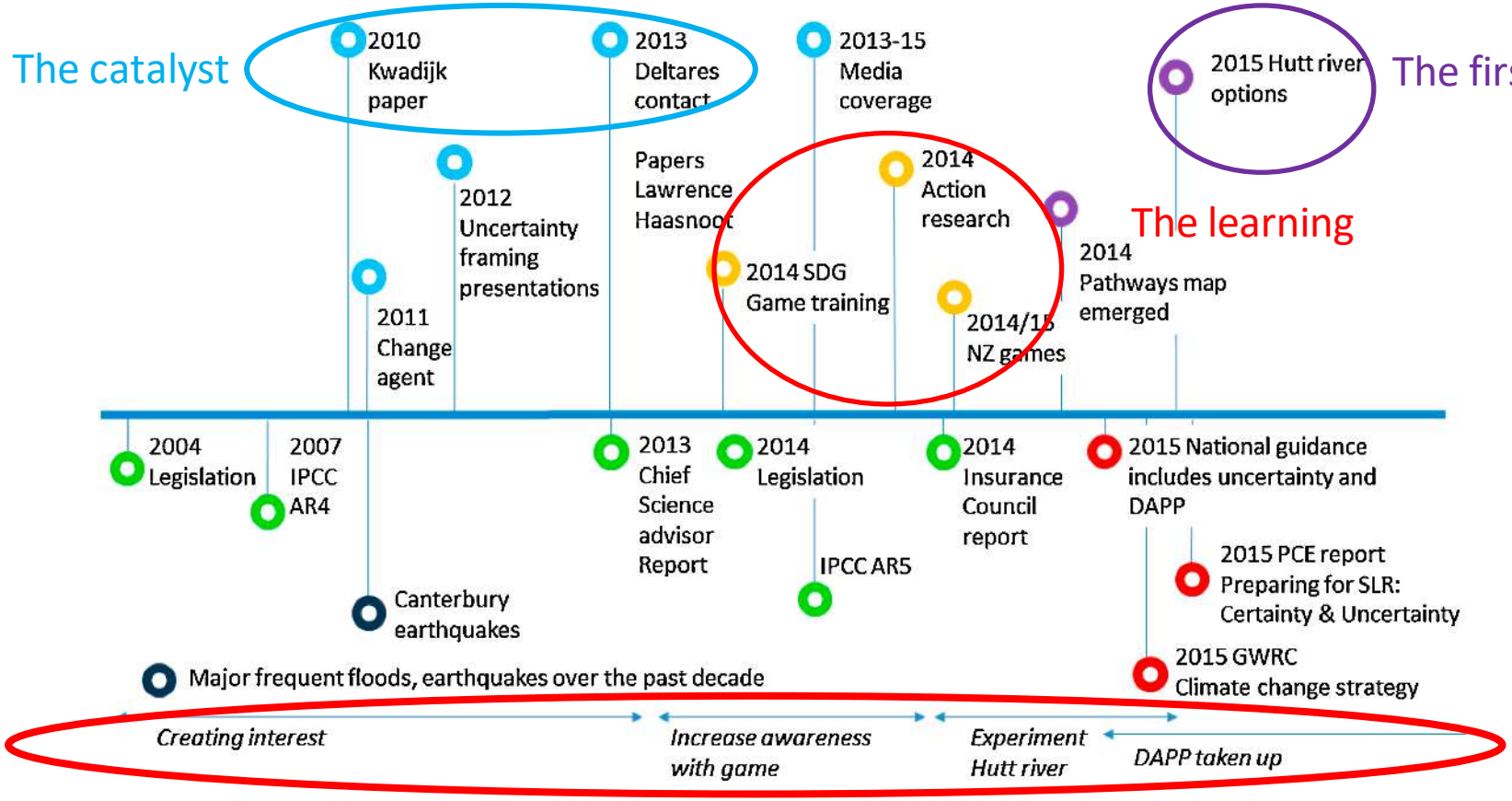




After Haasnoot et al. (2013), Hermans et

How did we get here?

Timeline from Serious Games to DMDU in New Zealand



Blue = Creating interest, Yellow = Increasing awareness
Purple = Experiment Hutt river, Red = DAPP uptake, Dark
Blue = Major hazard events, Green = context.

Lawrence and Haasnoot 2017

Integration with decision making processes 2017-2023

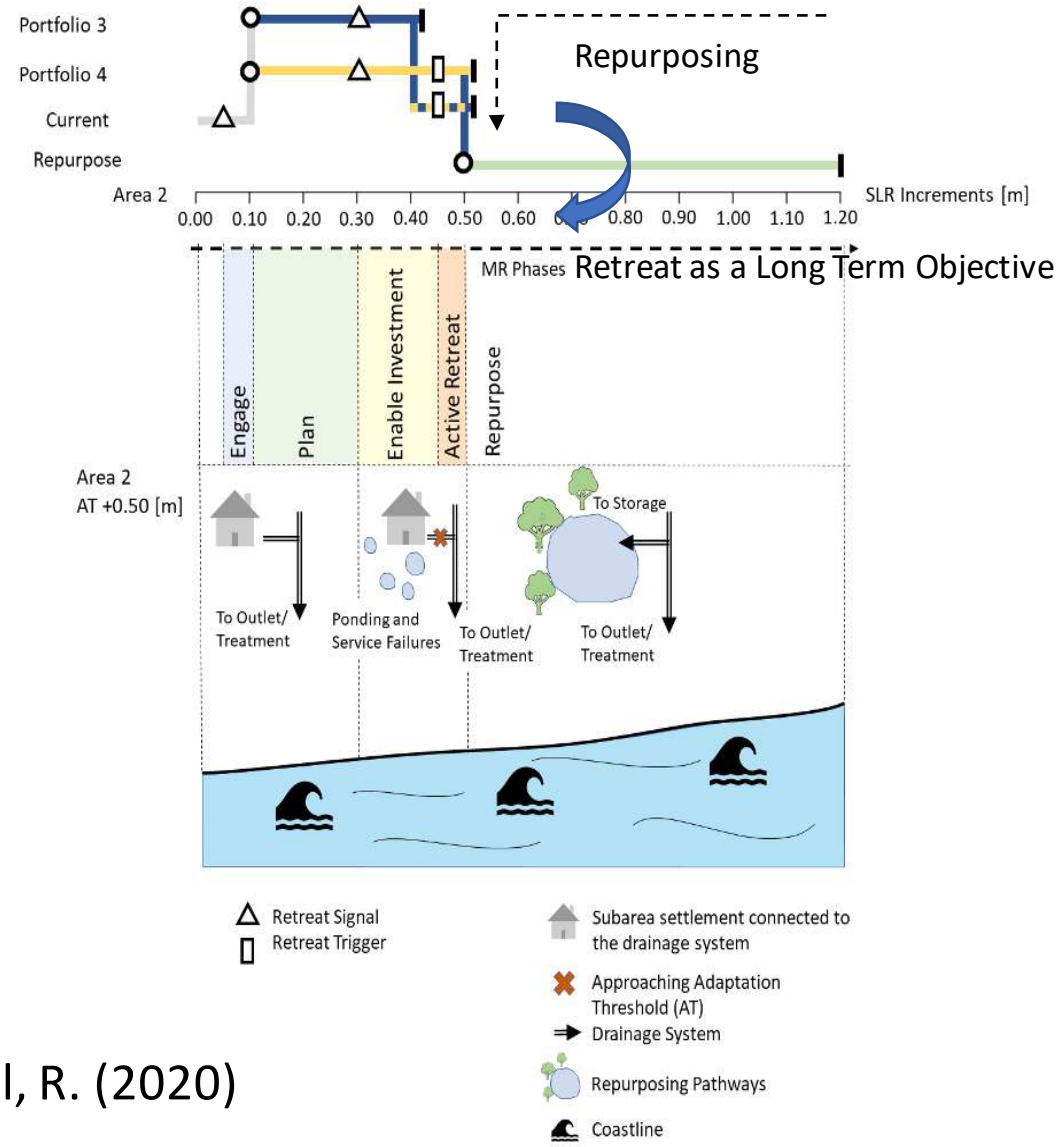
2017 Coastal Hazards and Climate Change Guidance → Clifton to Tangoio Coastal Hazards Strategy 2120 → Applications across coasts, flood, infrastructure, nature, engagement, legislation → IPCC AR6 2022 risk and deep uncertainty methods

Will experience and foresight prevail this time?

Opportunity for integration into Strategic Planning and Natural and Built Environment Bills

Will the 2023 extreme rainfall events catalyse greater use of DMDU decision tools?

Conceptual Spatial Pathways



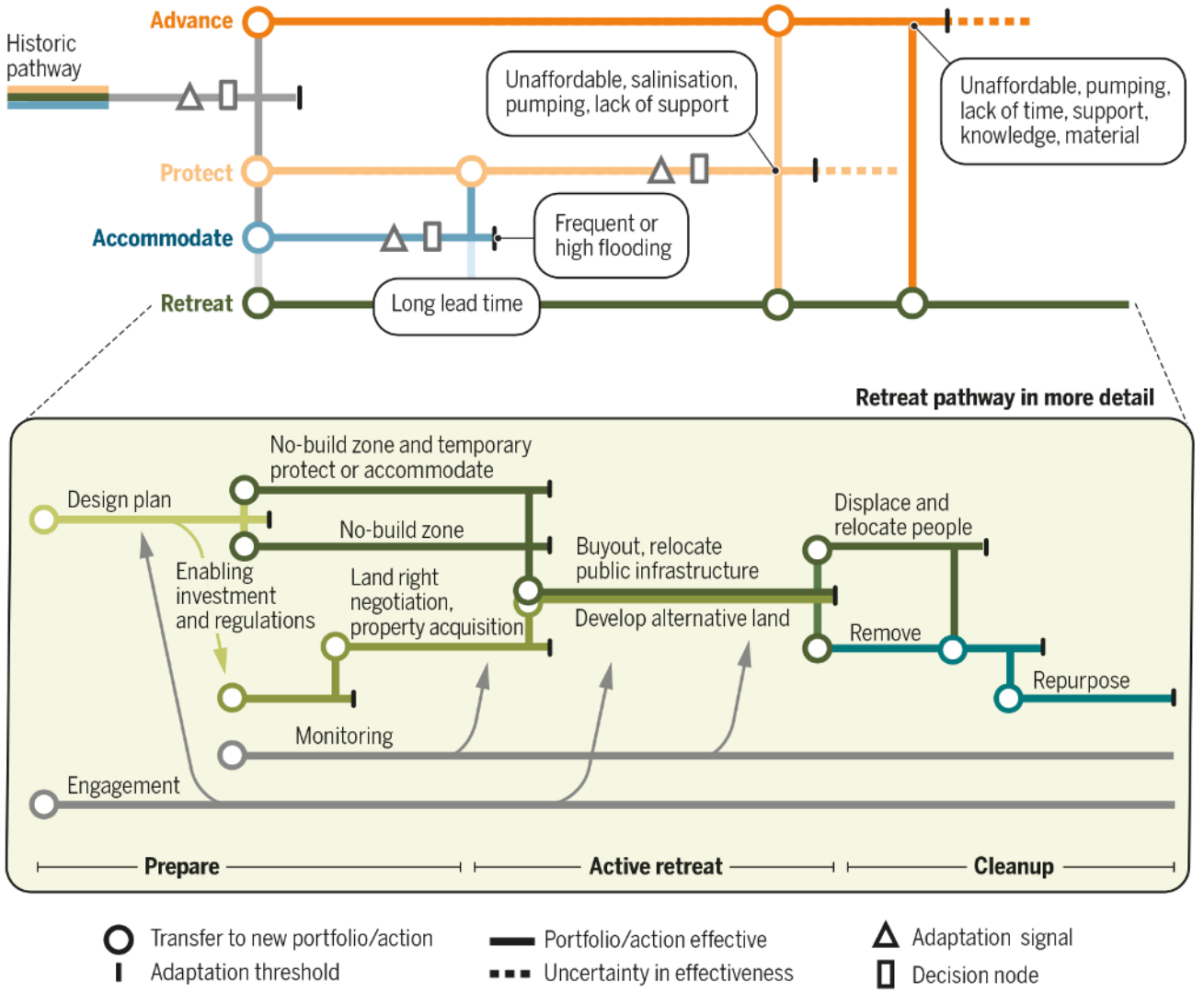
Kool, R.; Lawrence, J.; Drews, M.; Bell, R. (2020)

Pathways to deconstruct managed retreat

Olufson 2019

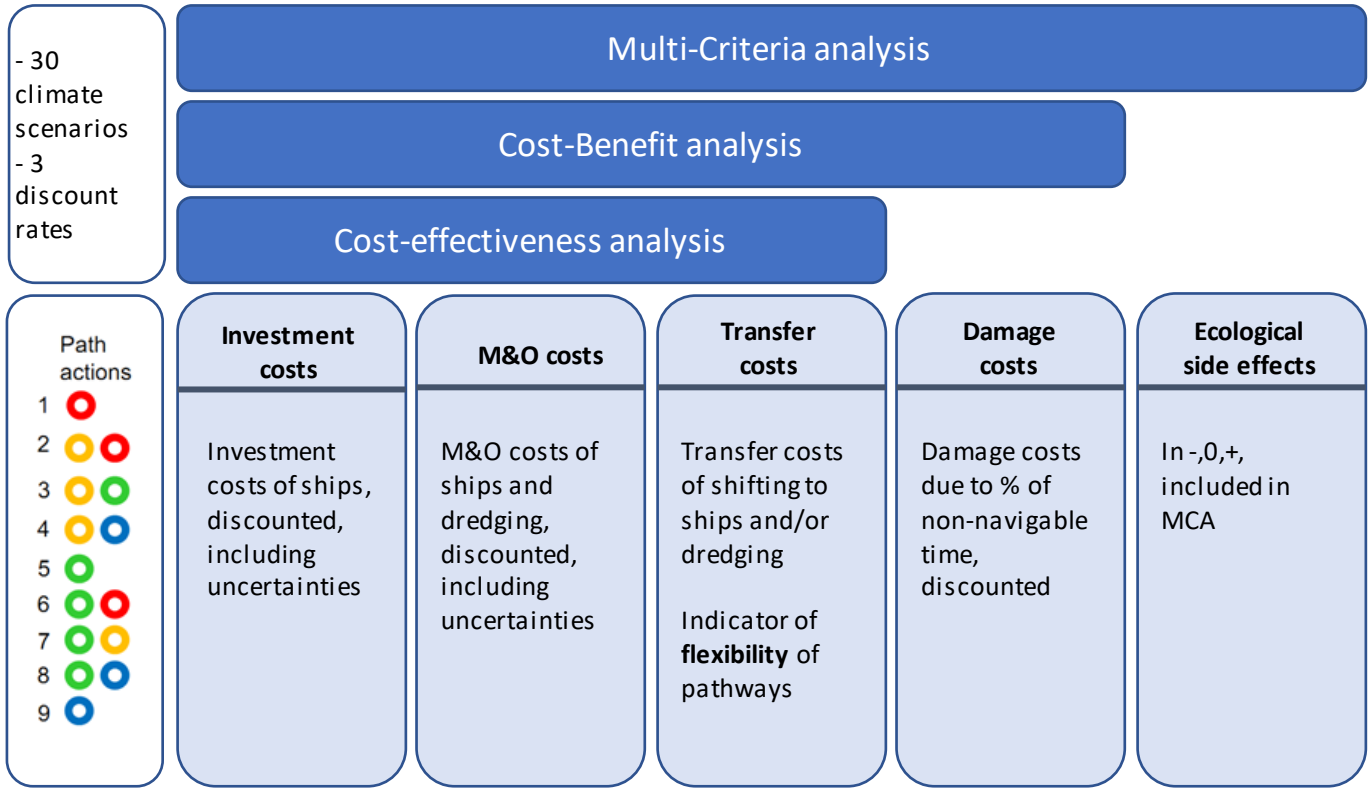
Indicative adaptation pathways of retreat

Retreat is presented as a nested pathway within a broader pathways map, including advance, protect, and accommodate. Retreat comprises three stages: prepare, active retreat, and clean-up. Engagement and monitoring support planning and implementation (grey lines). After designing a plan, land use regulations and temporary measures can be implemented, followed by buyout. Enabling investments and regulations are precursor actions.



Haasnoot, Lawrence, Magnan 2021

Evaluation of options



Adapted from Stroombergen & Lawrence 2015 for Greater Wellington Regional Council

The risks of maladaptive decisions

Those that lock us into unsustainable pathways. For example,

- More development in low-lying coastal areas and floodplains creates legacy effects and transfers risk to future generations
- Delay in developing and implementing adaptive plans means being unprepared for foreseeable and un-foreseeable climate risks
- Delay in reducing emissions increases the adaptation burden


Bron: Waterschap Limburg

Deltares

A changing reality:
experiences with DMDU and Dynamic Adaptive Policy Pathways

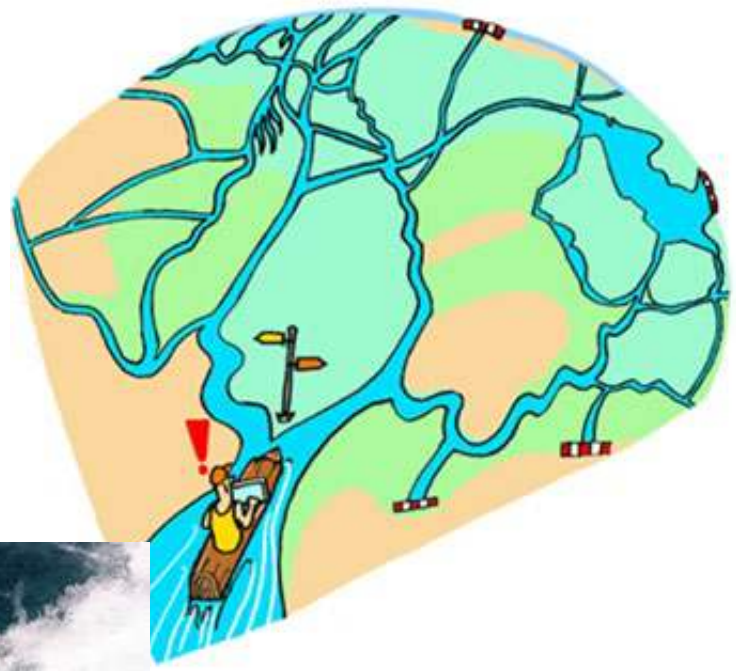
Marjolijn Haasnoot

Judy Lawrence

Decision Making under (Deep) Uncertainty (DMDU)

Steering a kayak on a river filled with currents and rocks, trying to avoid the rocks and using waves to move forward.

Being prepared with tools and information helps to anticipate and find your path towards your goals (even if goals may change underway).



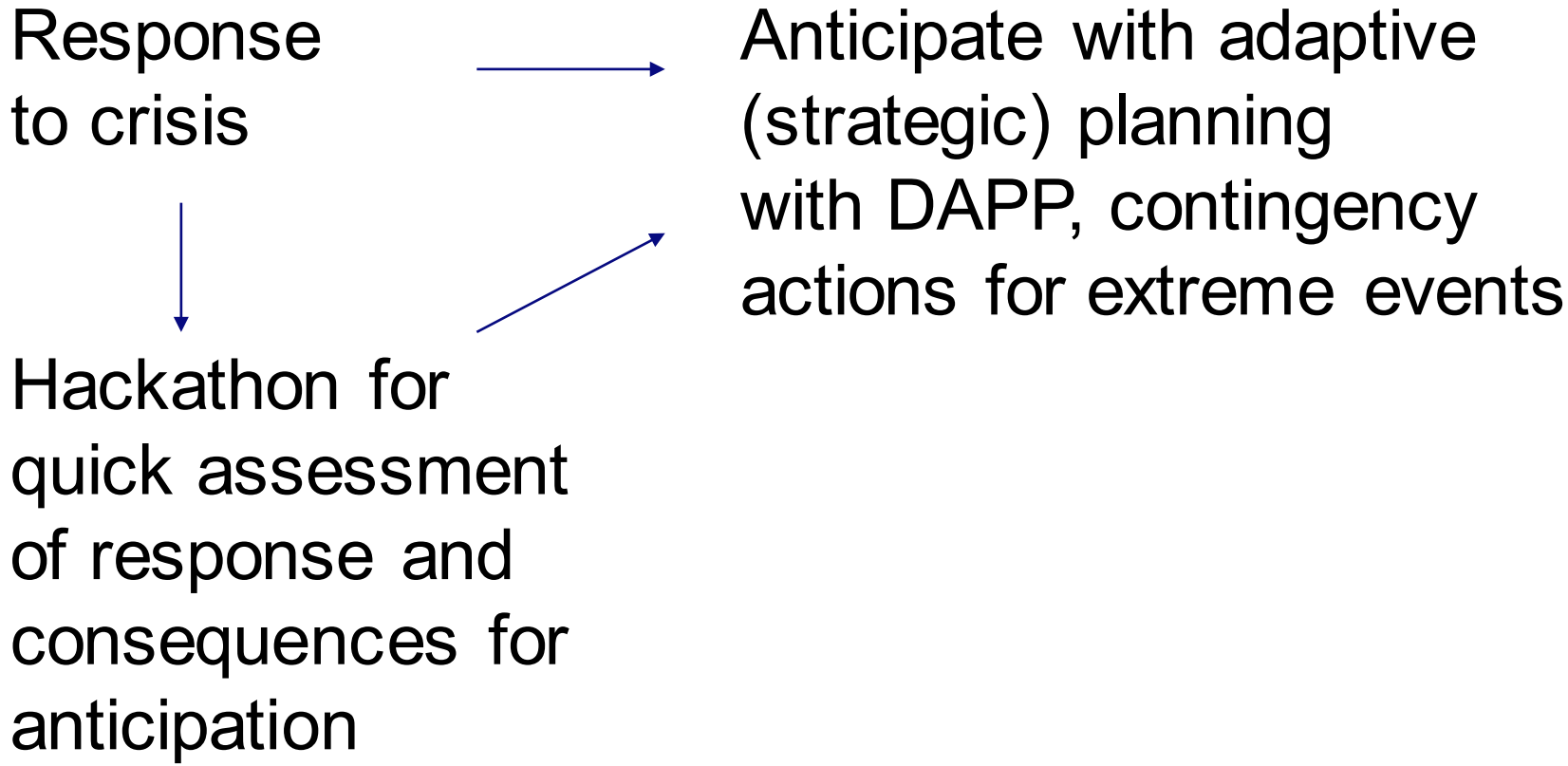
example inspired by Ann Pendleton-Jullian: navigating in a “white water world”: https://www.desunbound.com

Why do we need DMDU approaches?

- Not too late or too early, not too much or too little
- Avoid maladaptation with unintended consquences such as increased emissions, risk, lock-in

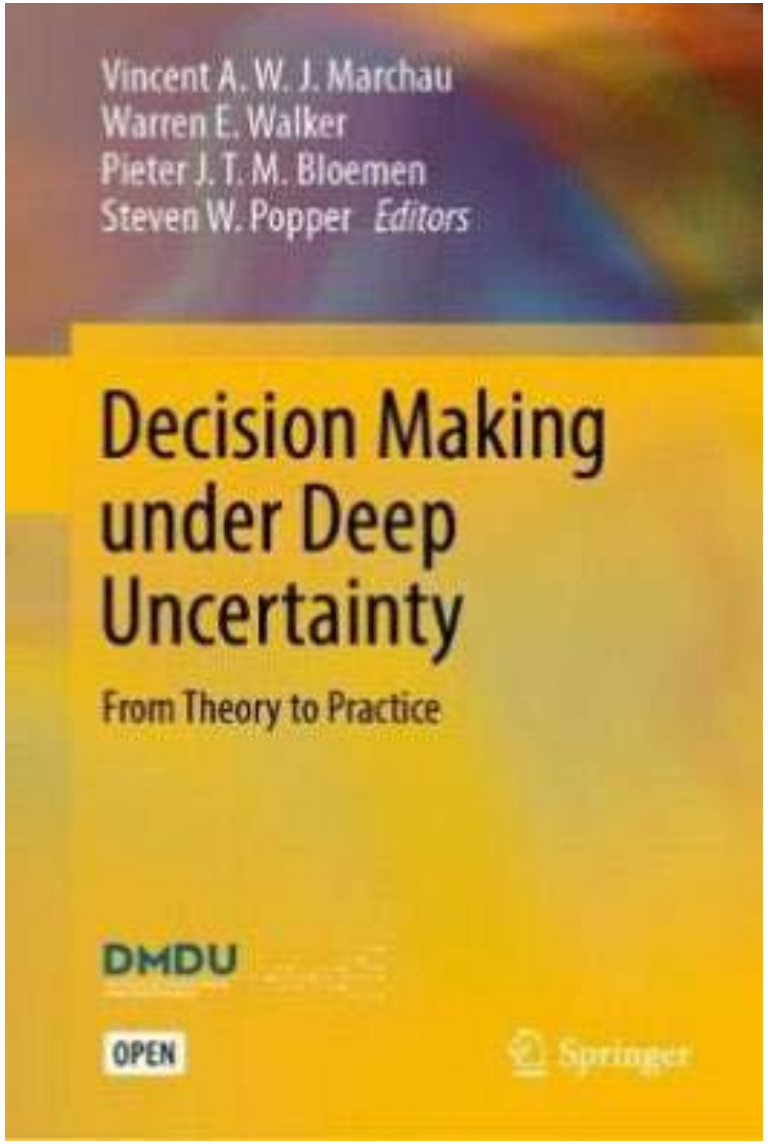
- Each investment/decision should be a meaningful step towards the long-term for next generations (for people and nature)

The new climate reality:
a stepchange to anticipating the long-term



DMDU approaches

- Robust Decision Making
- Adaptive Policy Making
- Decision Scaling
- Engineering Options Analysis
- Dynamic Adaptive Policy Pathways



https://link.springer.com/book/10.1007/978-3-030-05252-2

IPCC

Chapter 17 — Decision-Making Options for Managing Risk

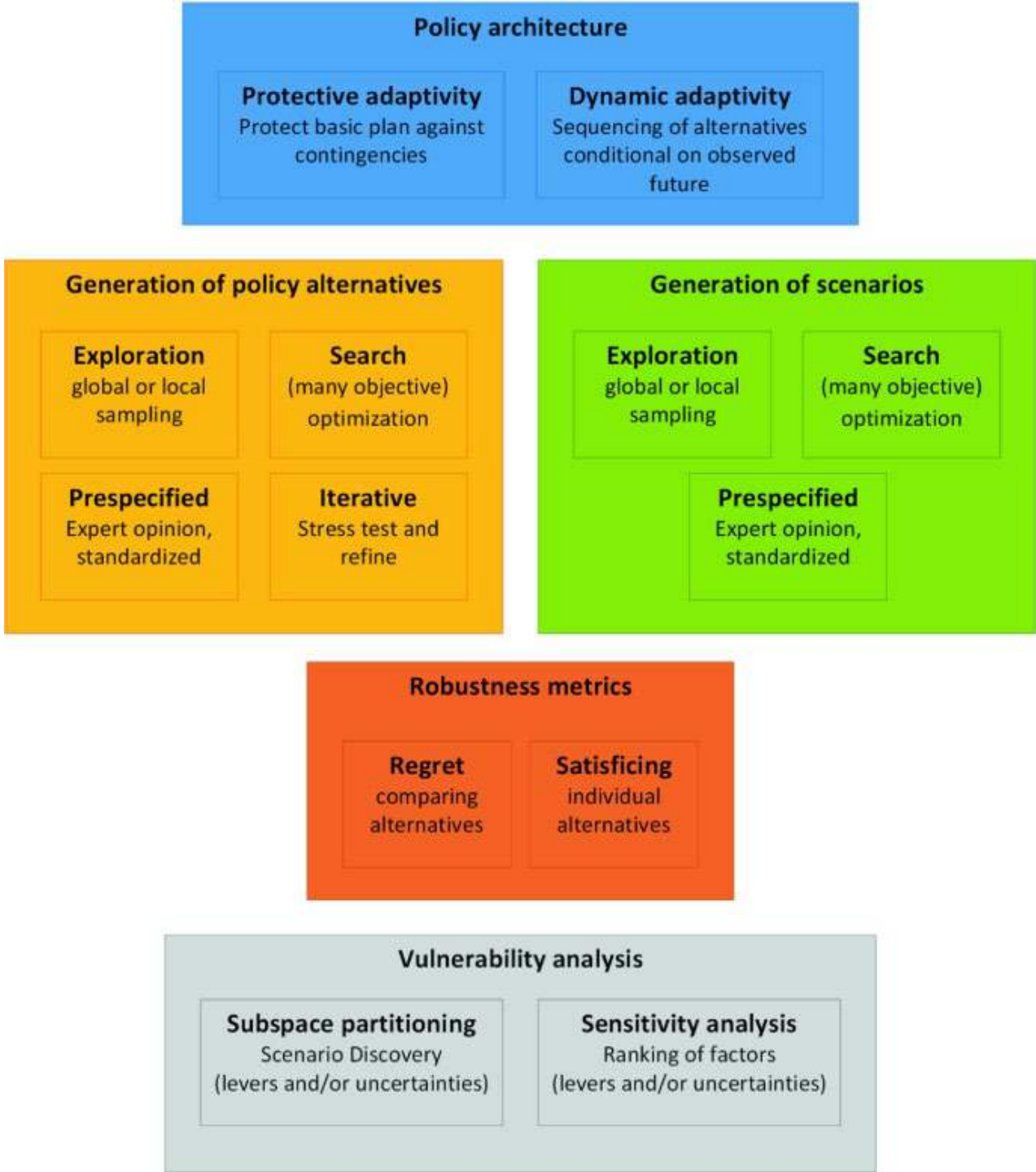
Cross Chapter Box DEEP | Effective adaptation and decision-making under deep uncertainties

'Adaptation pathways' provide another approach for addressing deep uncertainty and staging decisions over time (Haasnoot et al., 2013), by linking the choice of near-term adaptation actions with pre-determined future thresholds. Observation of such thresholds trigger subsequent actions in the planning or implementation stages of adaptation strategies. Adaptation pathways can begin with low-regret, near-term actions that aim to create and preserve future options to adjust if and when necessary. Alternative pathways can be explored and evaluated to design an adaptive plan with short-term actions and long-term options.

https://www.ipcc.ch/report/ar6/wg2/

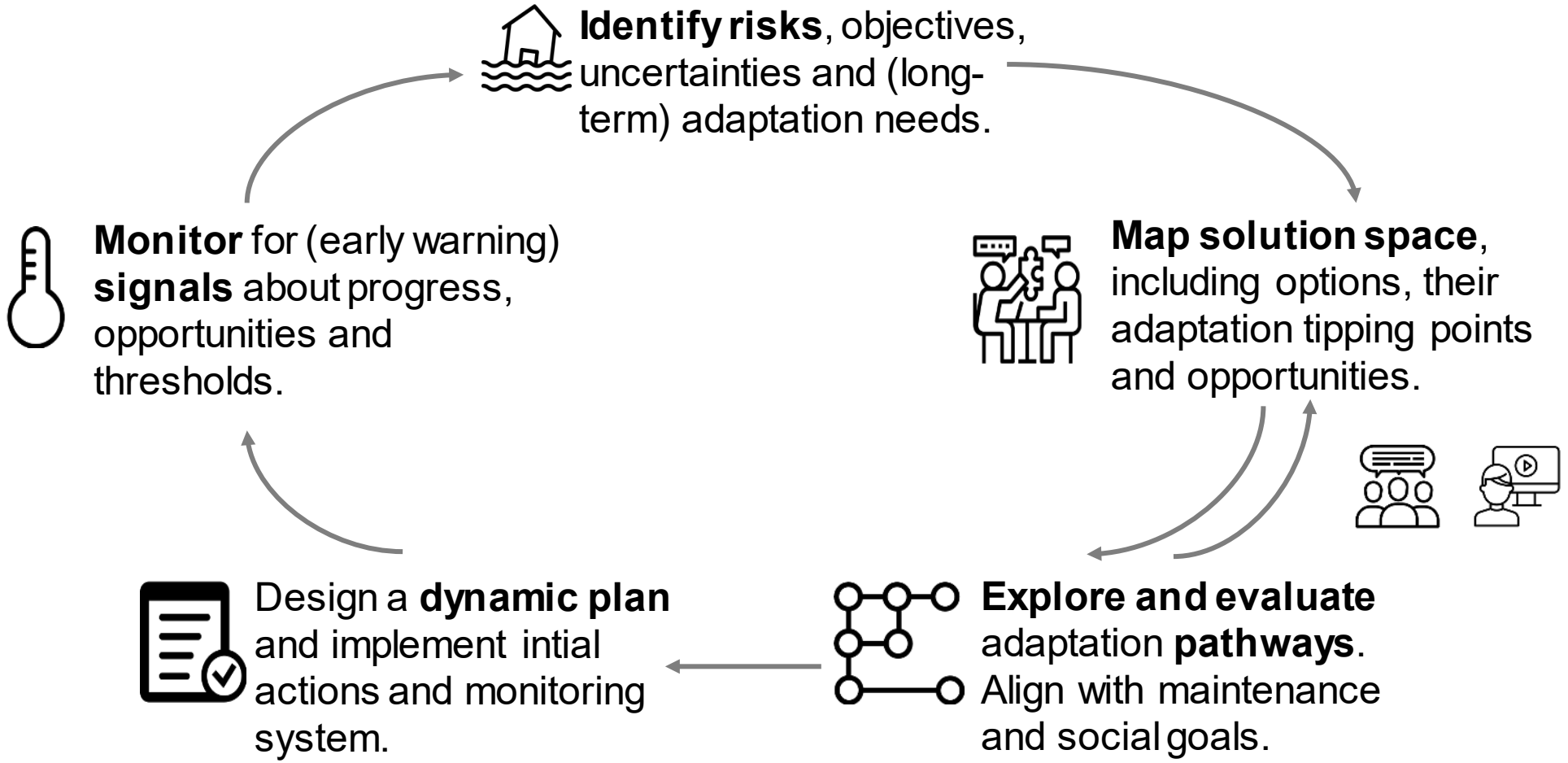
DMDU approaches

- Robust Decision Making
- Adaptive Policy Making
- Decision Scaling
- Engineering Options Analysis
- Dynamic Adaptive Policy Pathways



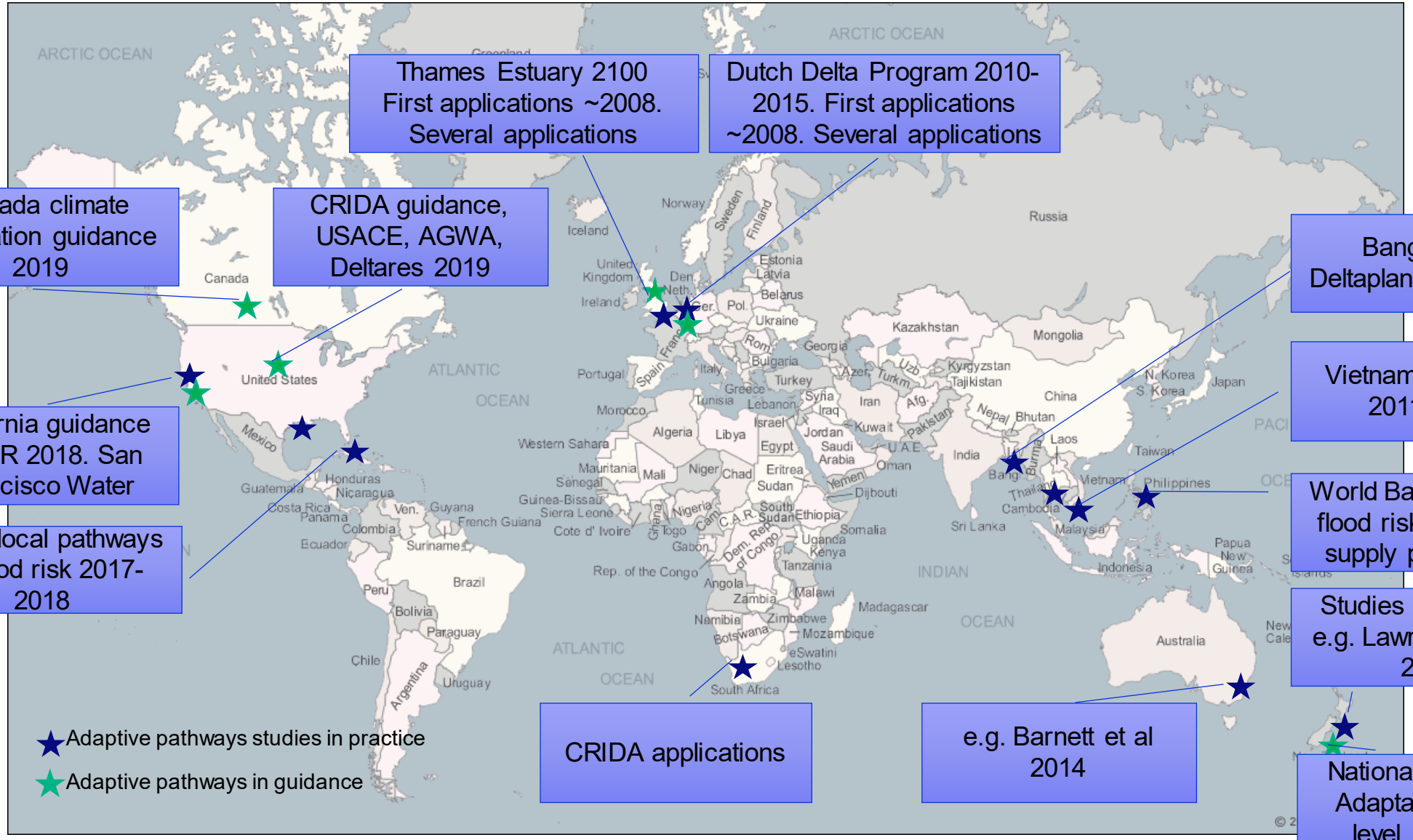
Kwakkel Haasnoot 2019,
https://doi.org/10.1007/978-3-030-05252-2_15

Systematic approach to Dynamic Adaptive Policy Pathways planning used and adopted in practice and theory

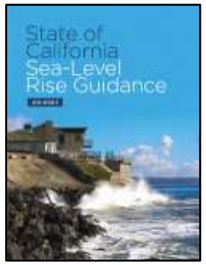


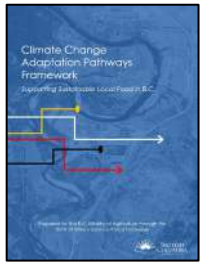
Haasnoot et al. 2013/2019, IPCC SROCC 2019. Several guidances exist: CRIDA, World Bank, national guidances (e.g. New Zealand)
https://doi.org/10.1007/978-3-030-05252-2_4

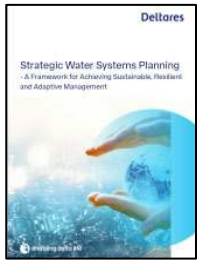
Some DAPP applications

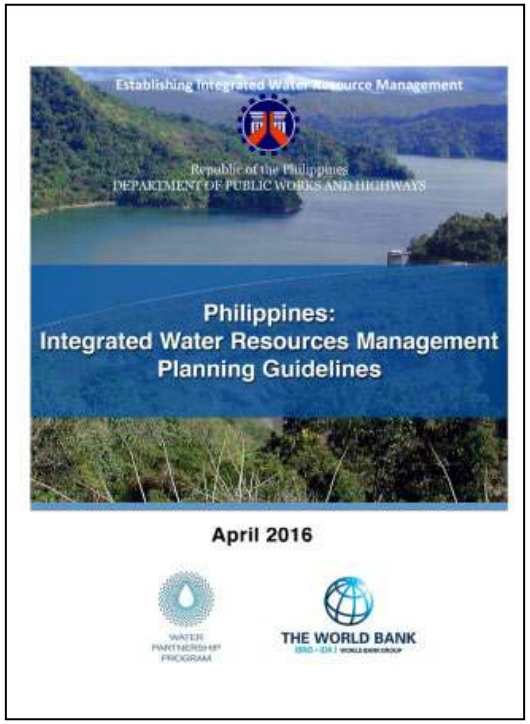


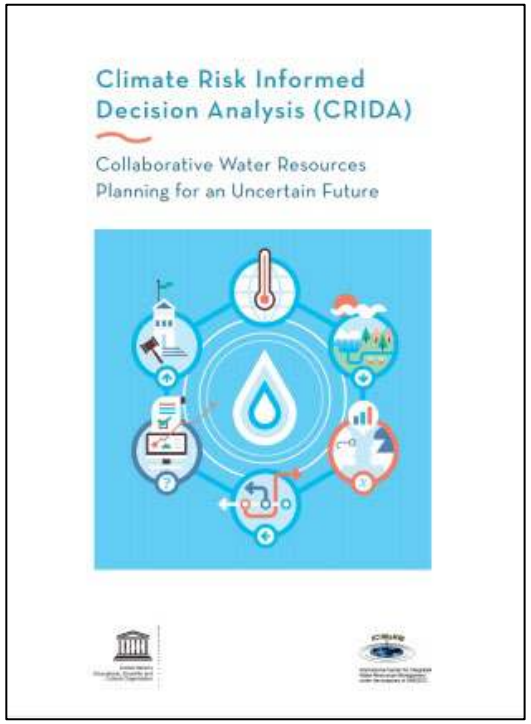
Pathways as part of other guidances

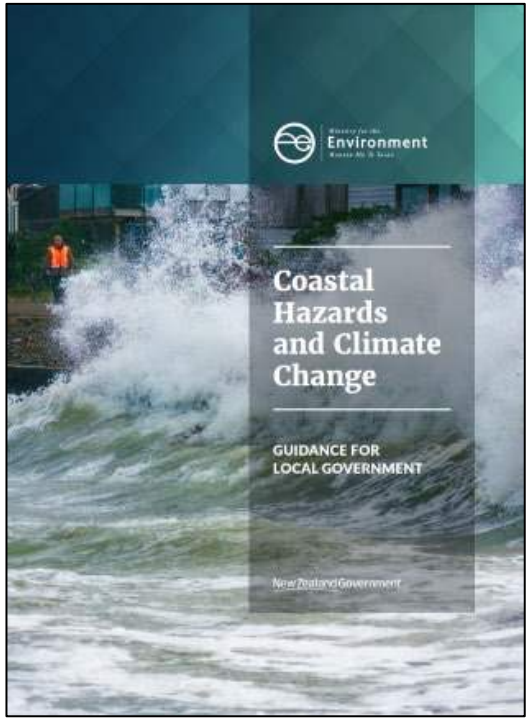


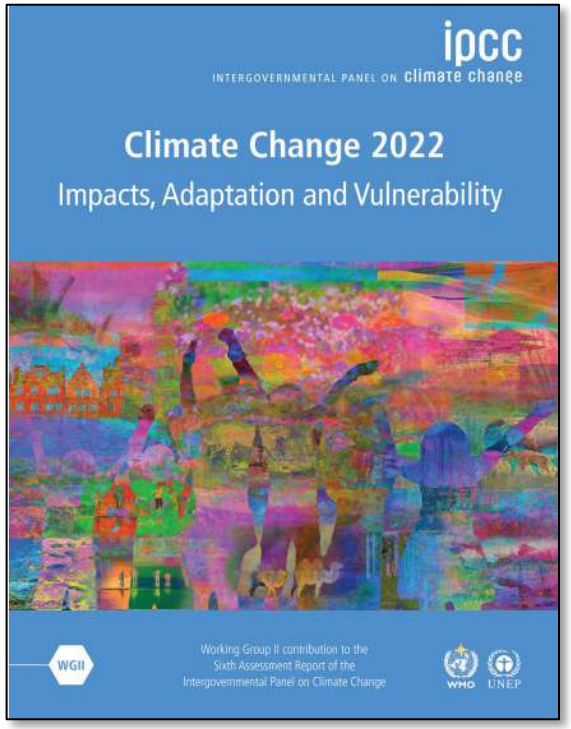












A phased approach to pathways

Awareness raising: serious gaming and introduction

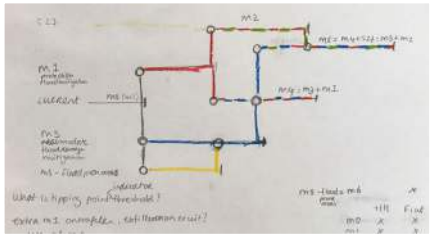
1. Qualitative pathways narratives

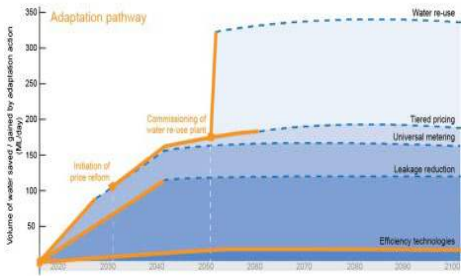
2. Quantitative design of pathways

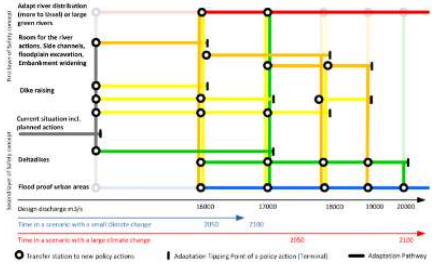
3. Full assessment of pathways

Narratives

Model requirements and further analysis







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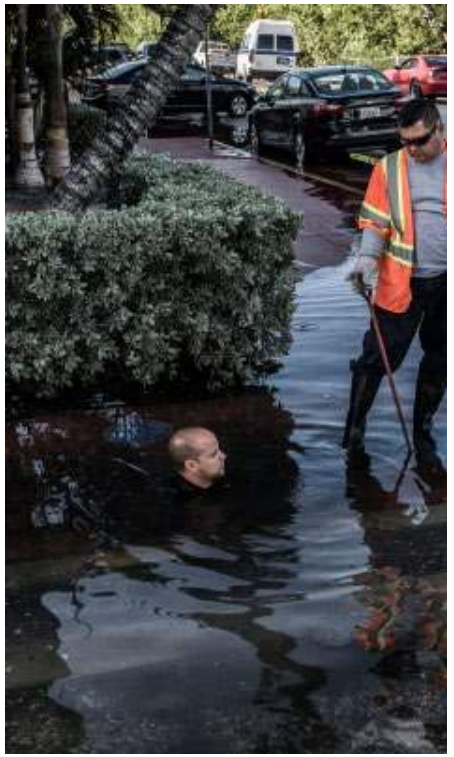
Adaptation Tipping Points, thresholds and limits to adaptation: reasons to adapt further

‘Hard’ (unsurpassable) thresholds and ‘soft’ (surpassable) thresholds, such as : technical (design), physical, cost-benefit, space, material, knowledge, social acceptability, economic productivity, time







Adaptation Pathways

Types

- Tipping points-based (e.g. Miami, Thames Estuary 2100, IPCC WG2)
- Short-medium-long-term (Delta Program)
- Generic pathways for archetypes (IPCC, Rocle, Magnan, Haasnoot)
- Multiple actors
- Narrative-style

Tools

Qualitative methods

- Narratives
- Scenarios
- Serious games (e.g., deltagame)

Quantitative methods

- Exploratory modeling (e.g., ema_workbench, rhodium)
- Many Objective optimization (e.g., BORG, platypus_opt)

Visualizations

- Pathways generator

Tools to explore pathways

Qualitative methods

- Narratives
- Scenarios
- Serious games (e.g., deltagame)

Quantitative methods

- Exploratory modeling (e.g., ema_workbench, rhodium)
- Many Objective optimization (e.g., BORG, platypus_opt)

Visualizations

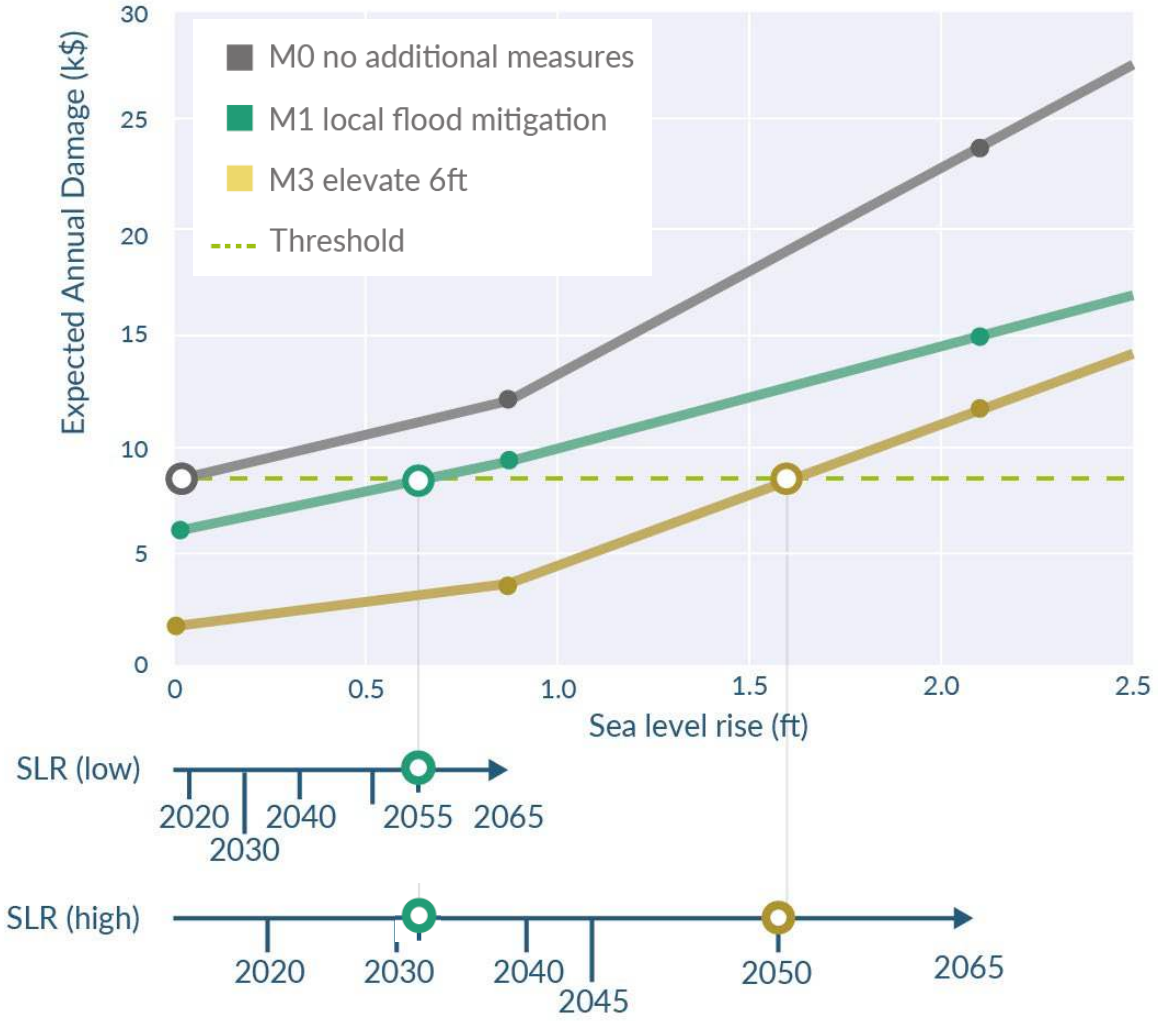
- Pathways generator

Miami case study

Narratives of pathways

pathways generator tool:
http://pathways.deltares.nl

Model-based pathways: ATP



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Bouwer et al 2017; Jayantha et al. 2020

Miami case study

Structural Measures

M2b regional flood mitigation

M2a regional flood mitigation

M1 local flood mitigation

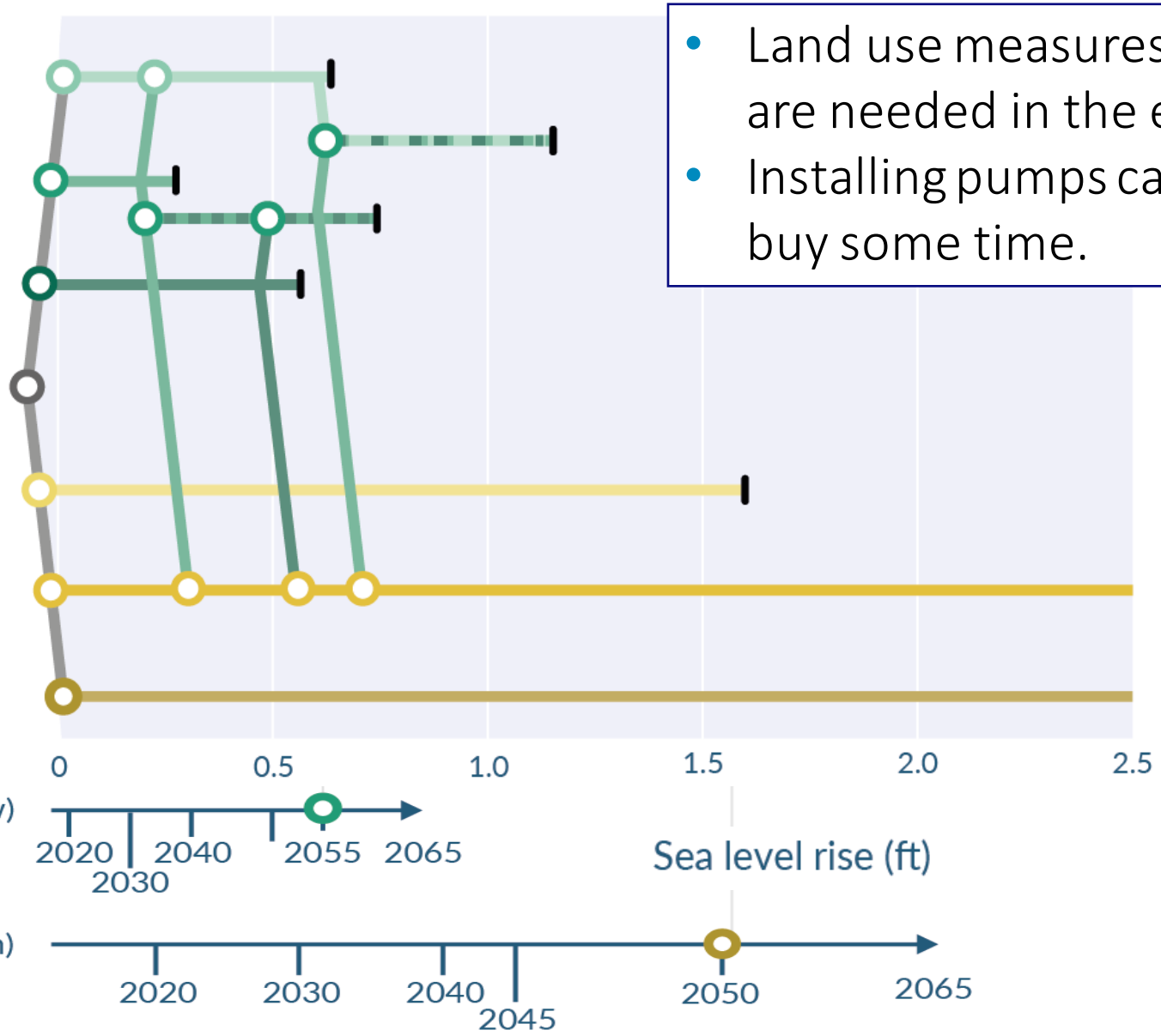
M0 no action

Land use measusre

M3 Elevate 6ft

M3 Elevate 7ft

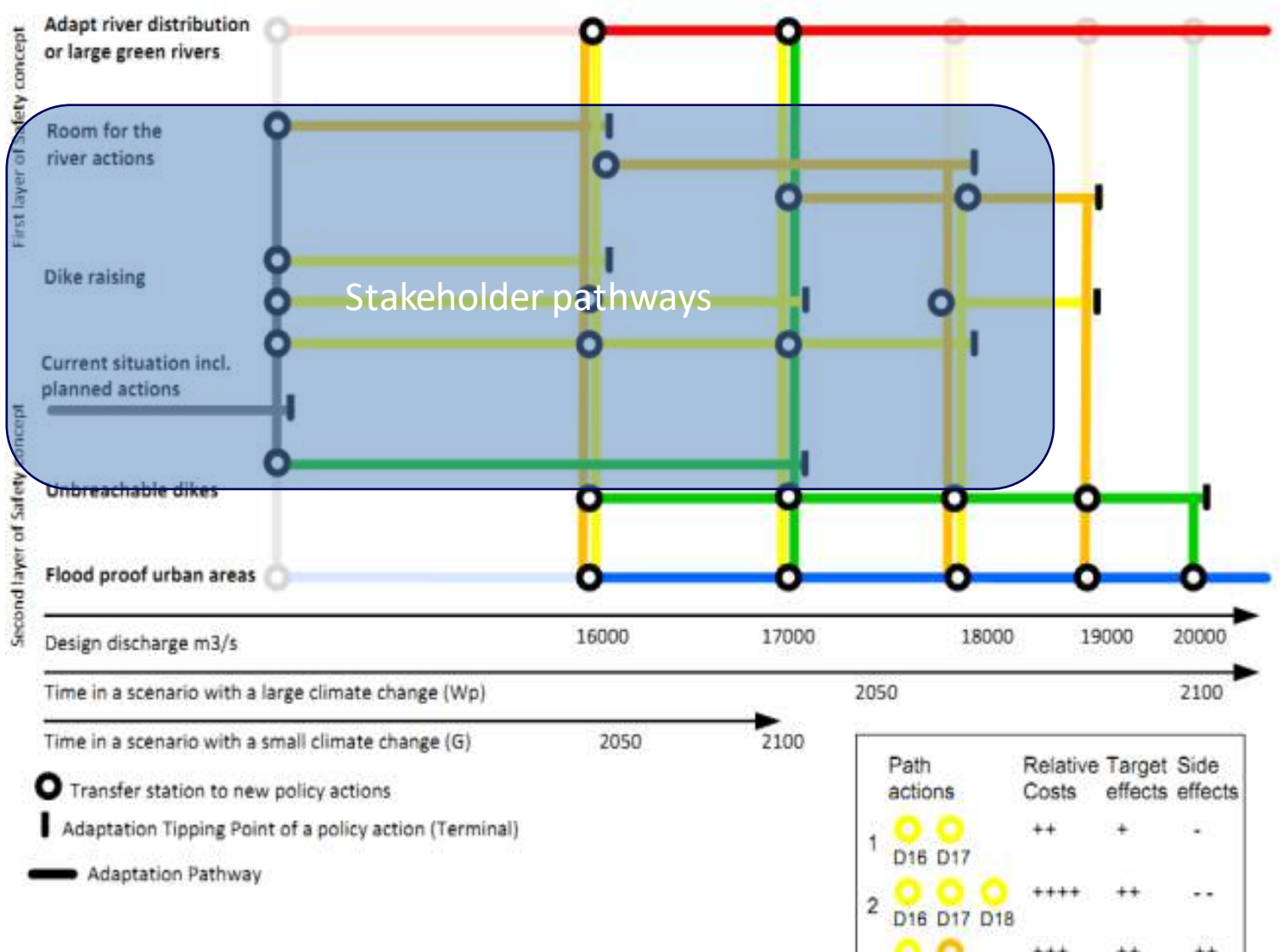
M3 Elevate 8ft

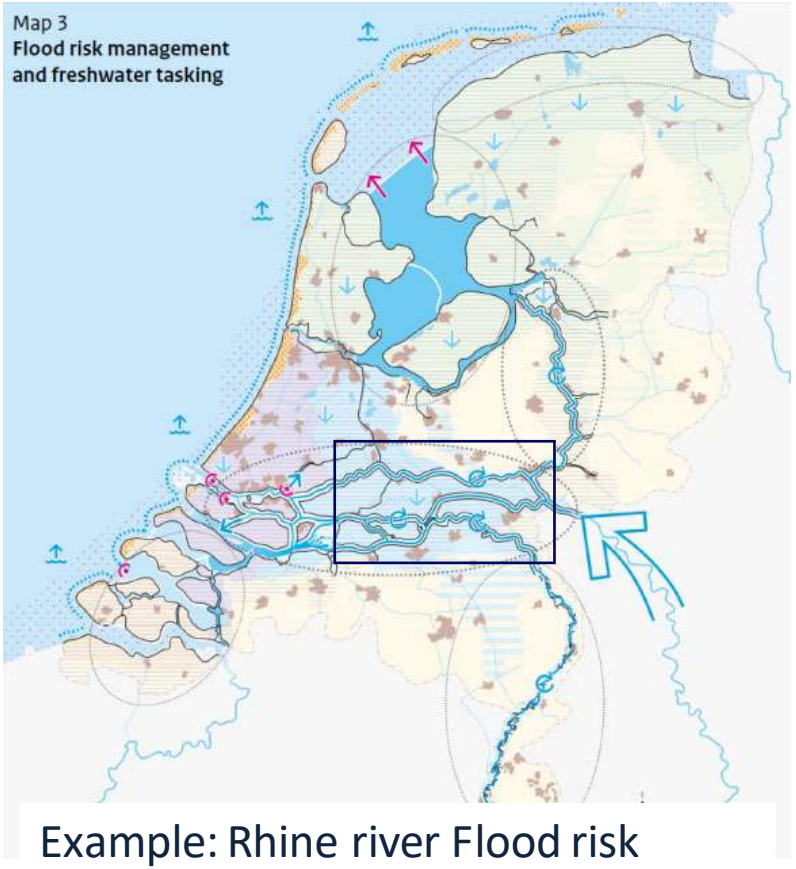


- Land use measures are needed in the end
- Installing pumps can buy some time.

Deltares

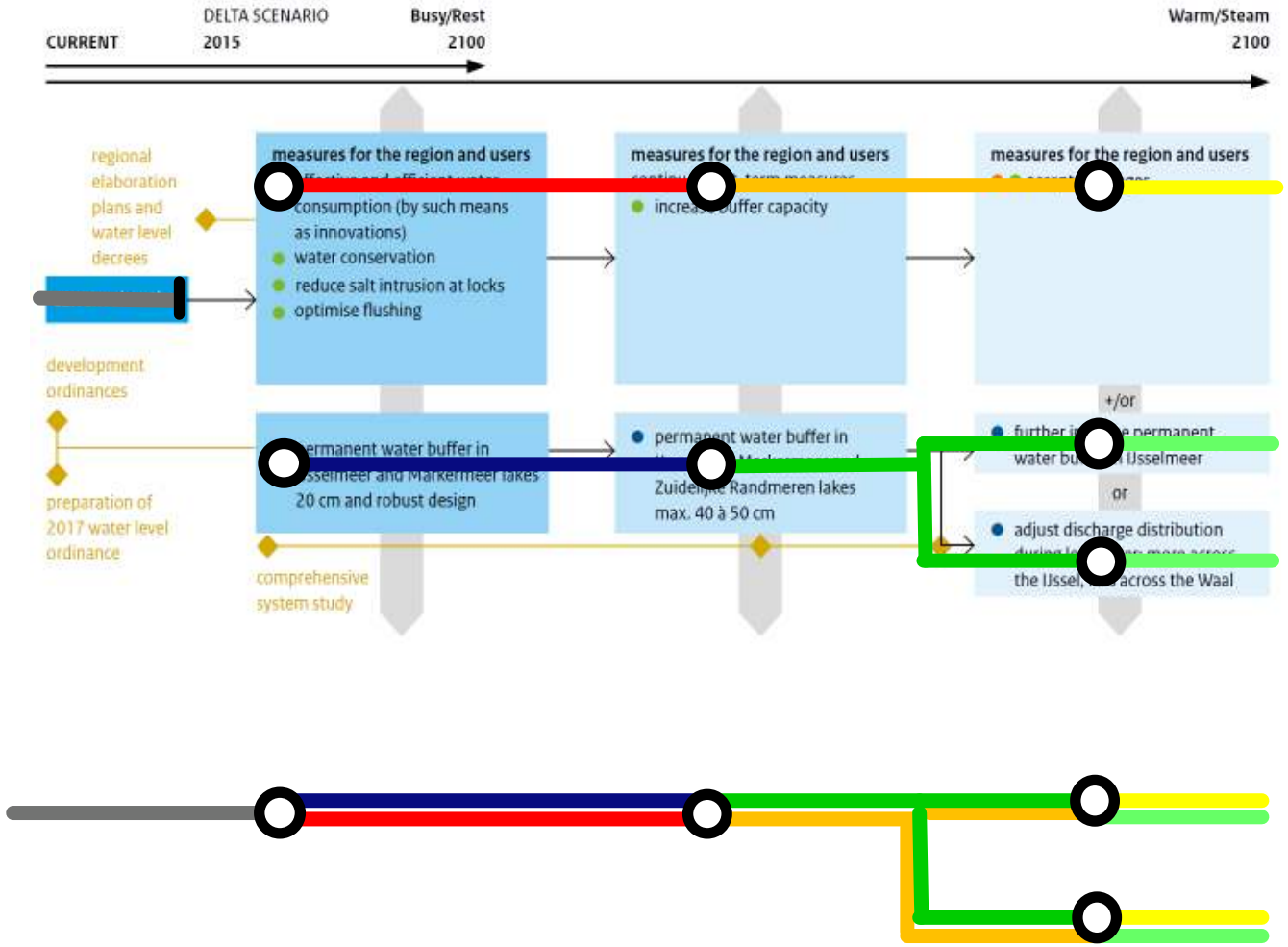
Delta Programme, The Netherlands





Example: Rhine river Flood risk Haasnoot 2013. Anticipating Change

Delta Programme, The Netherlands



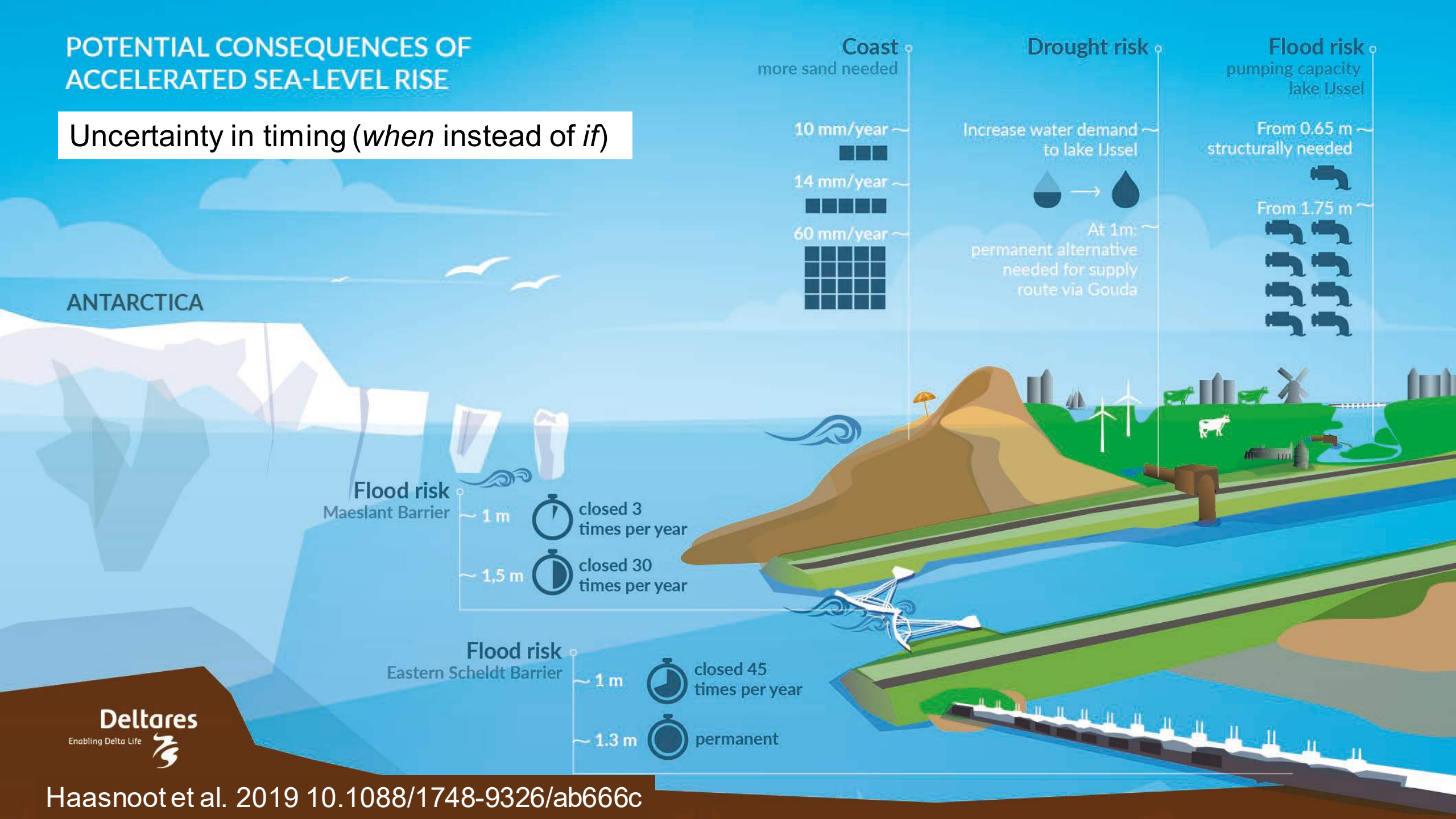
- Iterative participatory process
- Multi stakeholder pathways
- Reduced the number of pathways

- Short term: incremental actions
- Medium term: prepare for transformation
- Long term: transformational measures

Delta Programme 2015
Bloemen et al 2019

Deltares

Policy hackathon to map solution space to high-end sea level rise

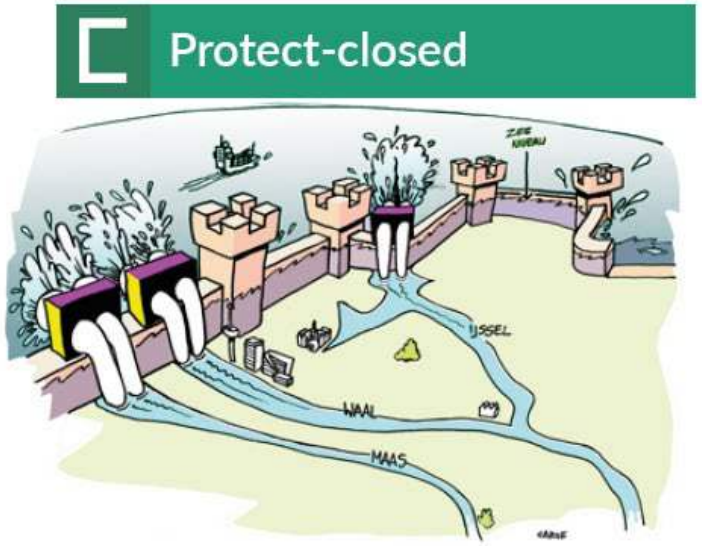


Haasnoot et al. 2019 10.1088/1748-9326/ab666c

Solution space to multi-meter SLR++

Assessment of options, pathways, short-term actions

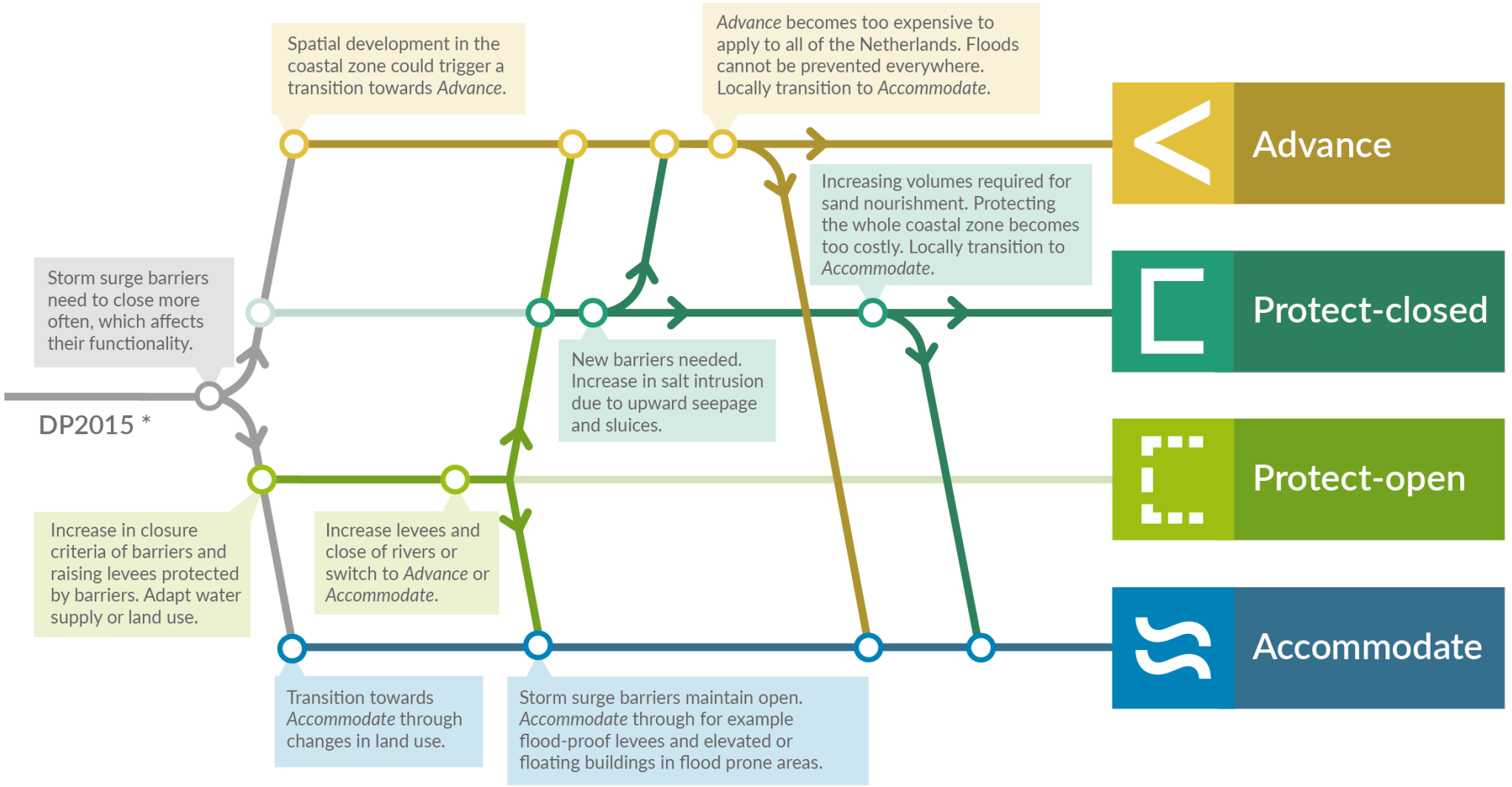
- Rivers: space & pumps ~3000 m3/s, storage space!
- Large amounts of sand needed:
  - ~240 times Palm island for Advance,
  - scalability of nourishment uncertain
- Salt intrusion cannot be avoided



Haasnoot et al 2019 (in Dutch), Van Alphen et al 2022 10.3390/w14101527

[redacted]

Mapping the solution space to high-end sea-level rise to identify critical decisions



Haasnoot et al 2019; Van Alphen et al 2022
10.3390/w14101527

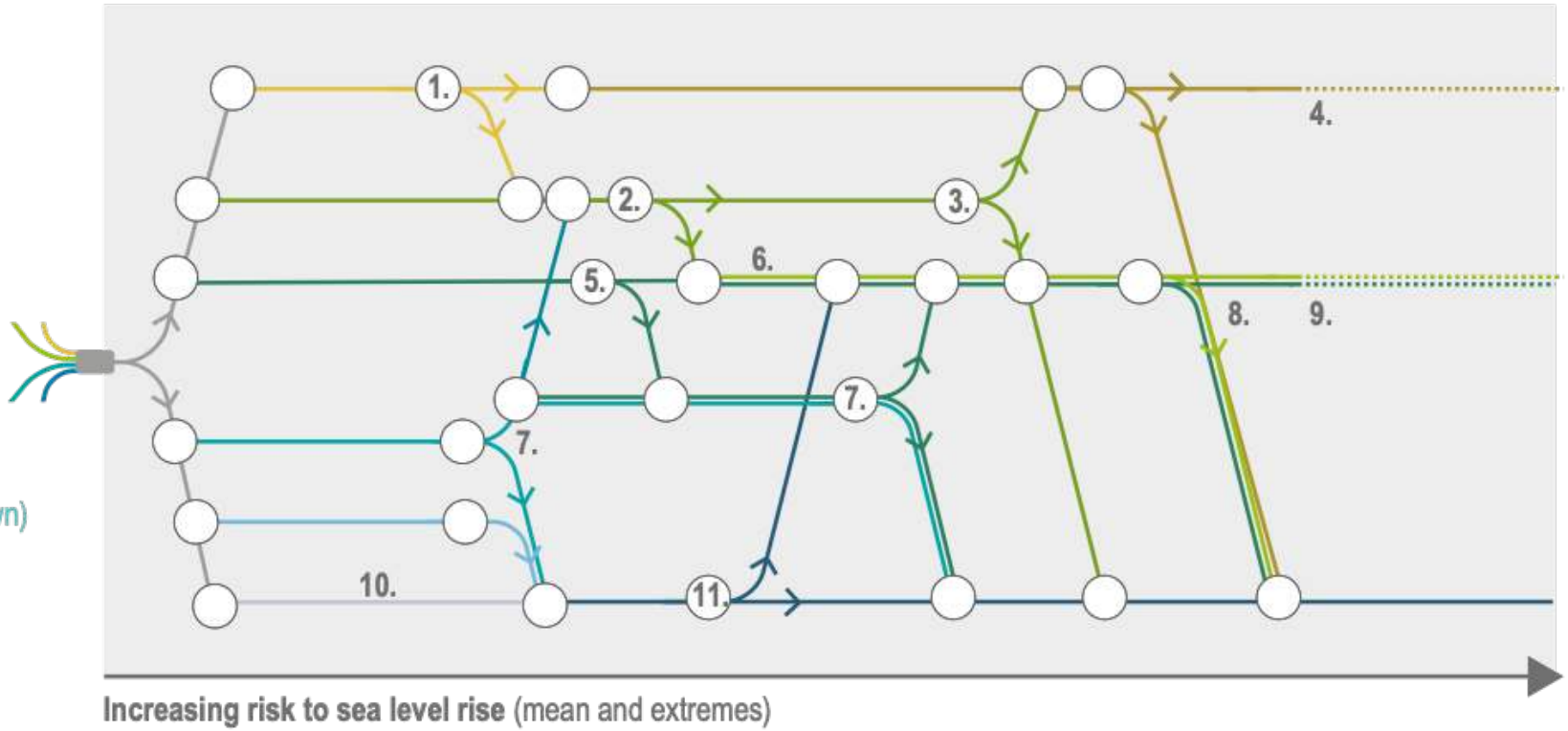
*) Decisions and strategies presented in the Delta Program 2015

Generic adaptation pathways

IPCC WG2, 2022
also: Rocle et al 2021, Magnan et al 2020, Haasnoot et al 2019, Muccione in review

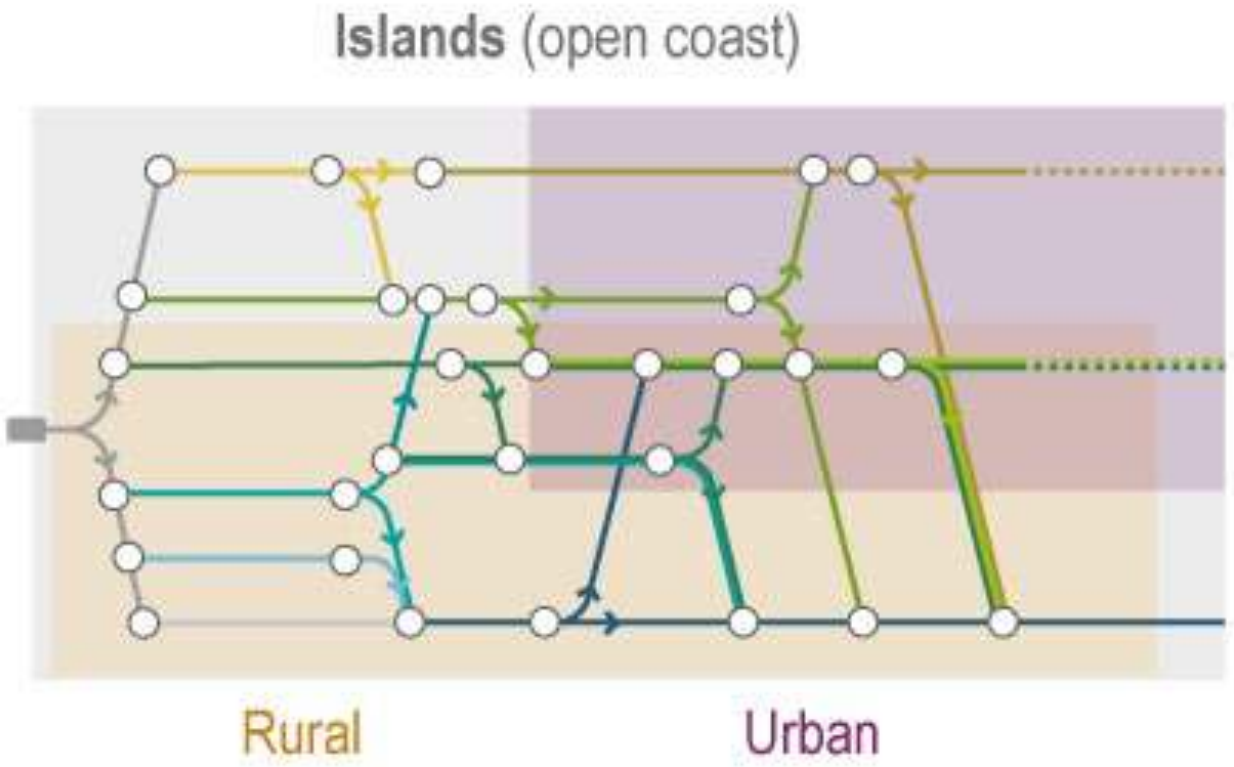
(a) Generic adaptation pathways for coastal cities and settlements to sea level rise

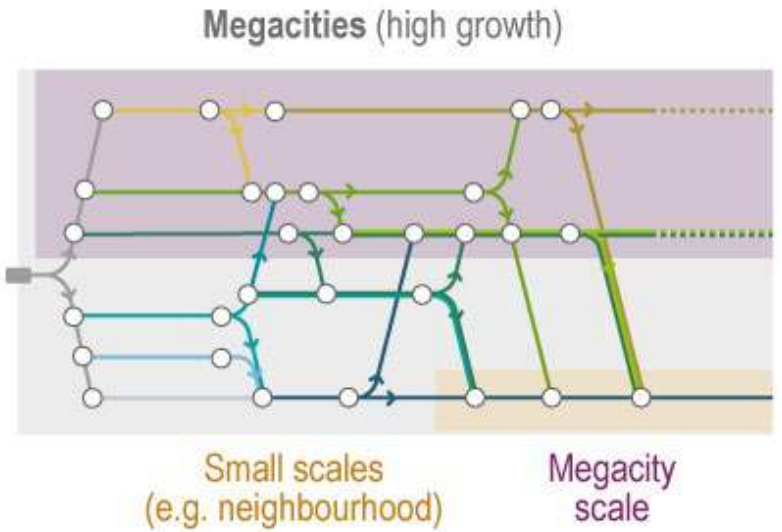
Generic strategies	Examples of specific measures
Advance	New seawards land claim above sea level
Protect	Sea walls, levees, storm barriers
	Wetlands, mangroves, coral reefs
Accommodate	Wet and dry proofing built environment
	Floating structures (experimental, not shown)
Retreat	No build zones
	Planned relocation

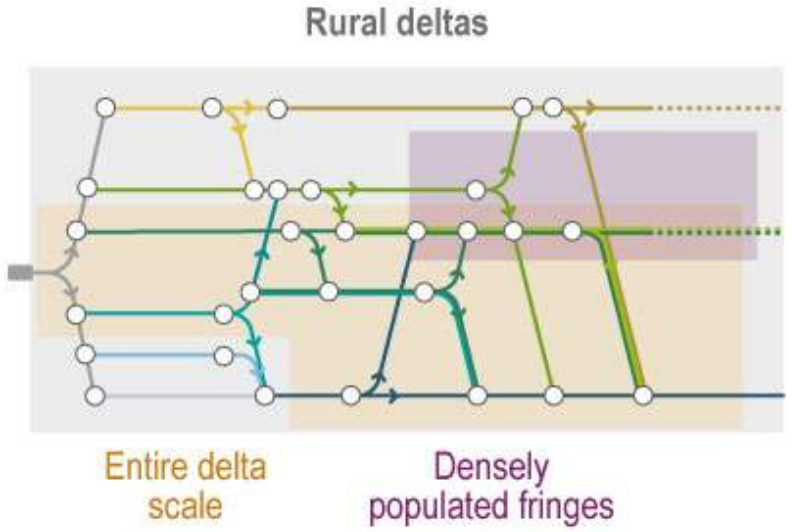


1. Successful pilot, lack of development space triggers advance, or protect due to lack of support, time or finance.
2. Preference for nature-based solutions.
3. Unaffordable, salinisation, pumping limit, lack of support.
4. Unaffordable, pumping limit, lack of time, support, knowledge, material.
5. Warming, limited space, human pressures, frequent flooding require additional measures.
6. Hybrid strategy.
7. Frequent flooding, flooding creates access problems.
8. Warming, limited space, human pressures, frequent flooding.
9. Unaffordable, salinisation, pumping limit, lack of support.
10. Long lead time to align with social goals and ensure just outcomes.
11. Lack of acceptance and equity triggers shift.

Generic adaptation pathways







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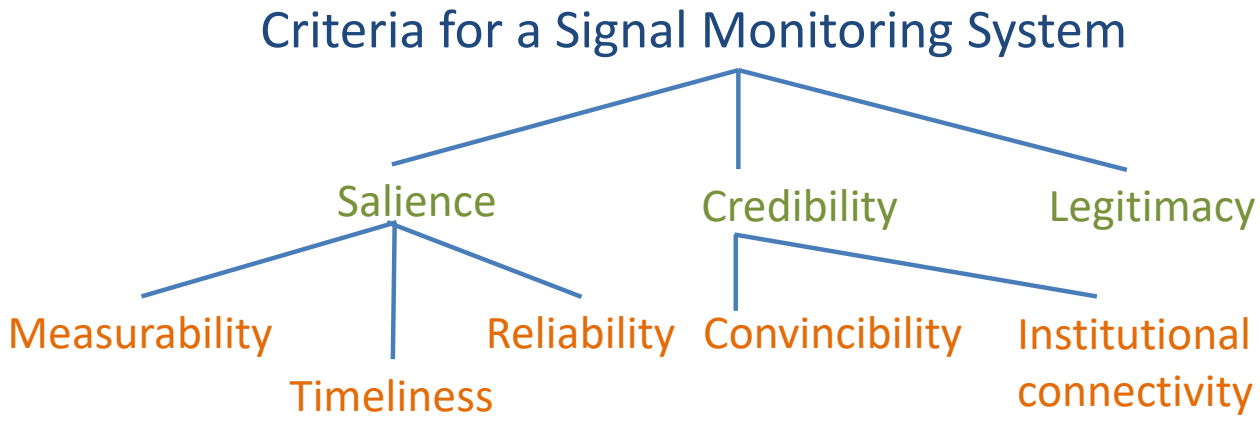
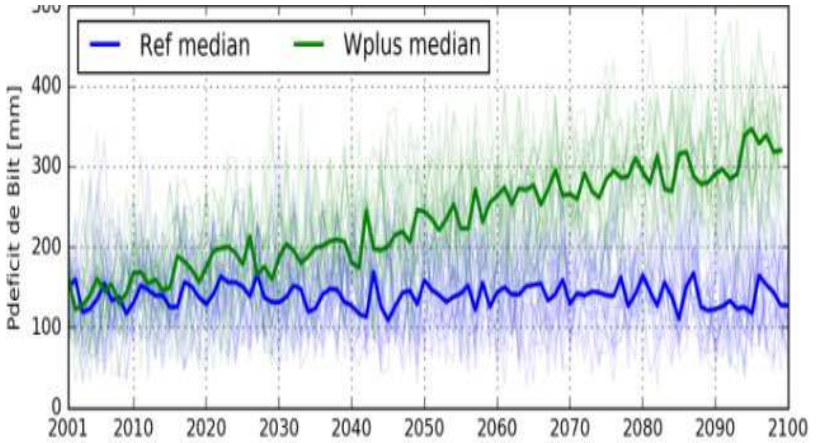
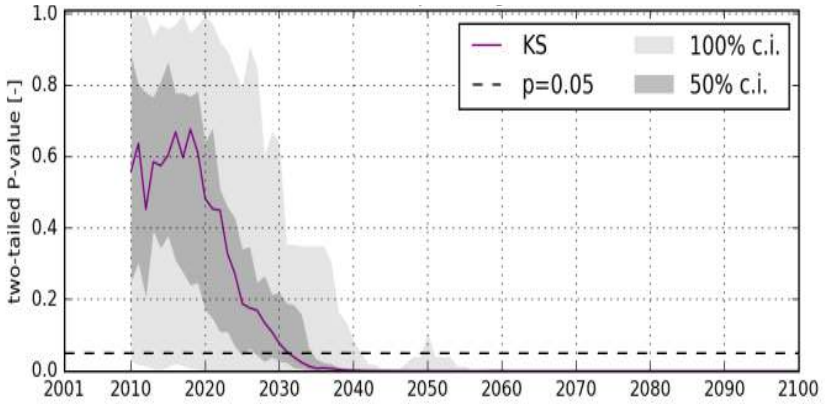
Monitoring for adaptation signals

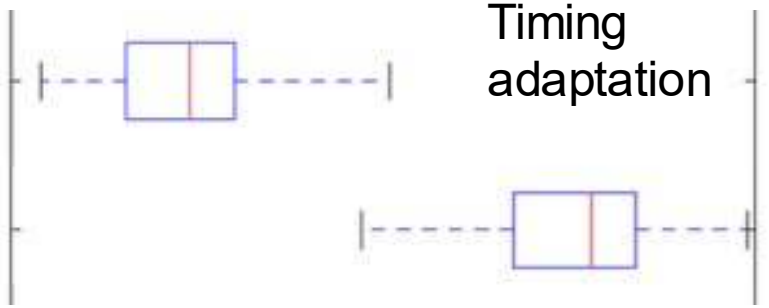
- What/where to monitor?
- Detect signal from the noise? weak/strong signals, primary+secondary indicators
- When can expect learning?



Haasnoot, M. et al. (2018).

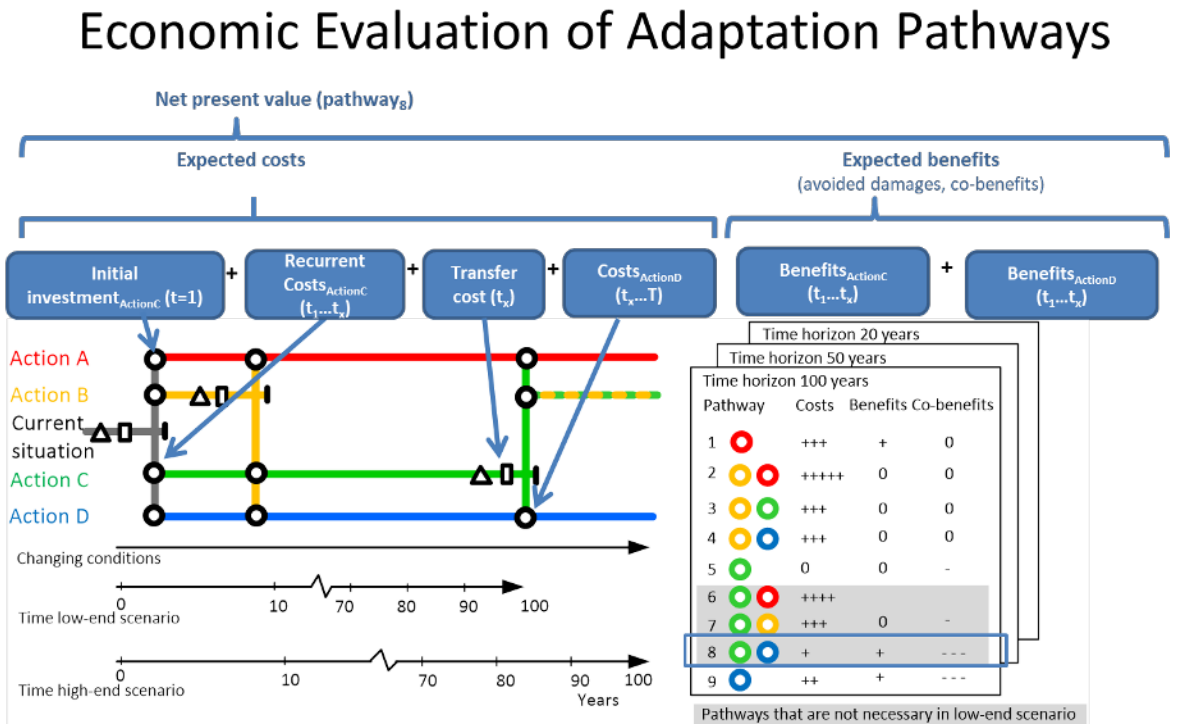






Evaluation of pathways: cost benefits, path-dependencies

- Cost benefits (for who, when, where?)
- Transfer costs
- Real options
- Lock-in and path-dependencies
- Inclusiveness
- Equity and climate justice

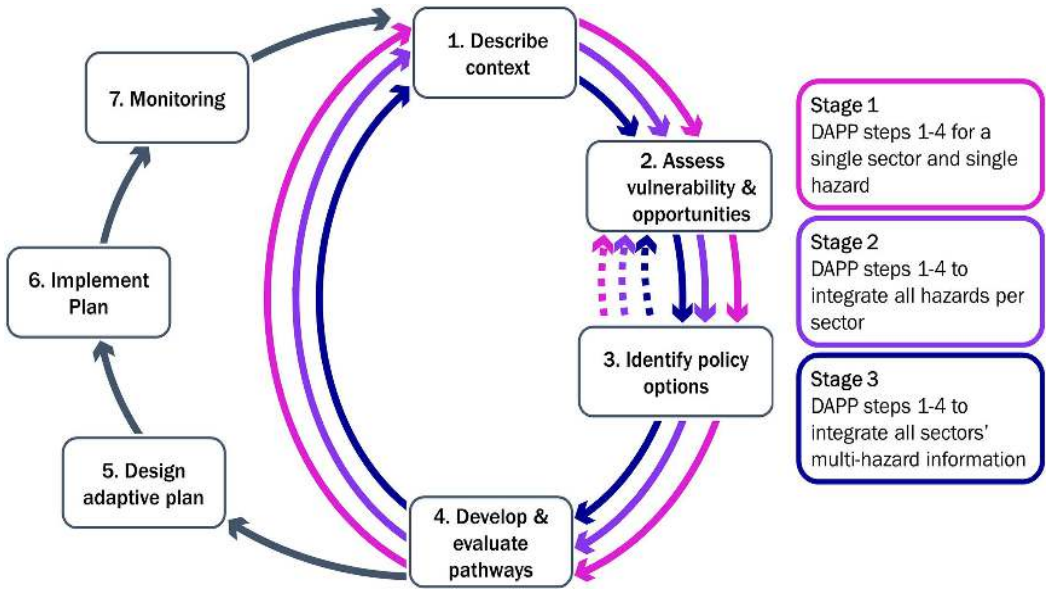


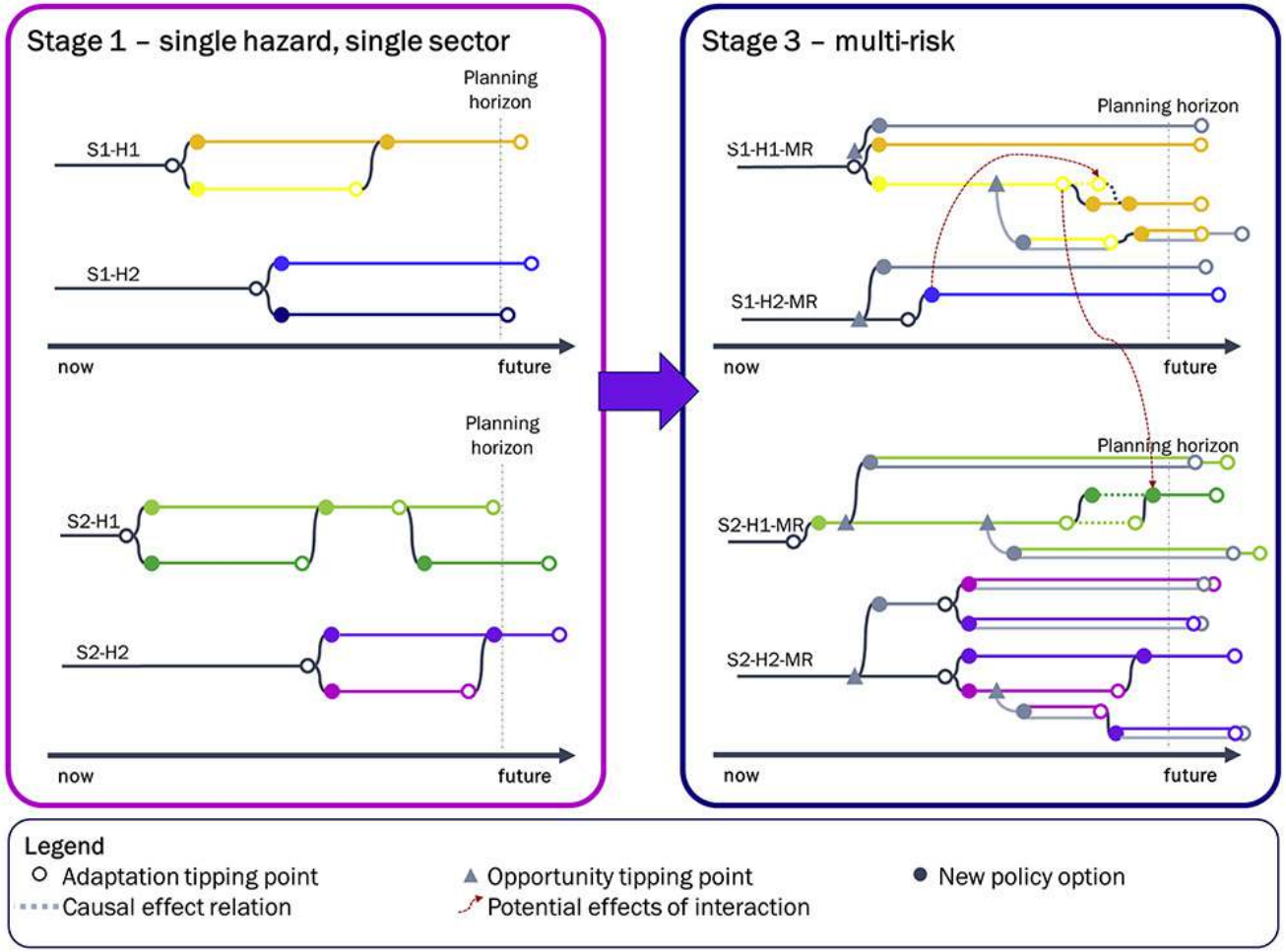
Stroombergen, Jafino, Buurman, Wreford, Haasnoot

Deltares

Multi risk and multi sector pathways

- Multi-dimensional Adaptation Tipping Points (e.g. Scenario Discovery/RDM)
- Linking multiple pathways maps with DAPP-MR

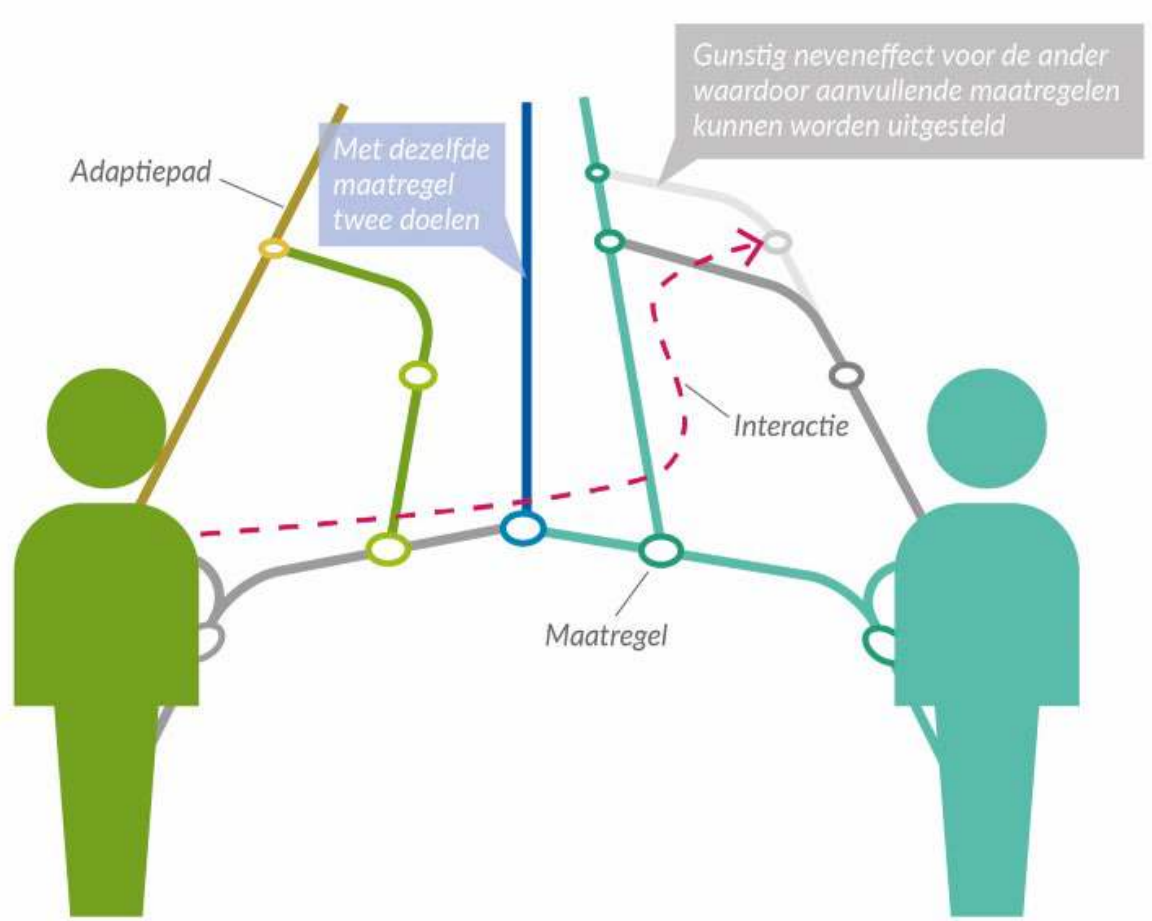




Schlumberger et al (2022) https://doi.org/10.1016/j.isci.2022.105219

Interactions with developments and mitigation climate resilient development pathways

- Risk change: adaptation with increase of emission, or mitigation/development investments in high-risk areas which require further adaptation. Synergies.
- Solution space: many options require space and water which
- System transition: transitions vragen niet alleen techniek maar ook verandering van gedrag, wetgeving en beleid, governance en financiële systemen



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Interactions with developments and mitigation: climate resilient development pathways

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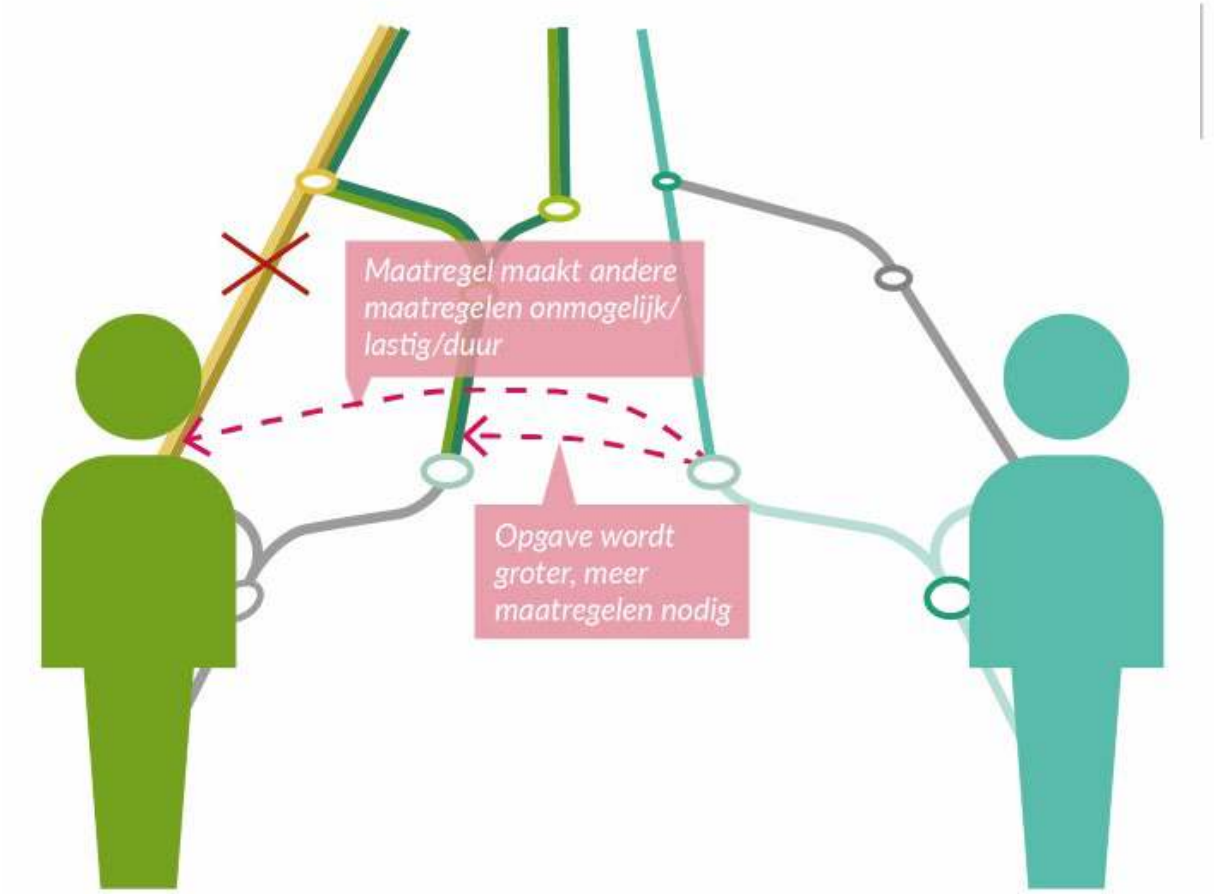
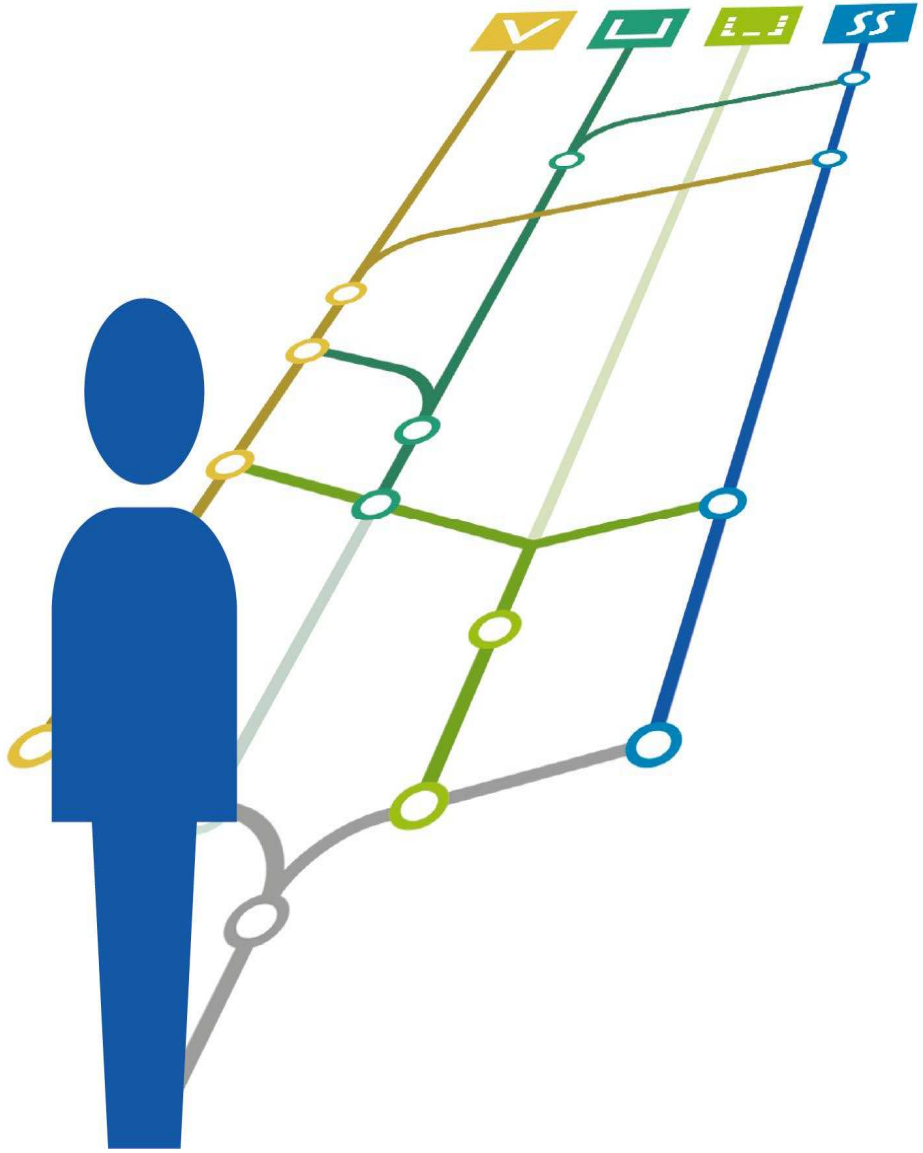


Deltares

Reflections

- Pathways analysis is a means to support DMDU, and typically follows a staged and iterative process.
- Approaches for exploring pathways include narratives, impact models, and stakeholder participation tools.
- DAPP has core elements and be tailored to local context and complemented with ingredients of other DMDU approaches.
- Given the new climate reality, we can use DAPP to link urgent actions to long-term adaptation needs



A Decade of Dynamic Adaptive Decision-making Tools in Aoteaora: Lessons learned and next steps

9 March 2023

Ministry for the Environment, Wellington

National SCIENCE Challenges

THE DEEP SOUTH

Te Kōmata o Te Tonga

National SCIENCE Challenges

RESILIENCE TO NATURE'S CHALLENGES

Kia manawaroa – Ngā Ākina o Te Ao Tūroa

Ministry for the Environment

Manatū Mō Te Taiao

Victoria University of Wellington

Te Herenga Waka

Te Pūtahi Hurihanga Taiao

New Zealand Climate Change Research Institute

Contents

Shoreline Adaptation Plans: Purpose and Scope

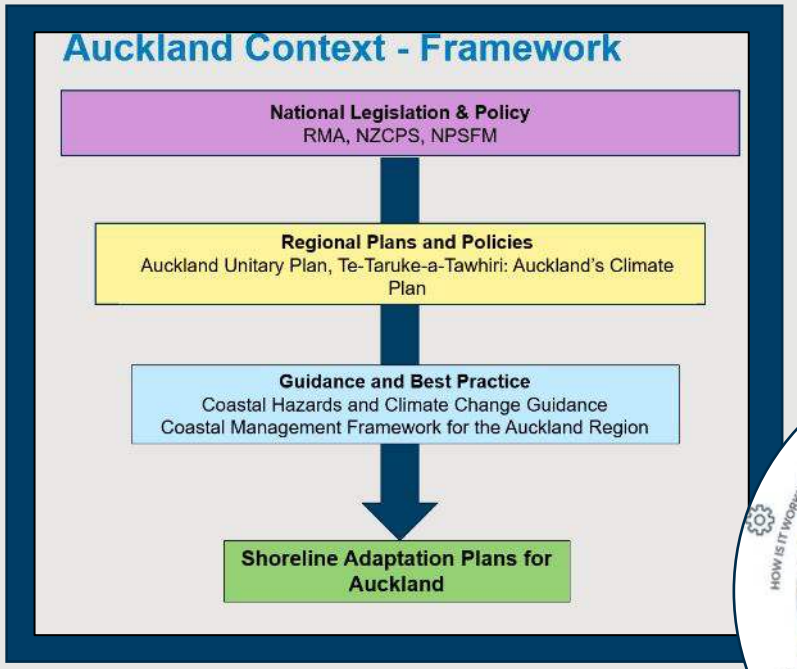
- Shoreline Adaptation Plans (SAPs) are adaptive plans that support the sustainable management of **Auckland Council owned land and assets,** across the regions coastlines over the next 100 years.

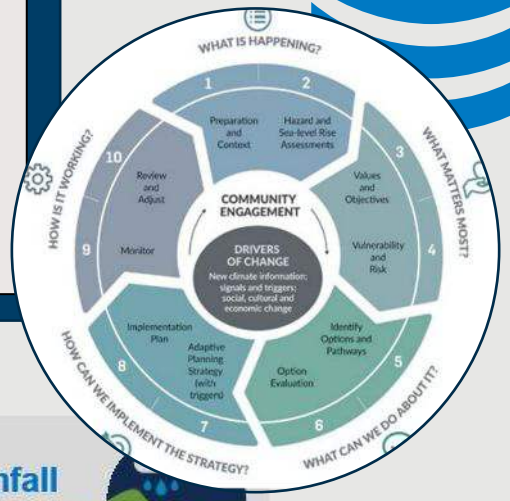
Purpose:

- Support strategic, holistic decision making for coastal land and assets
- First generation adaptative strategy; coastal hazards and climate change
- Support further education for the public regarding hazards and climate change in coastal areas

Scope:

- **Auckland Region**
- **Council owned land and assets** (including CCOs)
- **Coastal Hazards & Flooding** (Coastal erosion, inundation and catchment flooding (+Sea Level Rise))





Non-statutory. Living documents

Apply DAPP: Lessons learnt and methods use

Each SAP area has been broken up into units and stretches based on coastal morphology and the location of assets. From here work streams culminating in the development of Dynamic Adaptive Policy Pathways, providing a 'roadmap' for evolving coastal management strategies over time.

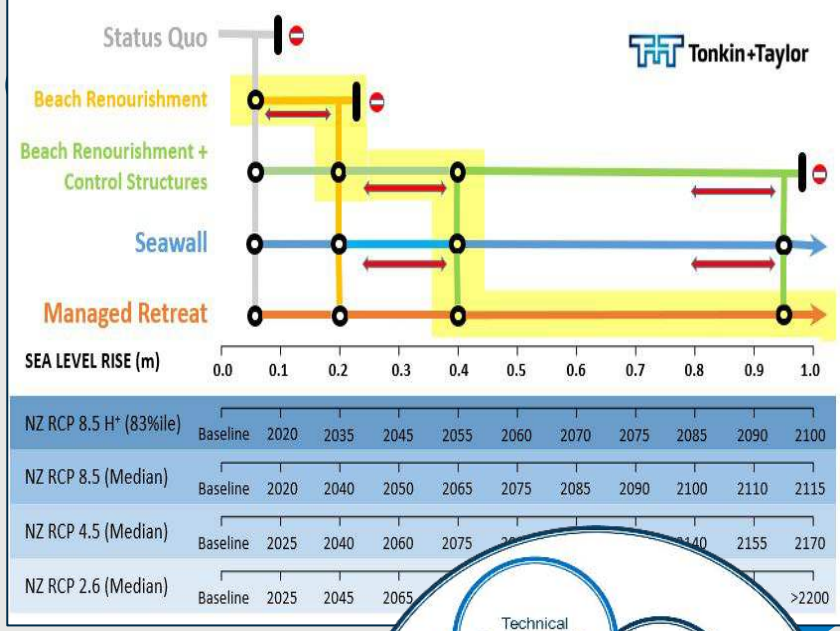
Lessons learnt:

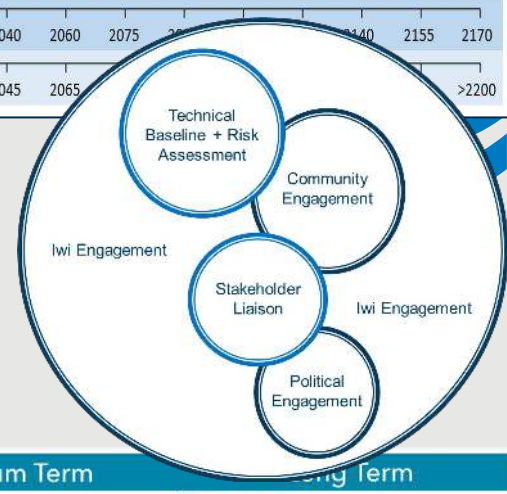
- The importance of acknowledging uncertainties in climate change and coastal hazard models, exploring different pathways early and testing the consequences.
- Applying cultural considerations and inputs into a DAPP approach is highly complex, especially when balancing the needs of 19 iwi entities in one region.
- The need for timely detection of signals and thresholds in situations with large natural variability and considering multiple perspectives and trade-offs involved in developing thresholds and triggers.
- At this stage, Auckland's SAPs are focused on only Auckland Council-owned coastal land and assets; this presents a challenge of:

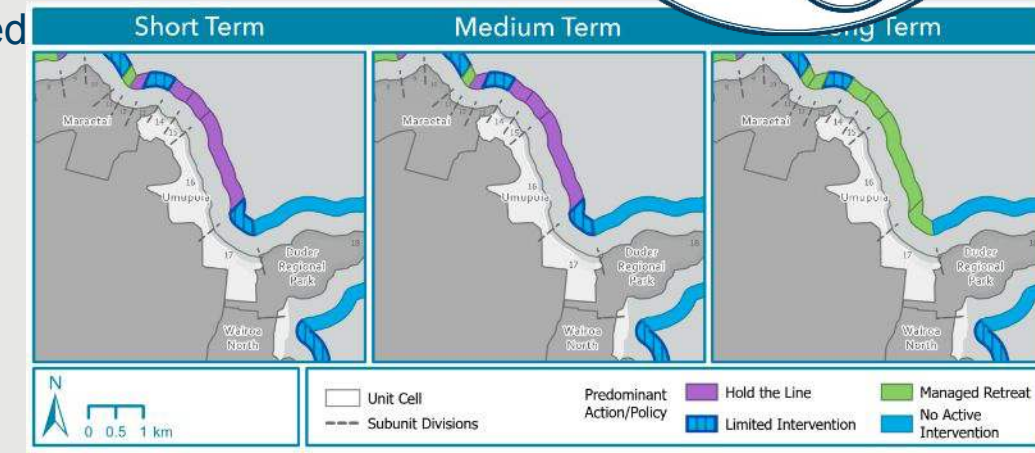
 Translating a DAPP pathway approach into Asset Management Plans

 Implementation of the SAP through statutory processes (e.g. Reserve Management processes) that are time frame bound rather than dynamic

 The requirement for ongoing monitoring to create place-based triggers and thresholds which may then become regionally applicable







Auckland Transport's use of DAPP

A Pilot Project

Auckland transport is trialing the use of Dynamic Adaptive Pathways Plan (DAPP) at a low-lying road along a coast at Maraetai Drive.

The objectives for this project are:

• Help AT to evaluate the effectiveness of different climate change adaptation planning approaches.

• Provide the basis for subsequent stages of work including the development of a detailed adaptation planning framework for AT.

Lessons learnt

Methodology

- Identifying climate hazards at the site.
- Developing adaptation thresholds .
- Developing signals and triggers for each pathway.

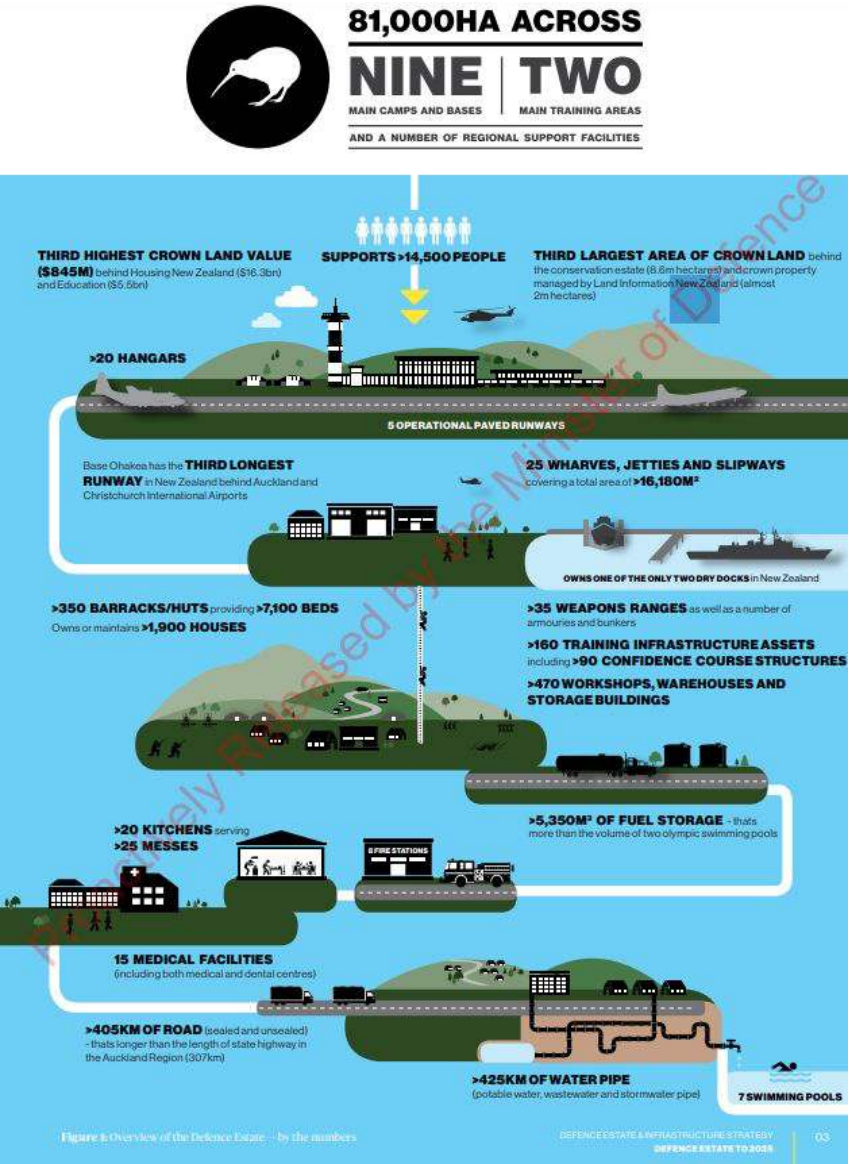
Application

- Adaptation pathways were developed and each option was assessed using the Multi-Criteria Assessment (MCA)
- This was presented to the internal AT asset managers to seek feedback on each option/pathway.

Implementation

- AT will start implementing the adaptation options for short, medium and long term as developed by this DAPP process.
- AT has already developed a Climate Adaptation Policy directing the business on how to assets are to be developed and managed in hazard areas. The DAPP pathways will feed into this policy as developed for each priority area.

Adapting the DAPP Framework to NZDF Context



- Just like any organisation, Defence Estate and Infrastructure (DEI) has its own:
  - Culture
  - Policies and protocols
  - Values
  - Ways of making decisions.

- We (the Defence Alliance) provided support to the DEI team to combine existing policies with national best practice for collaboratively evaluating risk and co-designing adaptation pathways. Over a series of workshops, this included:
  - Assessing risks to people, environments, platforms and infrastructure using a first pass risk screen
  - Developing an MCDA framework
  - Identifying and evaluating options to collaboratively build dynamic adaptative planning pathways (DAPPs) with a range of NZDF stakeholders.

Lessons Learned:

What worked well:

- We can adapt the DAPP methodology and the “MfE Wheel” approach to fit within organisation protocols.
- Participants in workshops were engaged, interested, and excited about building a shared future.

What needs some more thinking / testing:

- Building pathways diagrams “live” presents some real challenges when the objectives might not be infrastructure focused.
- When considering the range of climate hazards (increasing temperatures, extreme events, sea level rise) and potential responses, DAPPs can become complex, unless there are focused adaptation objectives.

NEWS & STORIES

Defence Force aids Auckland in flood emergency

The New Zealand Defence Force is assisting civil defence authorities and emergency services in response to catastrophic flooding across Auckland City.

Diverging sea-level rise projections – imperative for an adaptive paradigm

Dr Rob Bell

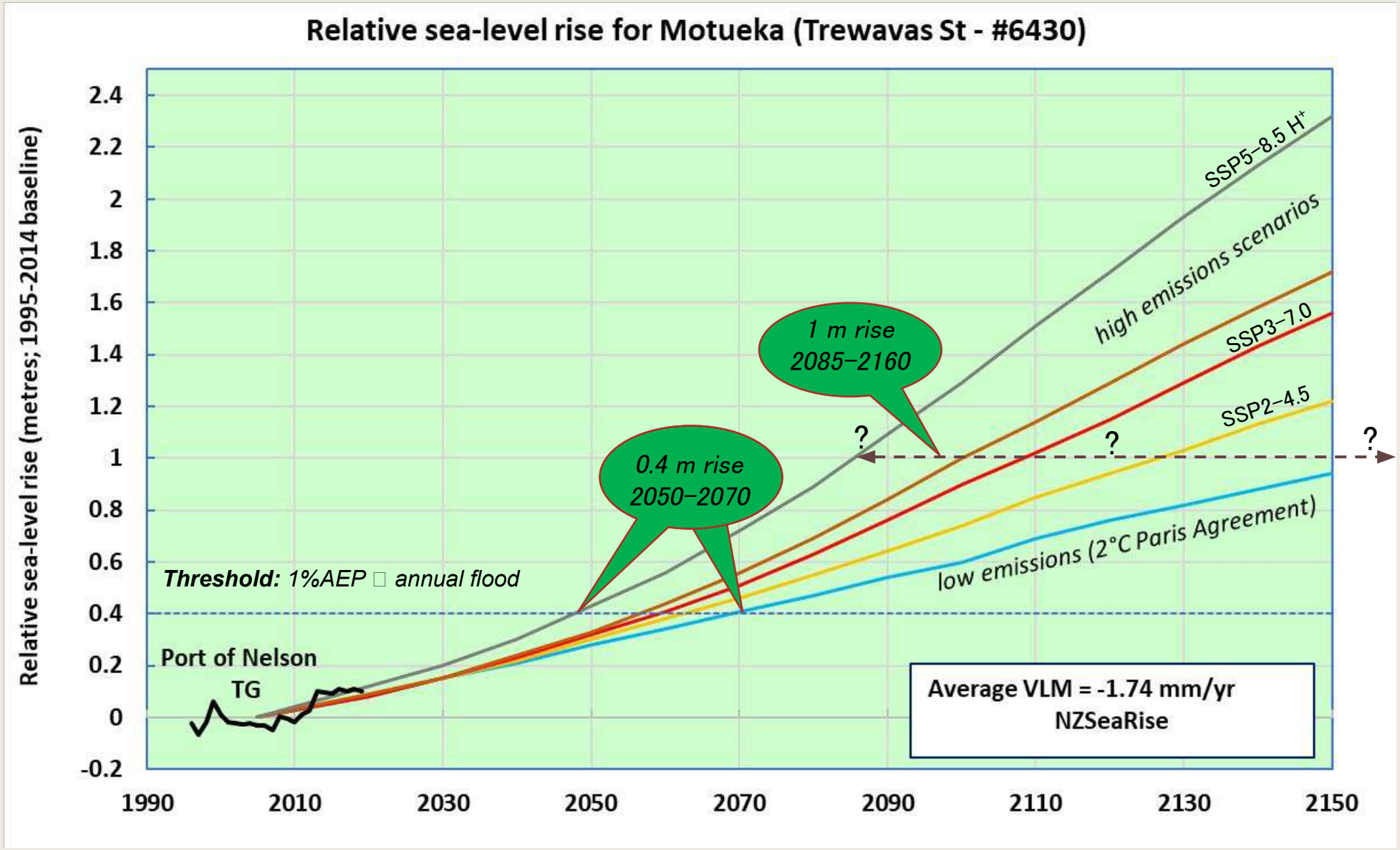
Bell Adapt Ltd, Hamilton, NZ

Environmental Planning Programme, Univ. of Waikato, NZ

e: [redacted]

Bell Adapt
MANAGING THE UNAVOIDABLE

Widening uncertainty in future relative SLR eg, Motueka (Tasman)



Deep uncertainty:
Rate of SLR ∝
emissions &
ice sheet tipping
points (1.5–2° C)

Another uncertainty is the future trajectory of vertical land movement (VLM)

Adaptive strategy is best for deepening uncertainty + monitoring change in RSLR and impacts eg, flooding

Projections:

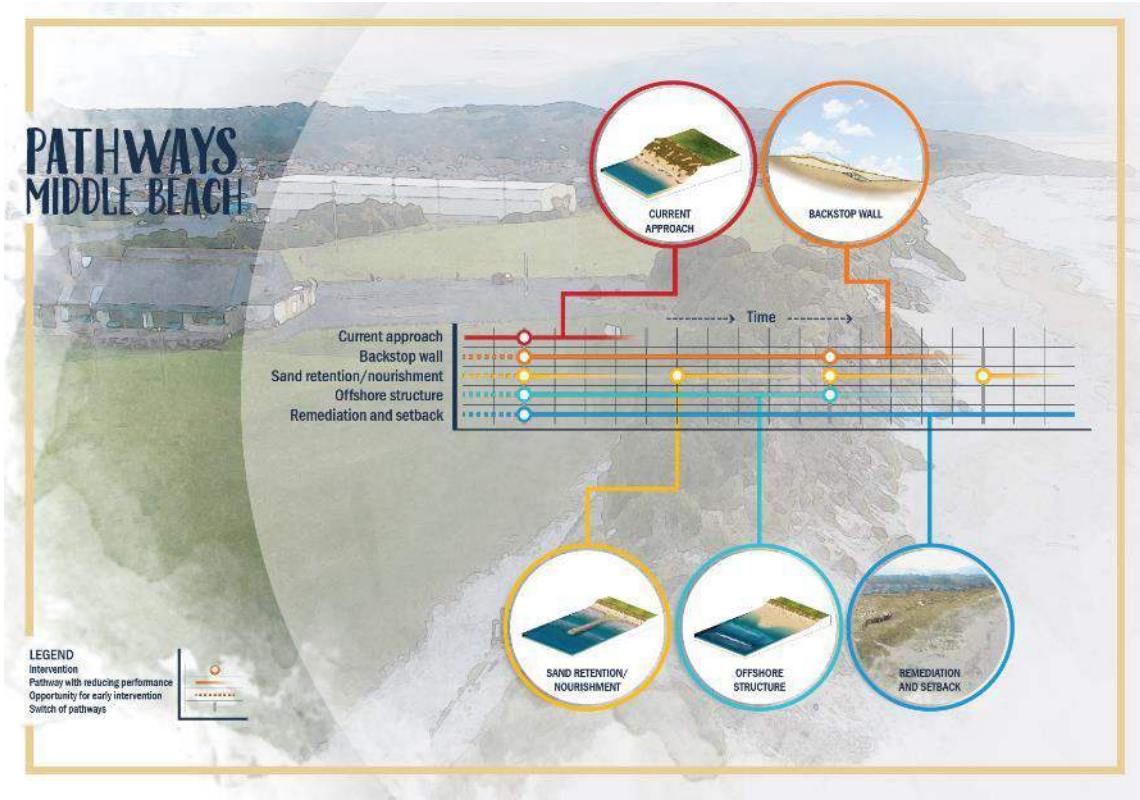
Moving to adaptive paradigm for infrastructure/communities

Conventional	Dynamic adaptive planning/design
Single-investment perspective: up-front, one-off	**Several timely investment options** mapped out in pre-planned adaptive strategy with alternative pathways
Nominal design life (or life cycle): in coastal areas often 100 yrs or buildings 50 yrs	**For each stage or option, determine possible range of "shelf life" from SLR/climate scenarios** (before a switch to next stage/option in a pathway)
Predict-then-act: choose most-likely or worst-case scenario for flood hazards	**Track-then-act**: scenario neutral, tracking the headway to a pre-agreed local adaptation threshold
Uses quantitative predictive models & risk assessment: to optimize solution *vs* cost & benefits for design life	**Applies multiple scenarios to stress-test options or select the most robust decision**: using simulator models, risk assessments & economic evaluation tools
Potential lock-in or path dependency of selected option. At worst, could become a stranded asset.	**Flexibility, in options/stages and when to invest, but flexibility has a cost.** Future generations can resolve some uncertainties with more info. Also, responsive to changing risk preferences, transport modal shifts, de-carbonisation & technology changes.
Monitoring when required: mostly for consenting requirements, focusing on construction & near-term effects of the project on the environment and social/cultural values	**Monitoring change is indispensable**: tracking indicators of change relative to early signals & triggers (decision points) e.g., diminishing LoS, maintenance costs, freq. of outages, SLR, erosion, and social impacts

Whakahekerau – Rakiātea Rautaki Tai St Clair – St Kilda Coastal Plan

Involved:

- Development of options and pathways
- Scoring of options using MCA
- Community contributing via surveys and the development of objectives
- Signals and triggers informed by community feedback – to be formed into monitoring framework later
- The resulting plan established direction for management and a platform for further work (including securing budgets for physical works and investigations) – did not select a preferred path



Process and lessons learnt

- Specialist advisory group undertook initial triaging of options
- Options formed into a range of possible coastal futures
- Coastal futures socialised and tested with the community – online and at workshops
- 1000Minds (decision-making tool) used to undertake pairwise comparison and establish weightings for different community derived criteria
- Community and technical processes were kept too separate, greater visibility of technical processes would have supported uptake and understanding in the community
- Risk was only communicated in a qualitative manner, would have benefitted from spatial application that considered cascading impacts across domains

Biodiversity and Conservation DAPP - Huts and tracks and things that move . .

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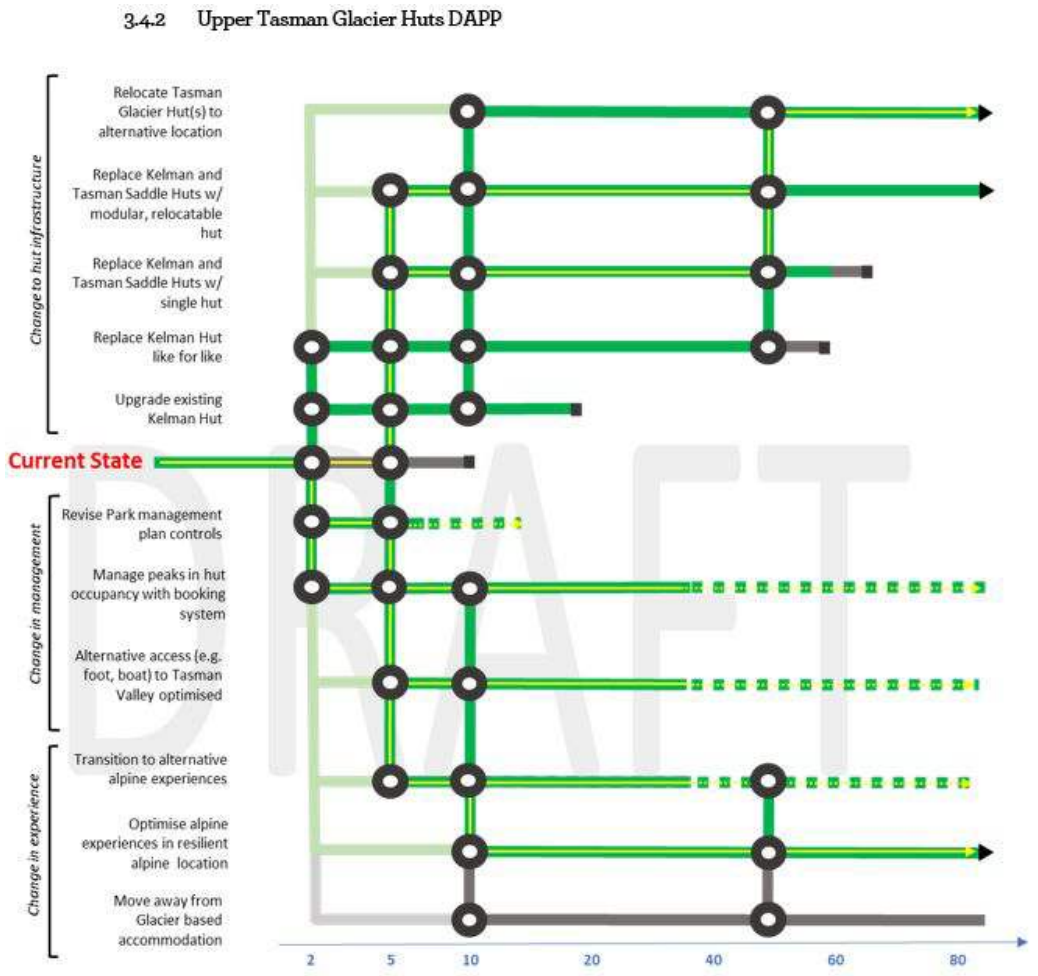

Biodiversity and Conservation DAPP - Huts and tracks and things that move . .

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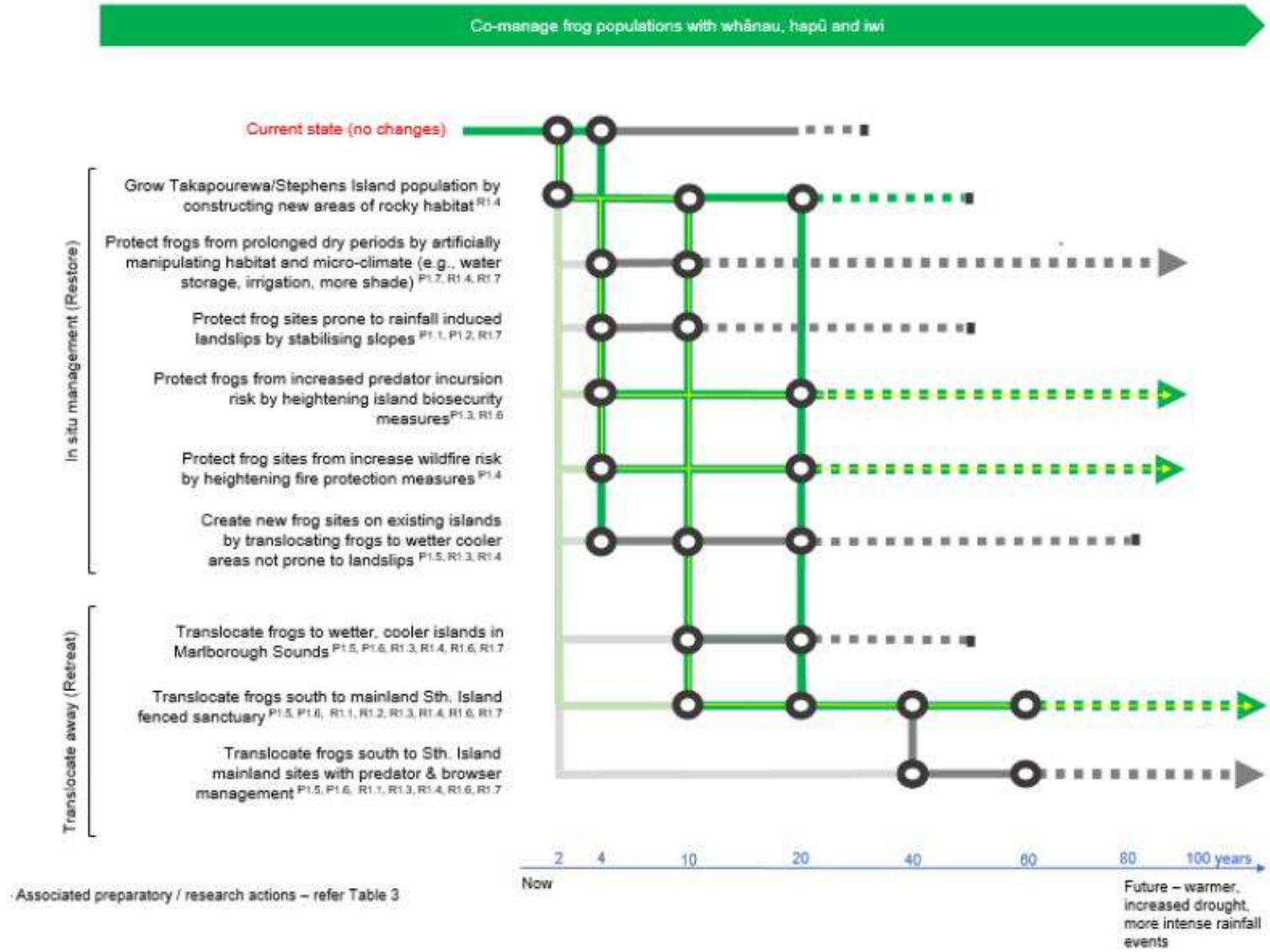


Context of DAPP experience & lessons

Based on the experience of Tom FitzGerald

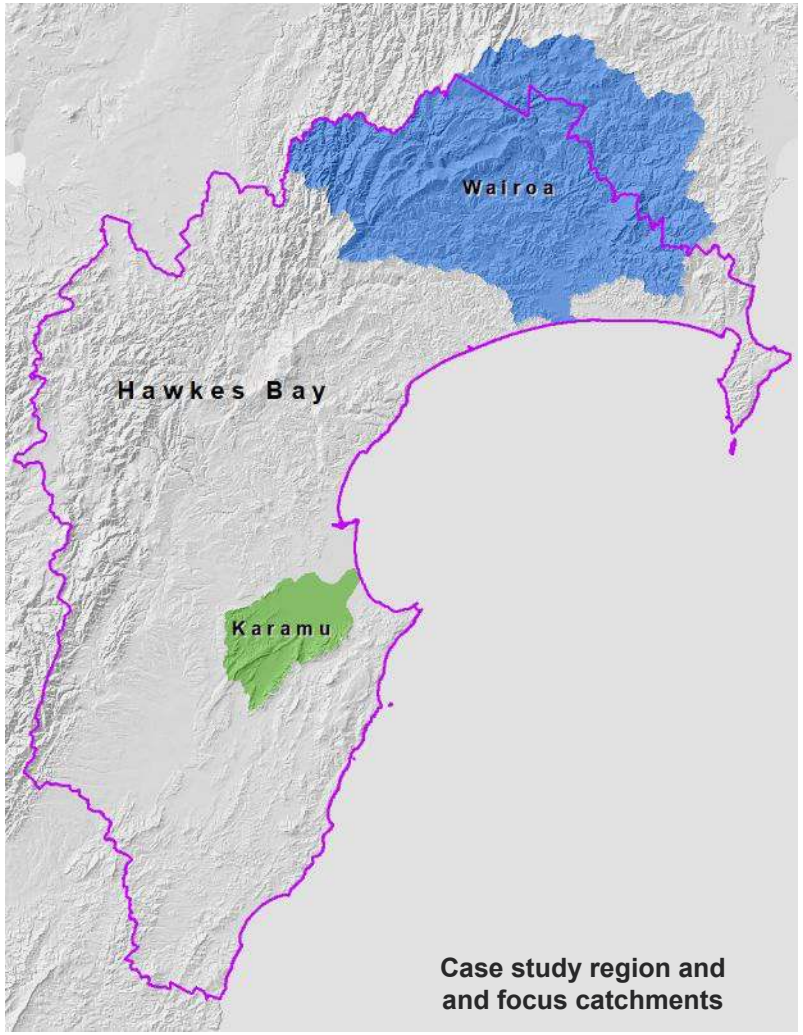
Established/contributed to DAPP in Thames-Coromandel, Auckland Council, Gisborne, Hawkes Bay, Northland.

- Expensive (both $ and FTE) and time consuming (2–3 years to complete planning stage)
- Need to think carefully about geographic scale
- Long lead time to start due to required budget setting, political buy–in, recruitment and programme management.
- Sector approach seems to go case–study–by–case–study
- Limited hazard scope – focused on coastal environment
- Current governance arrangements are hindrance to clear climate adaptation responses
- Lack of Local Government capacity and capability
- Iwi and hapū capacity variable
- Legacy issues of te Tiriti breaches and poor relationship with tangata whenua
- Lack of trust in communities around both climate change and local government

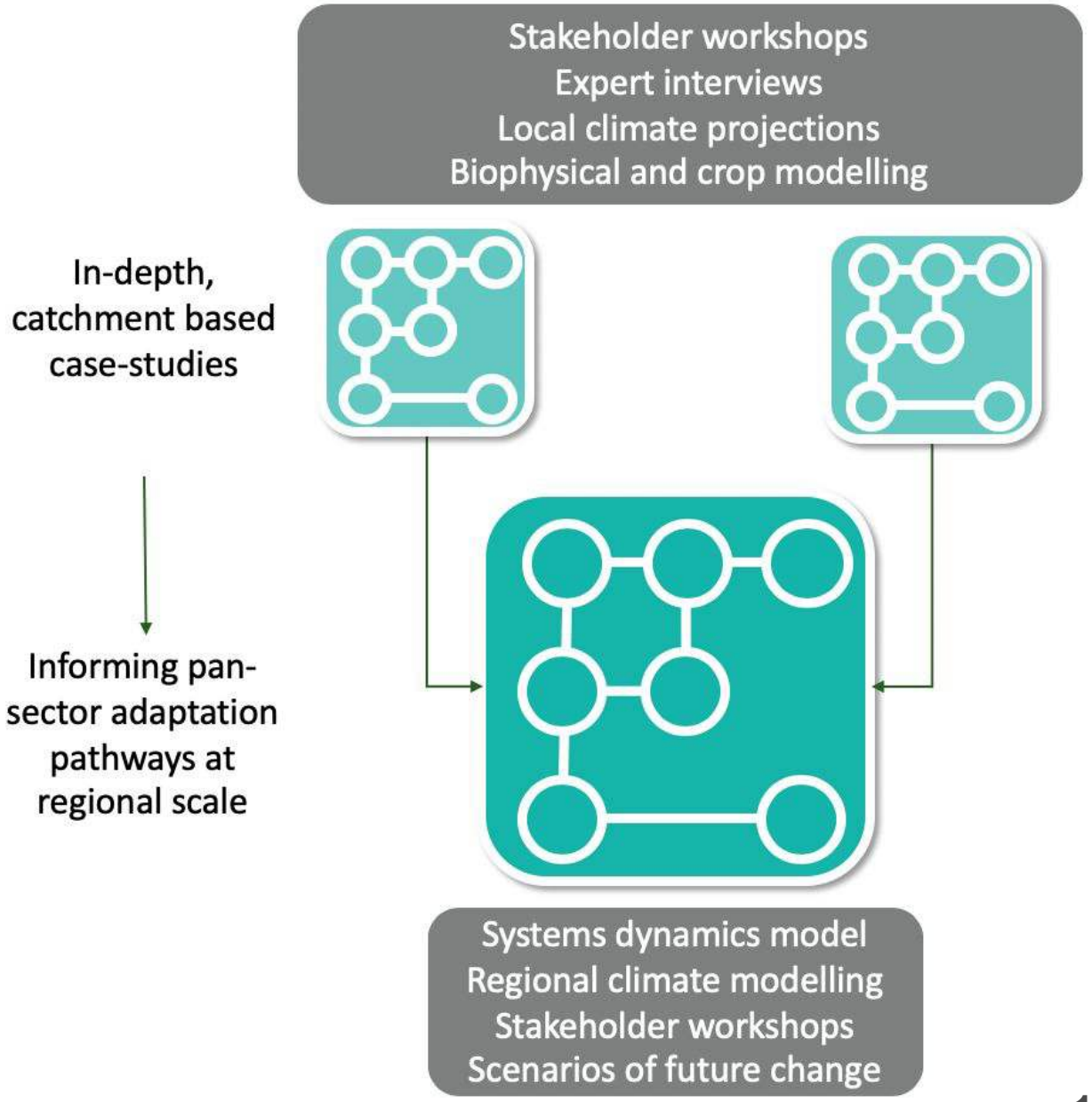
Suggested areas of DAPP improvement

Identify areas process shortcuts, including heuristics applications.	Expensive (both $ and FTE) and time consuming (2–3 years to complete planning stage)
Integration into council/community level planning	Need to think carefully about geographic scale
Useful tool allows pre-planning and 'watch and act'. Dependent on good MER (Monitoring, Evaluation and Reporting) – often left until last, needs to be earlier.	Long lead time to start due to required budget setting, political buy-in, recruitment and programme management.
Greater sectoral focus beyond coastal hazards	Sector approach seems to go case-study-by-case-study
Clearer responsibilities across different layers of govt and private/public. Who pays?	Limited hazard scope – focused on coastal environment
Significant opportunities for shared learning • ACAN (Aotearoa Climate Adaptation Network for LG practitioners) • ASAP (Aotearoa Society of Adaptation Professionals) group to be established.	Current governance arrangements are hindrance to clear climate adaptation responses
	Lack of Local Government capacity and capability
Self directed adaptation funds popping up e.g. BOPRC, Auckland, Northland.	Iwi and hapū capacity variable
	Legacy issues of te Tiriti breaches and poor relationship with tangata whenua
	Lack of trust in communities around both climate change and local government

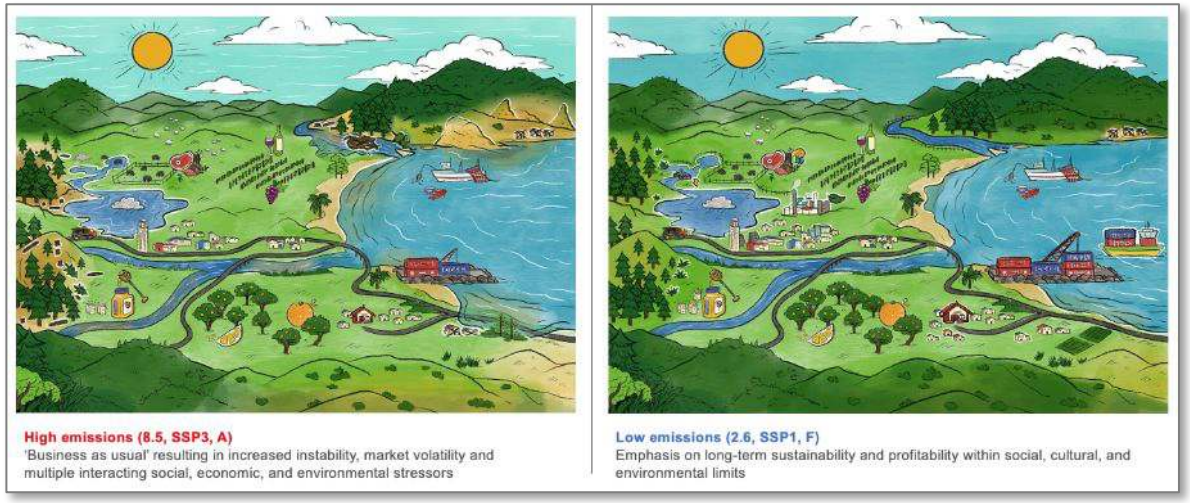
Support natural resource users to identify and proactively manage risks and opportunities arising from a changing climate



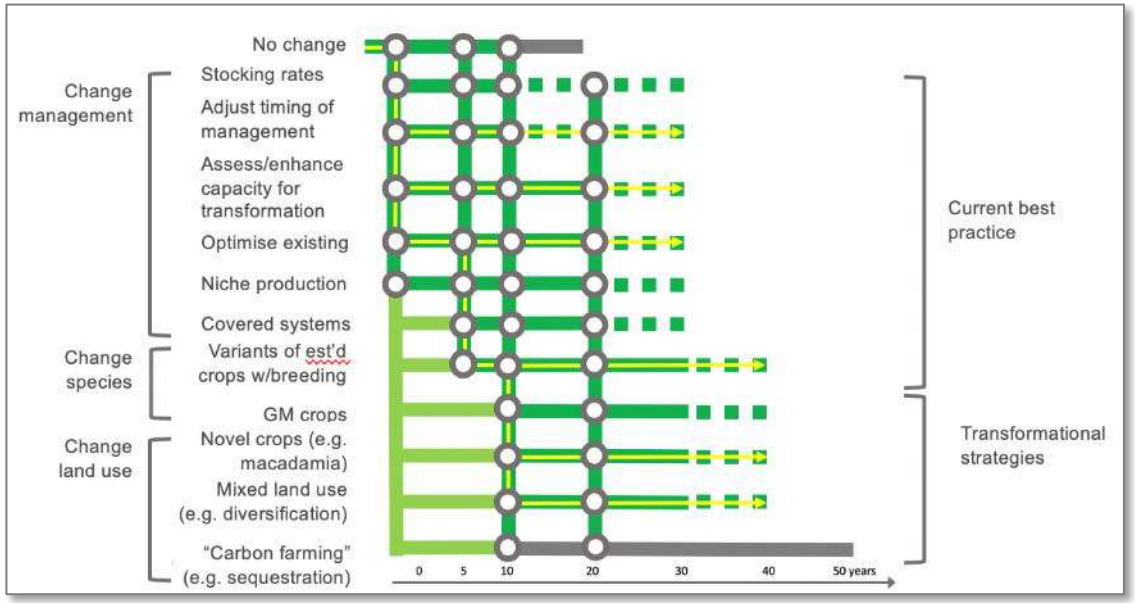
Case study region and and focus catchments



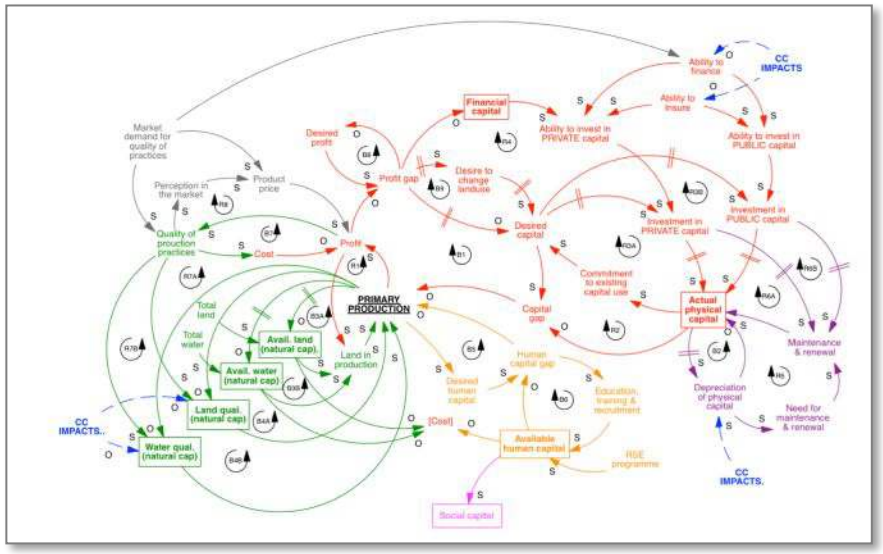
Cradock-Henry, N.A., Blackett, P., Connolly, J., Frame, B., Teixeira, E., Johnstone, P., Wreford, A., 2021. Principles and process for developing participatory adaptation pathways in the primary industries. Elem Sci Anth 9.



Contrasting, place-based scenarios can illuminate climate change impacts and effects of **non-climatic structural changes**



Systems thinking to **develop shared understanding:** what is the issue? How did it start? How can it be addressed?



Encouragement is needed to move beyond adaptability to consider transformational adaptations

Makara Beach – DAPP approach to long term planning in a coastal community

Iain Dawe, Greater Wellington Regional Council

- Small beach community (35 permanent homes) exposed to flooding and coastal storms eg, Gita Feb 2018
- Makara community, WCC with GW support formed Makara Beach Project
- Workshops over 6 months with community reps, tech advisors, DoC and council
- 17 adaptation pathways developed for 3 different areas over short, medium and long term 100yr horizon
- Considered environmental, cultural and social values

Makara Beach

Gita damage. Feb 2018

Recommendations and lessons

1. Estuary: ST mouth maintenance, MT and LT revetment and river bank wall
2. Beach: ST – renourishment using gravels from river mouth; MT - bund; LT – seawall
3. Walkway: ST – maintenance; MT to LT - low tide access only and new route developed

- Idea was to develop implementation plan over 2019-2020 working through cost and who pays (Annual and LTP) and detailed design

- Tended to be preference for hard engineered options (managed retreat was an unpalatable subject and not considered)
- Funding and consenting hurdles quickly hampered the project and weren't properly considered in the options stage
- Process put on hold and is only recently being restarted with pathways being reassessed
- Regional Council wasn't seen as a critical partner
- Important all stakeholders are part of the decision making process

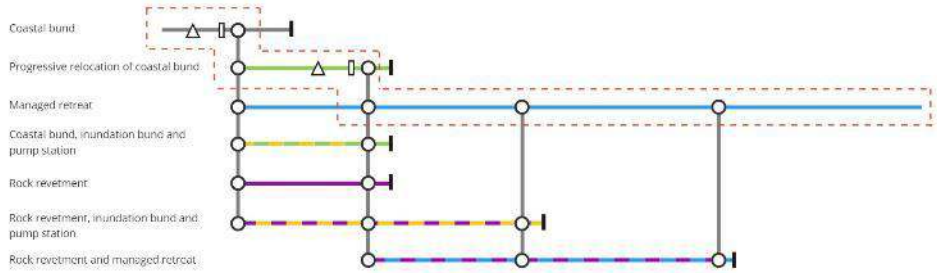
Our project

What is happening?

What matters most?

What can we do about it?

DRAFT Dynamic Adaptive Pathway for Amberley Beach



How can we implement the strategy?

How is it working?

Currently drafting a combined:

- Adaptation Plan,
- Implementation Plan, and
- Monitoring Plan.

Application of method

- Used a scaled down version of the DAPP process.
- Running five separate processes with five separate communities.
- Opted to engage directly with property owners.
- We are furthest along with Amberley Beach:
  - Over 50% of property owners have been part of the discussion; and
  - 8 public meetings, 6 community meetings, numerous one-on-one meetings and still on-going.

Learnings

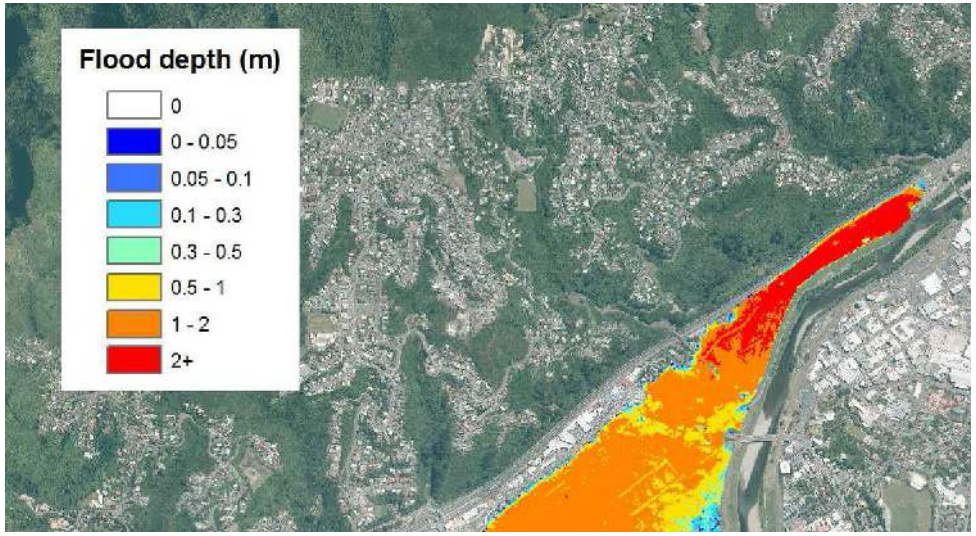
- Challenges with community turnover throughout process – end up having the same conversations multiple times and revisiting the same topics.
- It's a journey and you have to provide a safe space for frustration or anger to be shared prior to having a productive conversation about the future.
- The process isn't linear and often you are working on multiple steps at once.
- Some days it feels like you are taking more step backwards than forwards, but continued engagement is important to bring the community along.

Enablers

- Small engaged community with a visible hazard.

Examples of DAPP + Real Options Analysis

Hawke's Bay



Lower Hutt

Westport

Thames

Makara

Infometrics

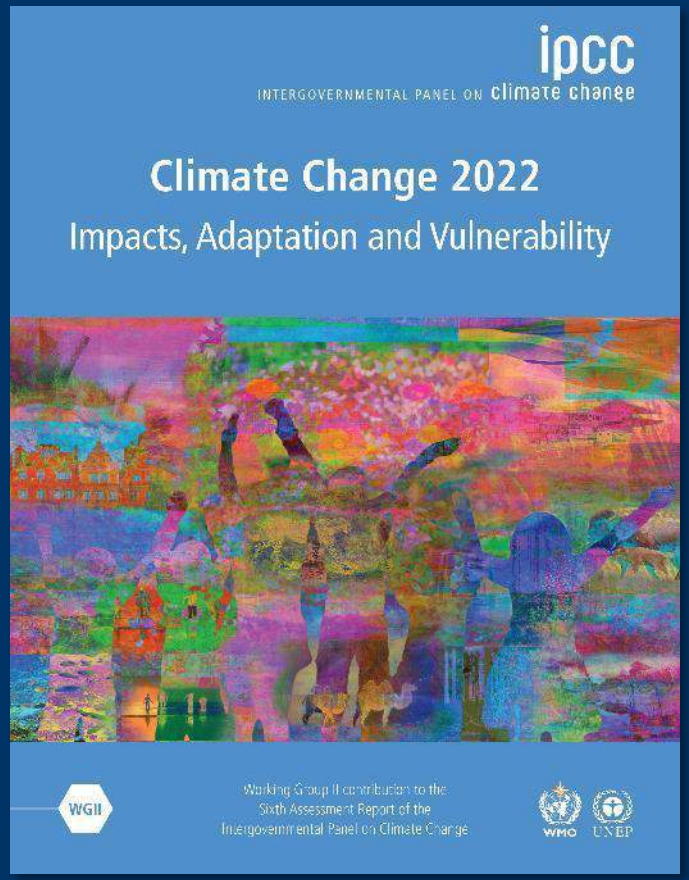
Lessons Learnt

1. ROA is complementary to the DAPP approach.
2. It can assess the value of taking early actions that retain flexibility to implement later options as more is learnt about the risks of economic loss from hazards associated with climate change.
3. ROA does not need the probabilities of climate change scenarios to be set in advance.
4. The case for more expensive adaptive options (such as managed retreat) is enhanced with a lower discount rate.
5. To date most (or our) applications of ROA have lacked good data (eg AEPs, risk distributions, costs of adaptation).
6. Budgets for thorough evaluation are often too tight.
7. So sensitivity analysis is important.
8. ROA deals with economic costs, not who pays or how costs are financed.
9. Non-economic benefits and costs need more attention.
10. Common insight: Think carefully before committing resources to expensive and/or inflexible protection pathways.

Moving to implementation: lessons learned

IPCC AR6 Working Group II Chapter 11 Australasia

(Lawrence and Mackey et al 2022)



Many hazard and risk assessments and some plans developed

Implementation is slow

Enablers for implementation include

- Decision frameworks
- Capacity building
- Access to information
- Community understanding
- Legislative mandates
- Political will
- Funding instruments
- Behavioural change on mitigation and adaptation

Scenarios with DAPP/ DMDU

Sea-level rise scenarios are used to give decision makers, communities, and individuals the opportunity to stress test adaptation options they are considering today for their:

- path dependency and lock-in potential.
- unintended consequences including inevitable flaws.
- their sensitivity to different timeframes and sea-level rise increments.
- costs over the lifetime of the option.
- ease of shifting between options and pathways as the seas advance.
- acceptability, tolerability, and adaptive capacity of government at all levels, communities, investors, and other stakeholders.

Judy Lawrence, Sylvia Allan, Lara Clarke (2021). *Enabling Coastal Adaptation: Using current legislative settings for managing the transition to a dynamic adaptive planning regime in New Zealand*.

https://resiliencechallenge.nz/wp-content/uploads/Enabling-Coastal-Adaptation-FINAL011121.pdf

Coastal Adaptation Explorer

Choose Erosion and Flood Management Options

Epoch	2020	2050	2070	2120
Bund Maintenance				
Bund Relocation				
Rock Revetment				
Concrete Wall				
Inundation Bund				
Raising Floors				
Waterproofed Buildings				
Relocatable Dwellings				
Avoid Development				
Maintain District Plan				
Managed Retreat				

Choose a Future Scenario

How Will You Measure Success?

Climate Change Scenario

Shortlisted Options tailored to the settlement, including
- Physical works
- Planning Options
- Retreat Options

Success of the option for both erosion and flooding hazards

Quasi-multi criteria to understand the intangible values

Using different metrics to measure success against community objectives (e.g. access)

Location

Option Pathway Summary

Total Cost of Options
$56.7M

Total Benefit
$-499K

Damage Avoided
$56.2M

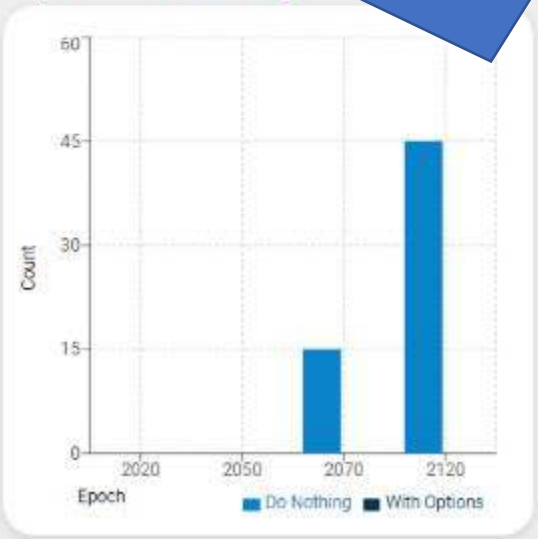
Buildings Protected from Flooding
6

Buildings Protected from Erosion
45

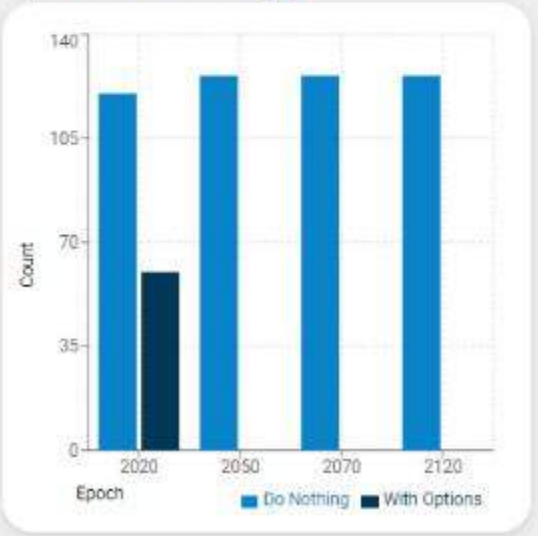
Roads Protected
0%

Multiple Criteria

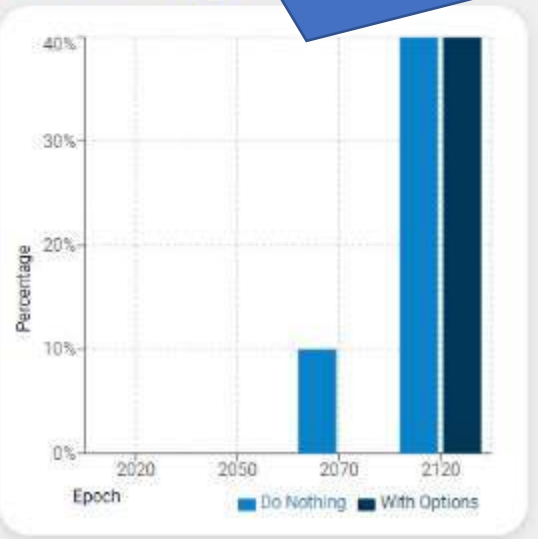
Properties at Risk of Erosion



Properties at Risk of Flooding



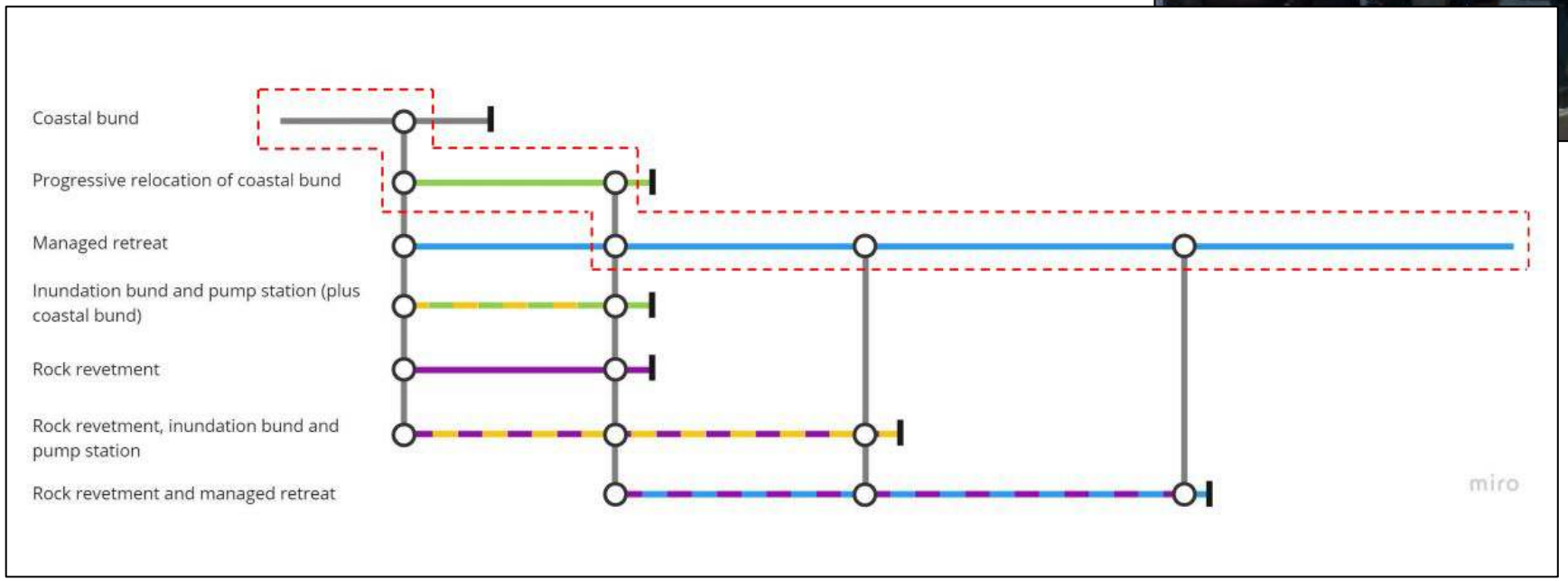
Critical Roads at Risk



- Run in facilitated workshop environment (groups of 4-7 people)

- Developed to promote discussion around the concept of DAPP, as well as having an in-depth look at their options

- Information required:
  - Short-listed options (engineering, planning, retreat)
  - Costs
  - MCA analysis
  - Success Criteria



Robust Adaptation Decision-Making Under Uncertainty: Real Options Analysis for water storage

Anita Wreford[1], Ruth Dittrich[2] ,Christian Zammit[3], Channa Rajanayaka[3], Alan Renwick[1], Daniel Collins[4]

1 Lincoln University (NZ); 2, University of Portland (US); 3 NIWA (NZ); 4 Independent (NZ)

- **Research question**: What is the most cost-effective size to build a reservoir to maintain current dairy production, with the option to extend it in future, in a way that minimises the expected life-time cost of the system?
- Using **Real Options Analysis** (decision-tree)
- 24 member ensemble of potential future (4RCPs, 6GMS) – collapsed into 4 equal "bins" for simplicity
- RCM outputs used as input to hydrological model of surface water and river flow to identify water storage requirements under all RCP/GCM combinations for each year out to 2090
- Constructed decision tree with 2 decision points, 2018 and 2050
- Identified four storage sizes to cover range of requirements to 2049
- And another four sizes from 2050 – 2090 (total of 256 branches)
- Used backward induction to calculate the Expected Net Present Value of all branches to identify the most cost-effective sizes in each time period.

Lessons Learned

- Challenge = Assigning probabilities to each branch:
  - Our approach:
  - Conducted the analysis assuming all GCMs and RCPs were equi-probable
  - And again, assuming RCP2.6 and RCP8.5 had lower probabilities
  - Demonstrated the importance of probabilities as it did lead to the decision to select a different sized reservoir in the first time period
- Interest from stakeholders in the water sector
- No known implementations as yet

Multiple Objective Adaptation Planning under Deep Uncertainty Considering Plurality of Stakeholder Values in the Environmental Justice Neighborhood of East Boston USA

Shailee Desai and Paul Kirshen

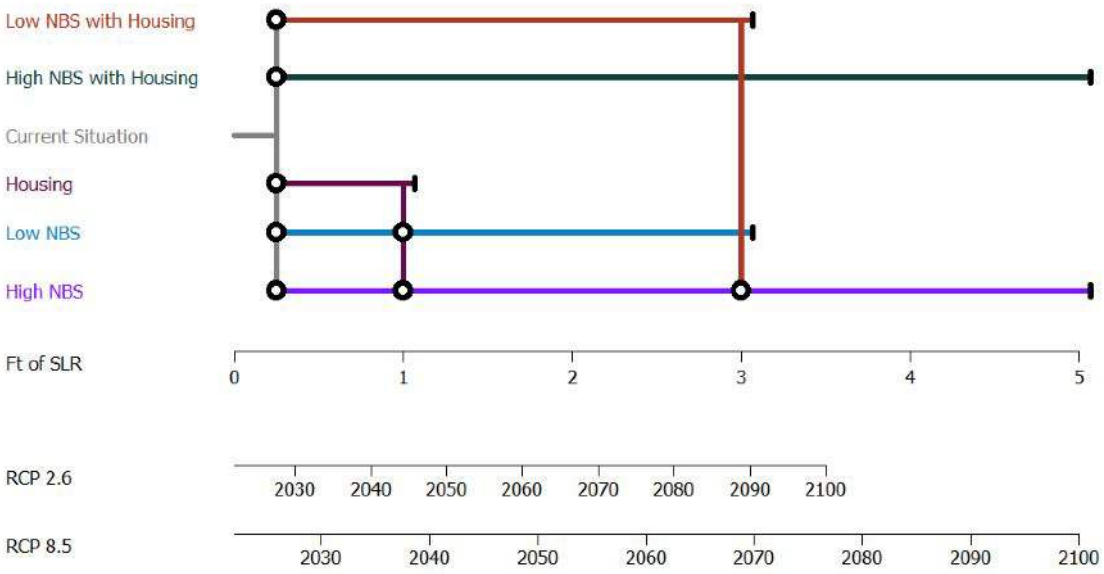
School for the Environment, University of Massachusetts Boston USA

shailee.desai001@umb.ed
paul.kirshen@umb.edu

Map of the present 100-year flood under RCP 8.5

Map of the 2100 100-year flood under RCP 8.5

Individual DAPP Route Maps for Stakeholders – What is best initial adaptive path ?

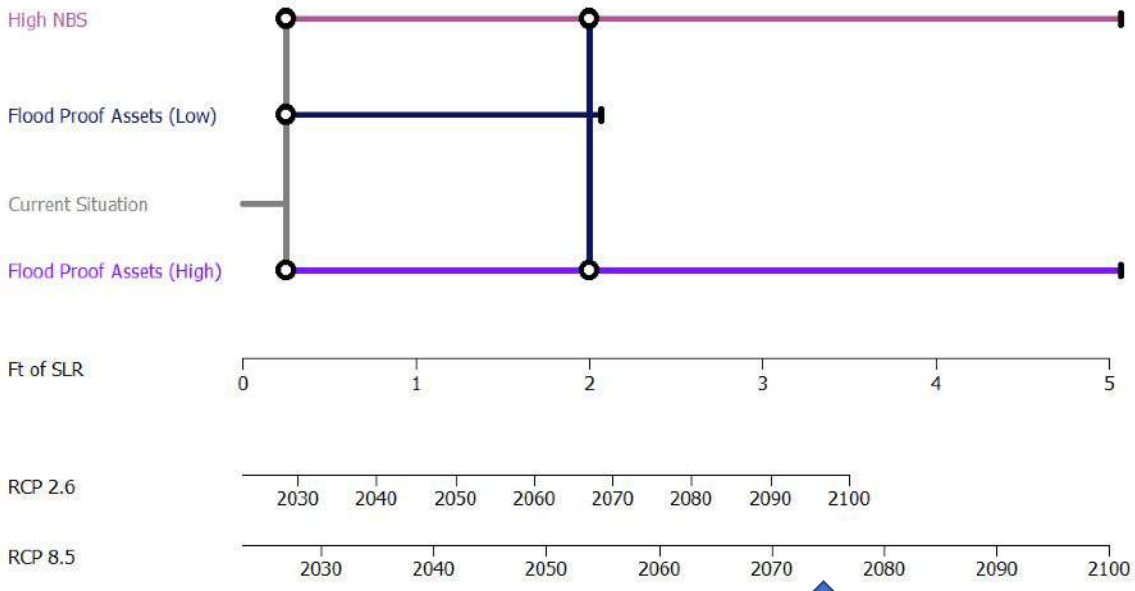


Residents

They value FRR, affordable housing, access to green space, recreation, protection of public transportation, district level solutions

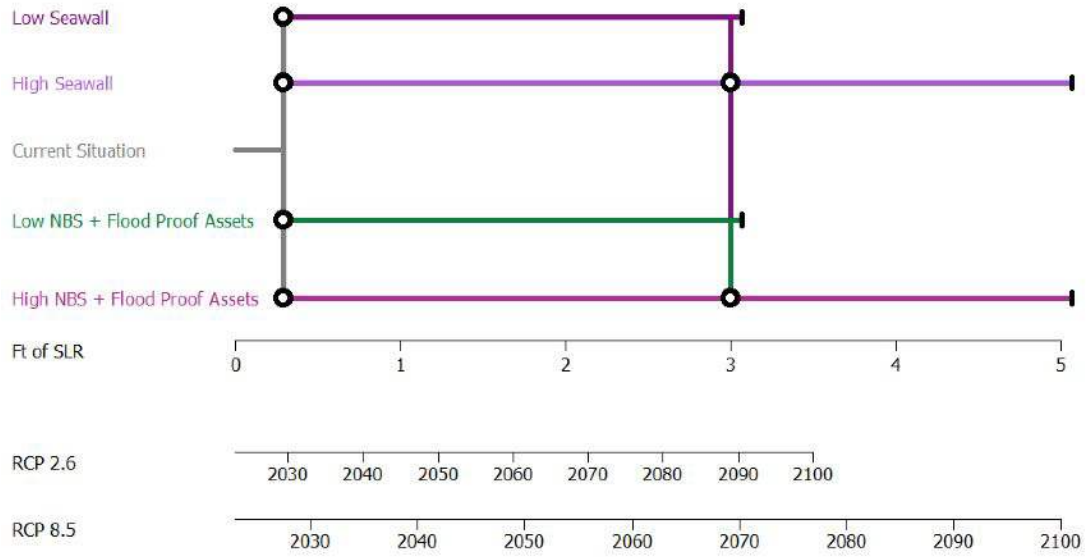
MassDOT

They value FRR, very low risk tolerance, cost, smooth functioning of assets after flood events



Developers

They value FRR, access to green space, cost, district level solutions



NBS = Nature-based solutions
FRR = flood risk reduction

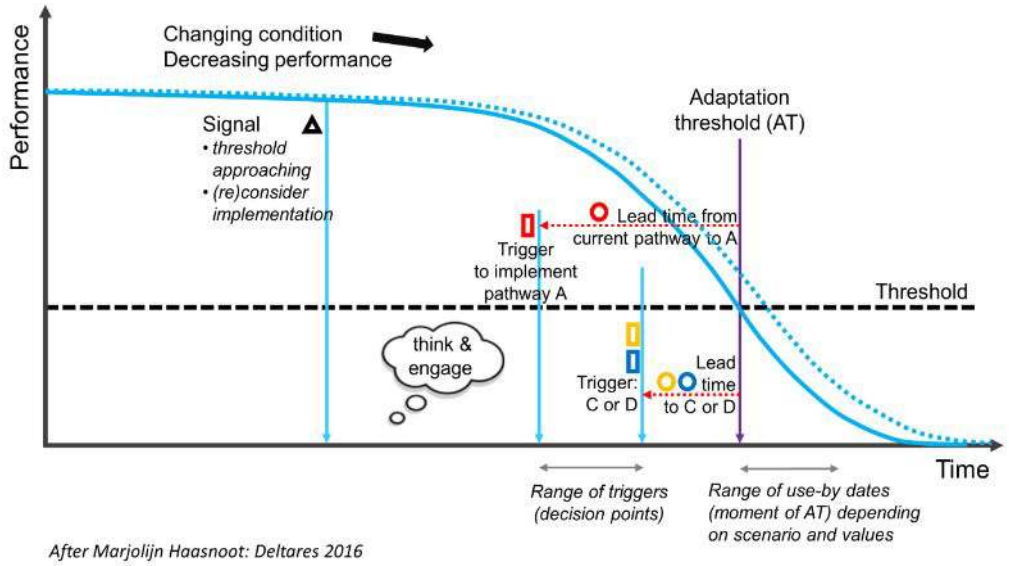
Monitoring performance of adaptation measures
Signals, triggers and thresholds

Lawrence, J., Bell, R., Blackett, P., Stephens, S., Collins, D., Cradock-Henry, N. & Hardcastle, M. (2020). *Supporting decision making through adaptive tools in a changing climate: Practice Guidance on signals and triggers*. Wellington: Deep South Challenge.

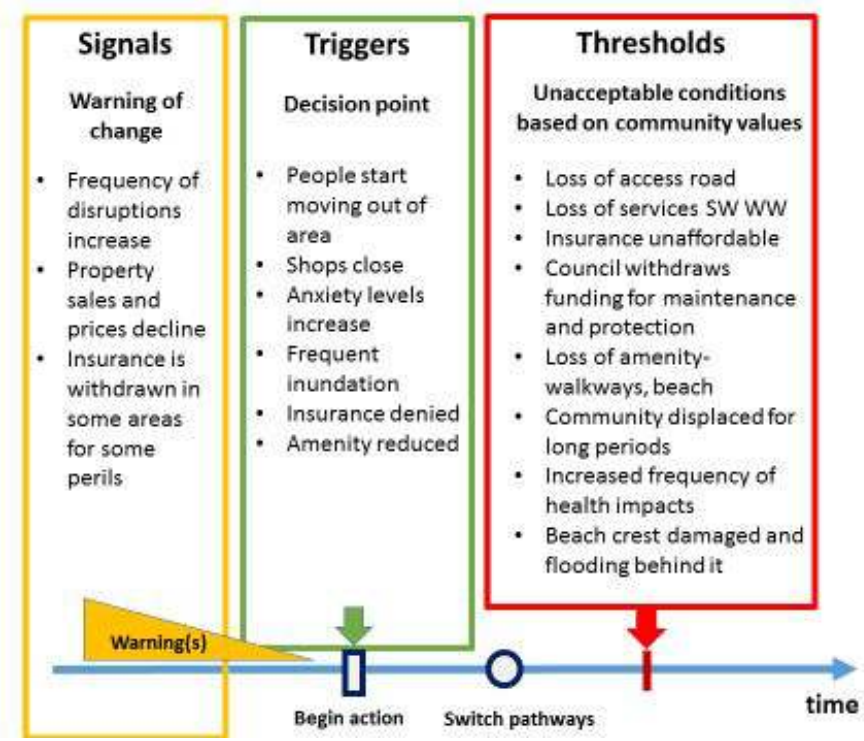
Performance of options/designs/infrastructure decreases over time and reaches limits

Adaptation limits

- Physical and socioeconomic
- Soft limits
- Hard limits



After Marjolijn Haasnoot: Deltares 2016



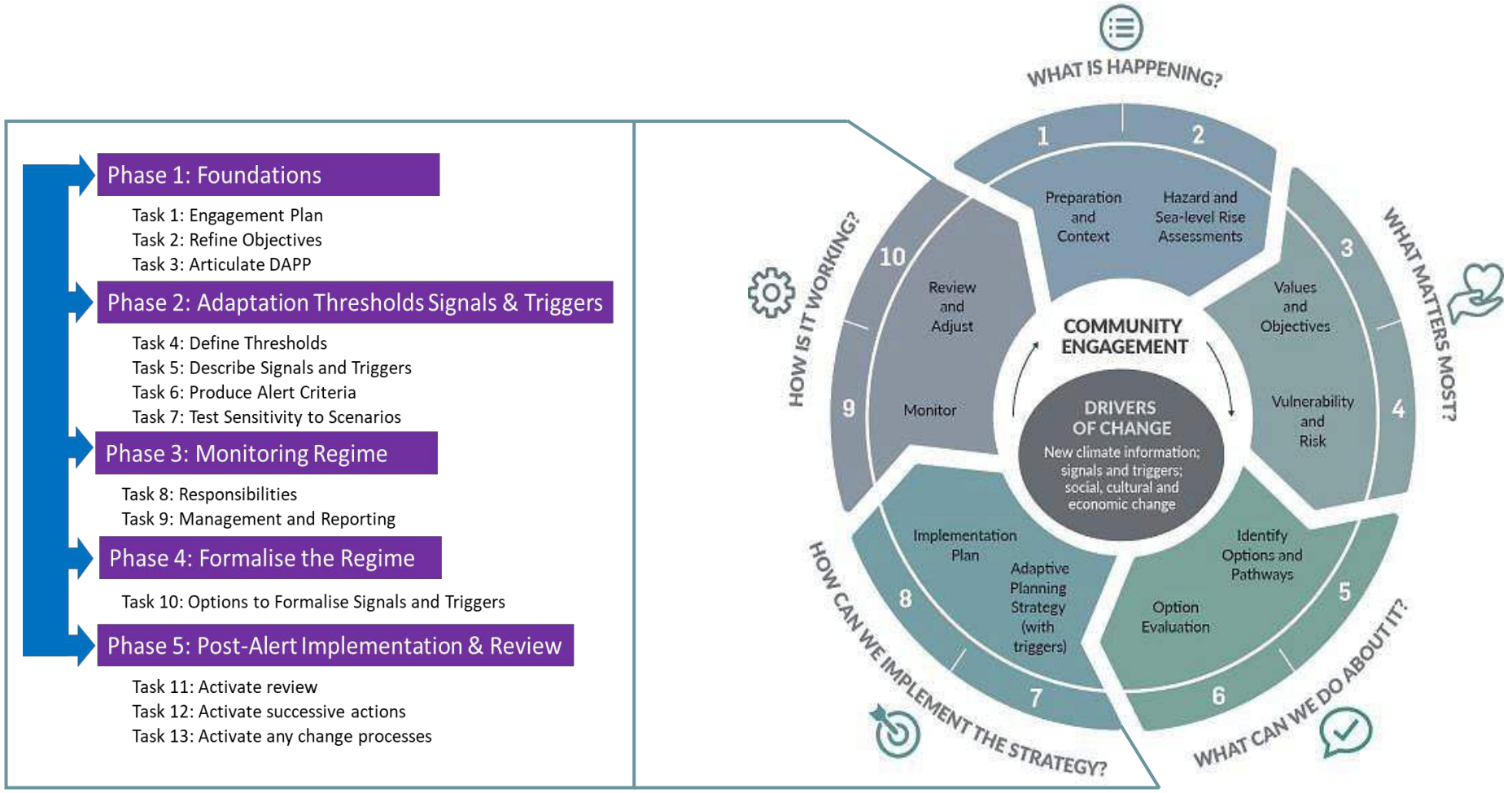
https://deepsouthchallenge.co.nz/wp-content/uploads/2021/01/Supporting-decision-making-through-adaptive-tools-in-a-changing-climate-.pdf

National SCIENCE Challenges

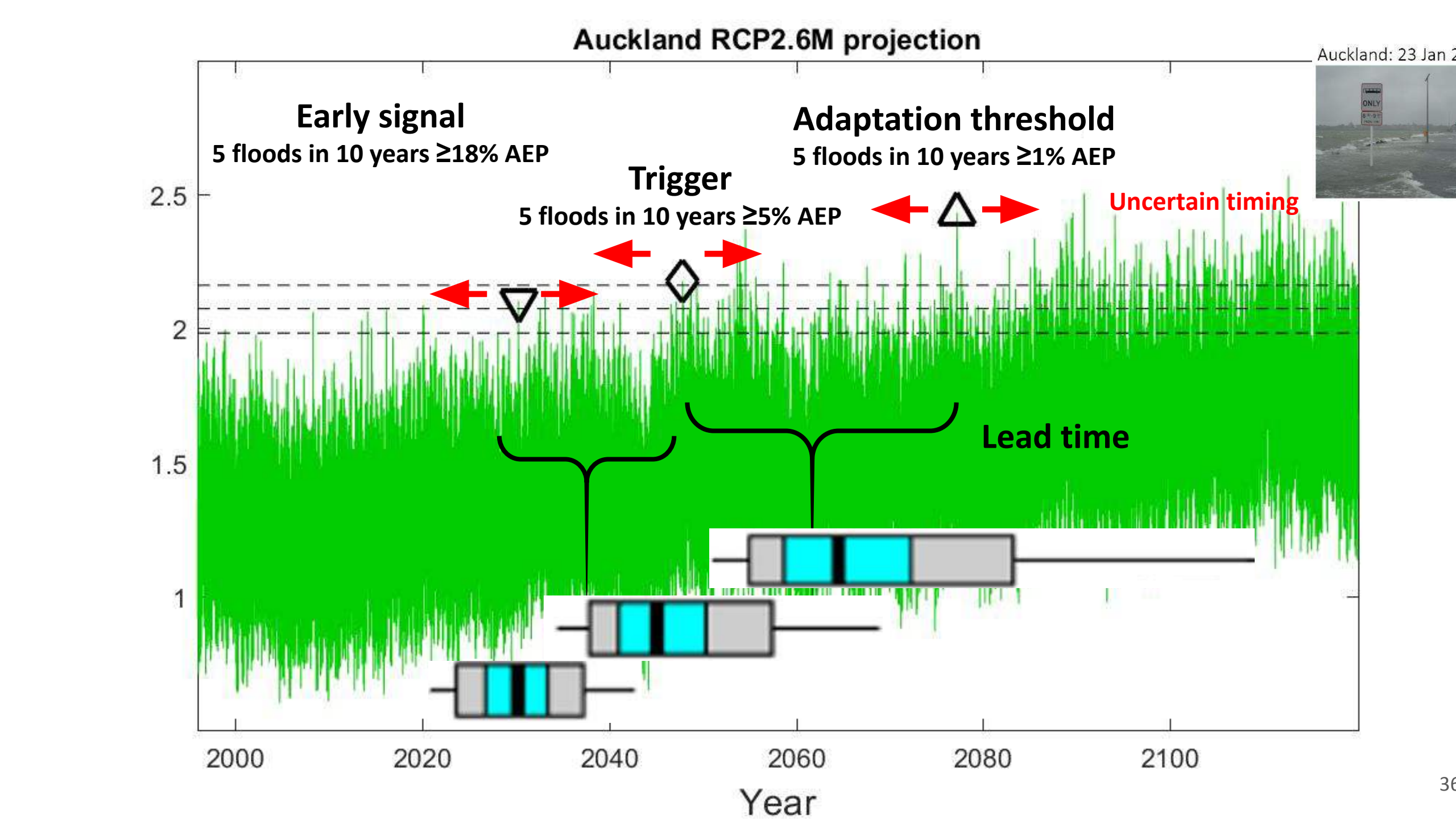
THE DEEP SOUTH

Te Kōmata o Te Tonga

Monitoring and review of adaptive pathways



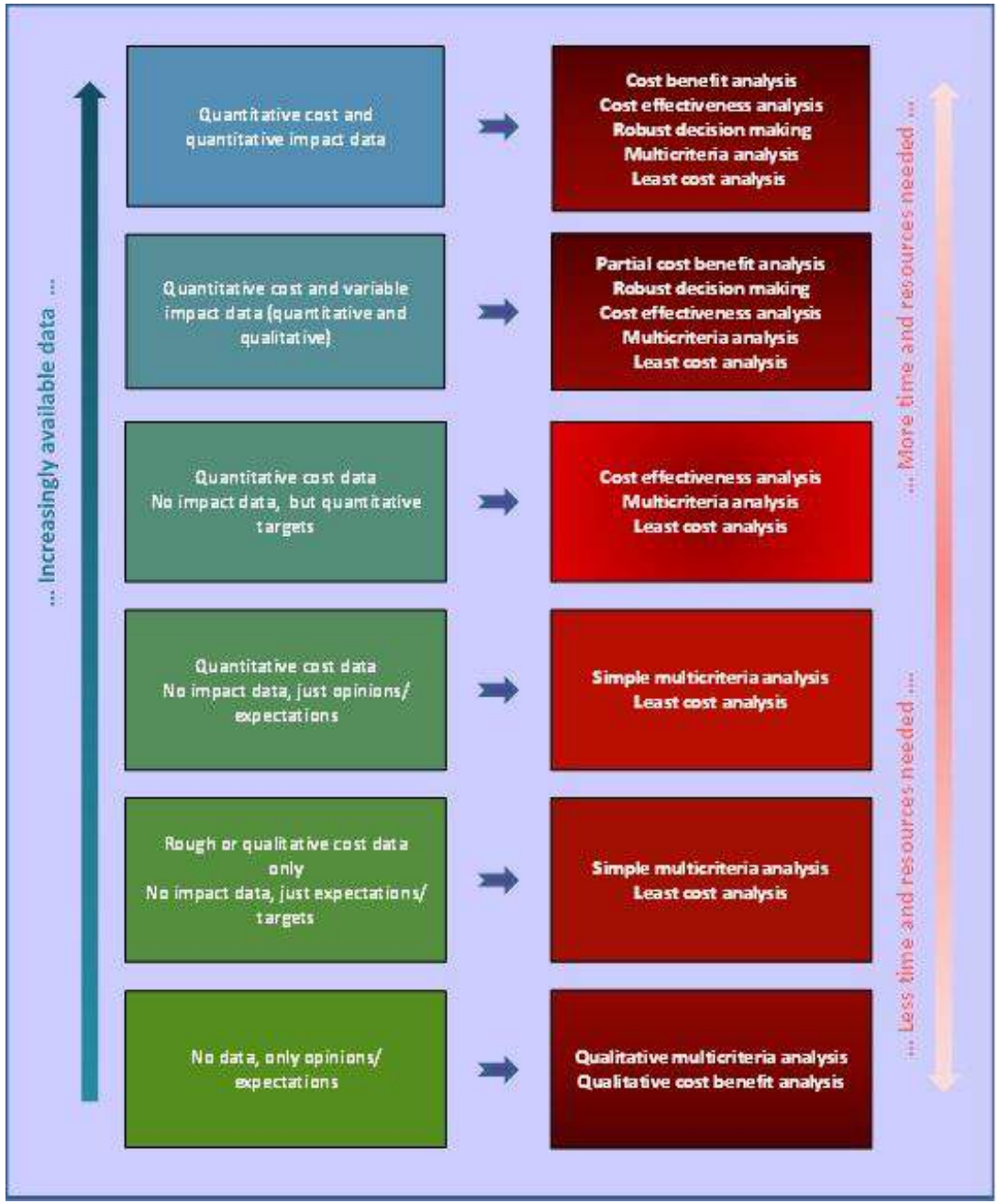
https://deepsouthchallenge.co.nz/wp-content/uploads/2021/01/Supporting-decision-making-through-adaptive-tools-in-a-changing-climate-.pdf


Auckland RCP2.6M projection
Early signal
5 floods in 10 years ≥18% AEP
Trigger
5 floods in 10 years ≥5% AEP
Adaptation threshold
5 floods in 10 years ≥1% AEP
Uncertain timing
Lead time
Auckland: 23 Jan 2
2.5
2
1.5
1
2000
2020
2040
2060
2080
2100
Year

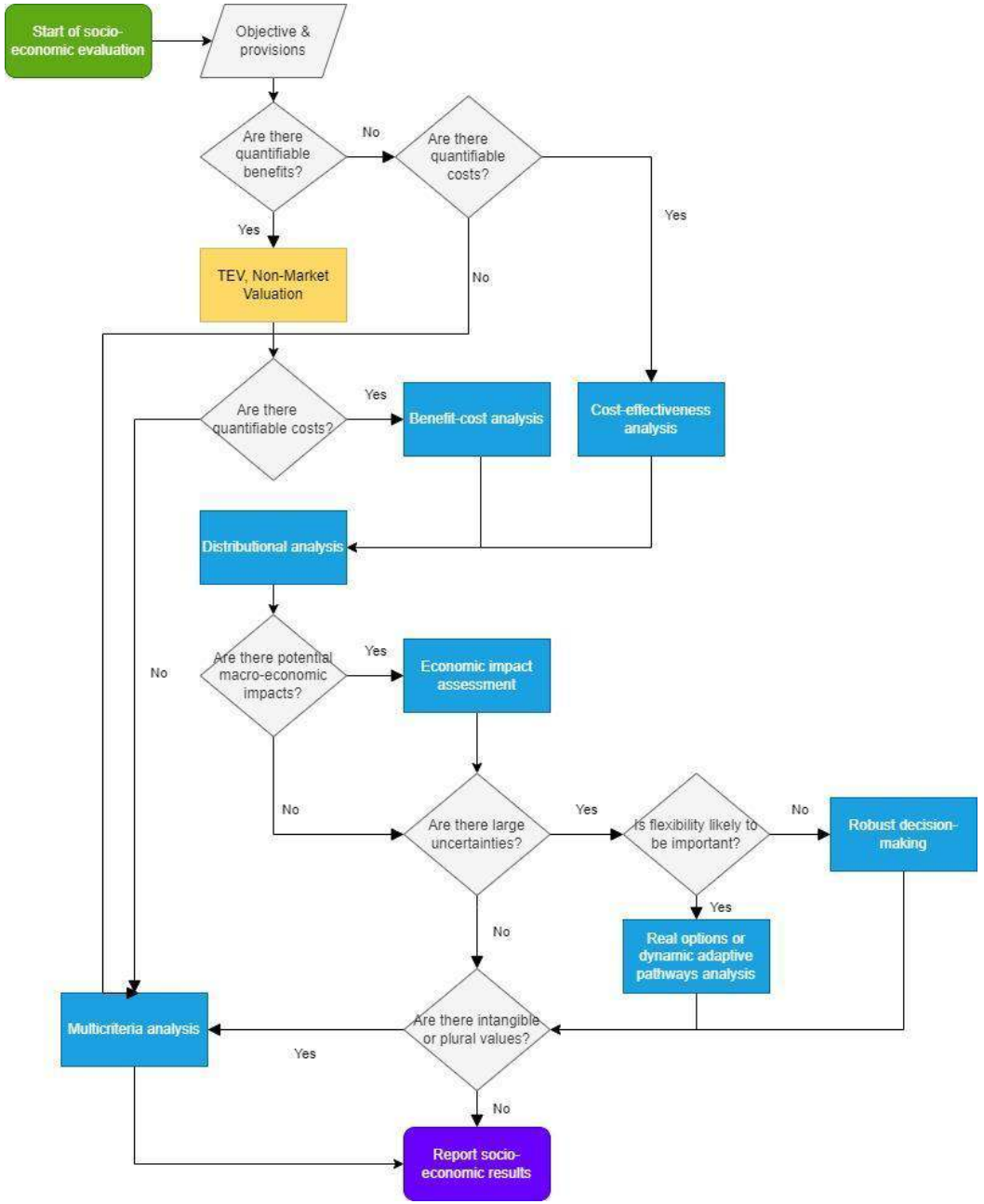
Lessons learned

- Signals are already upon us
- Triggers to act are approaching fast
- Adaptation thresholds are not too far away (> 2050)
- May not have much time to design a trigger in the near term
- The spread of probability ⇒ only medium confidence the chosen signal or trigger threshold that will occur with enough lead time to act.
- To be highly confident would need very sensitive triggers leading to very early action ⇒ overdesign.
- The quantitative method provides one essential element, but needs other social, cultural and economic signals, which may or may not be quantitative

Information availability ladder



Assessment flowchart



Resilience to Nature's Challenges
Coastal Theme. Pillar 2: Coastal Flooding
What adaptive actions are viable and under what conditions?

We developed a multi-hazard risk interaction model to investigate drivers of change in urban coastal systems: Multi Hazard Coastal Agent-Based Model (MHCABM). It is an agent-based model with an integrated Dynamic Adaptive Pathways Planning submodel and five interacting hazards. Case study is Tauranga, NZ.

RSLR combined with episodic storm events is the main driver of pathway changes and new actions being selected. Adaptive actions have limited lifespans in relation to RSLR, because actions triggered at lower levels of RSLR have a limited effectiveness with rising RSLR and become insufficient to prevent other actions being triggered. Active retreat is the most likely action to succeed at avoiding new triggers being reached and new adaptive actions being implemented at this location under this DAPP.

This approach allows users to stress test a DAPP and future proof it. To quantitatively determine values for adaptation thresholds and triggers in relation to RSLR. To question whether there is sufficient time after the trigger to plan, consult on and implement a new adaptive action before the adaptation threshold is breached. And if not, it tells you that you need to change your trigger value in order to avoid that adaptation threshold.

Lessons learned

- **For the methodology:** DAPP can be more than a planning tool – DAPPs can be simulated to test the longevity of actions and the circumstances under which they may fail in a multi-hazard environment
- **How the method was applied:** Agent-based model with an integrated DAPP sub-model
- **If and how results were implemented:** Results shared and discussed with Bay of Plenty Regional Hazards Forum. Improved version of this approach is now being implemented in Future Coasts Aotearoa
- **Key enablers:** Interdisciplinary, multi-agency research team; research funding

Head of Lake Wakatipu natural hazards adaptation

A programme to;

“enable preparation for, and proactive management of, or adaptation to, natural hazards challenges in the head of Lake Whakatipu area.”

Natural hazards being considered;

- Floodplain hazards (flooding & erosion)
- Alluvial fan hazards (flooding, debris flow)
- Seismic hazards (shaking, liquefaction)
- Plus geomorphic & climatic influences on these hazards

Key programme activities completed to date;

- Data collection & natural hazards investigations
- Assessments of potential hazard management approaches
- Community engagement and comms

First iteration of a natural hazard adaptation strategy planned for completion by June 2024.

How the method was applied

- Most natural hazard investigations now completed
- Currently in stage *"What can we do about it?"*
  - Investigation of potential approaches to hazard management.

Implementation?

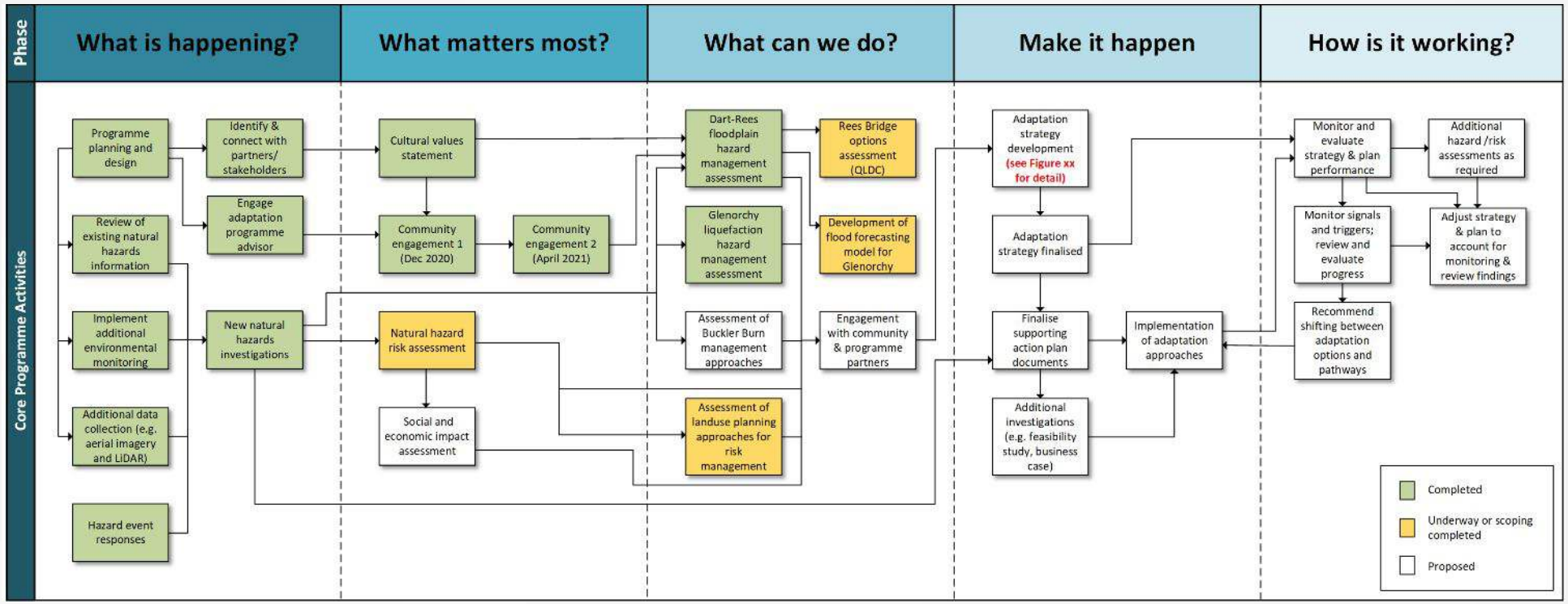
- Some implementation of short-term responses already;
  - environmental monitoring & flood warning systems
  - river/vegetation management activities.

Lessons learned for methodology

- Tension in approaches required for managing liquefaction vs. flooding hazards.
- Increasing complexity (and cost, time) as programme evolves.
- Not a linear process (cycle back as required).

Key enablers

- Robust science base & expert advice.
- Open comms, collaboration & building relationships.



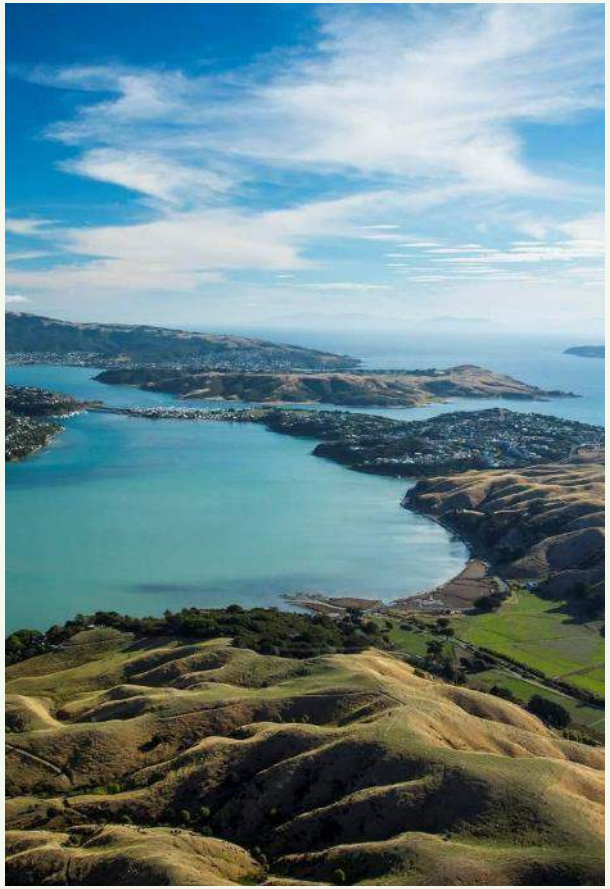
Applying DAPP in Porirua City – we are here:

What is happening?

- September 2020 coastal hazards assessment and community meetings

What matters most

- Internal conversations re. hazard management; moving from reactive to planned approach
- Planning for community engagement



Lessons learned

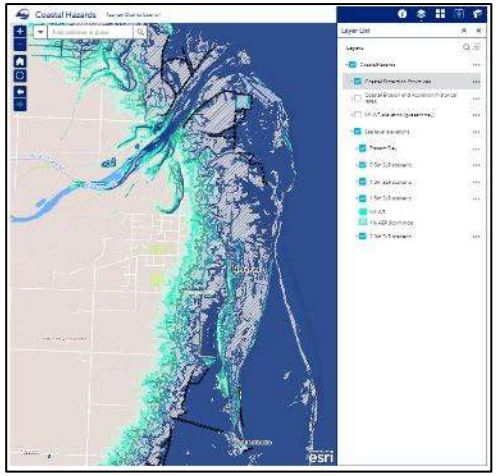
Preparatory tasks need to include:

- A focus on what's in council control
- Solid internal engagement before external
- Understand current approach to hazard management
- Broaden risk beyond coastal hazards (flooding, slips)
- Manage expectations re. funding

- Guidance adaptable to the specific community context

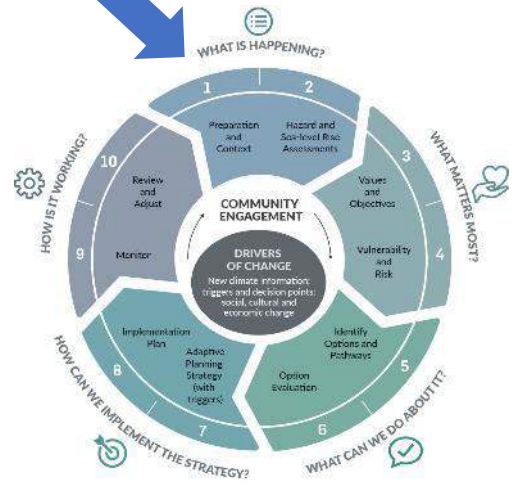
Tasman Coastal Management Project

Working towards long-term adaptive planning for sea level rise and coastal hazards. This is our journey so far…..



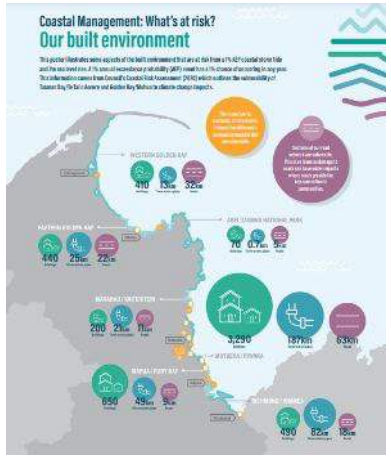
Release of coastal hazards mapping & community engagement, July 2019

Tropical Cyclone Fehi, Feb 2018



MfE 2017 Coastal Hazards Guidance released

Public release of Coastal Risk Assessment, Dec. 2020



Work ongoing…

Educational community engagement on high-level regional options, Sept-Oct 2021

- In 2018, TDC initiated our ‘Coastal Management Project’ following best practice in MfE’s 2017 Coastal Hazards and Climate Change Guidance.
- Work to date with our community has focused on raising awareness and developing a common understanding about what we know and the options we have to respond to sea level rise and coastal hazards.
- Positive feedback from the community on the educational approach to date, but we are yet to have the “hard” discussions!
- Progress is slow and hindered by staff resourcing, other work priorities and wider RMA system reform.
- Tension between this strategic work versus outdated land use planning rules and immediate local issues with residents wanting coastal protection structures.

SERIOUS GAMES AND DAPP

Eleanor Chaos and Judy Lawrence

- Serious games are games designed for experiential learning.
- They can capture and communicate complexity, enable learning in a 'safe to fail' space, encourage understanding of others' knowledge and values, and importantly can embed a motivation to change from static to proactive strategies.

Examples of Different Game Applications

- The Delta Game (Deltares) was used in 2014/15 to prime decision makers to develop options and an adaptive plan using DAPP for the Hutt river flood risk management plan completion.
- Hawkes Bay Coastal Hazards Strategy 2120 used a modified DAPP, MCDA and modified ROA to derive pathways and strategies for coastal compartments
- Community consultation – games used in 'town hall' huis to help raise awareness of coastal hazards and their impacts.
- Community planning – games used with coastal communities and marae to support understanding of risk levels and trade-offs of different adaptation options.

TE WHARE WĀNANGA O TE ŪPOKO O TE IKA A MĀUI
VICTORIA
UNIVERSITY OF WELLINGTON

LESSONS LEARNT – SERIOUS GAMES

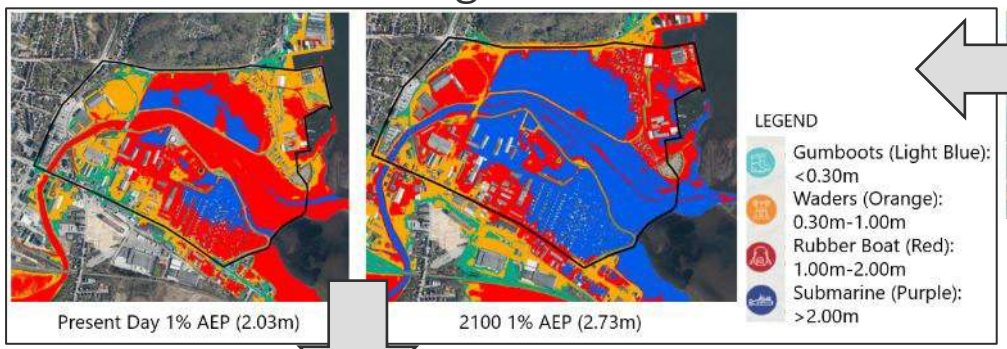
- Not mainstream yet (adaptive planning is catching on with the help of coastal guidance).
- An organisational ‘champion’ necessary for motivating uptake.
- Work best with senior leadership support/endorsement – and even better if you can get them to play the game.
- Games are different from scenario exercises – more pure ‘play’ allows for more creative experimentation and disruptive thinking.
- Both in-game role playing and playing with people from different roles/backgrounds helps players better understand others’ thinking and perspectives.
- Role of games in Aotearoa NZ – Time to go beyond ‘awareness raising’ and instead use games to determine communities’ key values, encourage understanding of systems and their vulnerabilities, and to support practical planning and its implementation.

- Project: **Optimal adaptation to uncertain climate change**
- Author: **Graeme Guthrie**, independent researcher, graeme.guthrie@vuw.ac.nz
- Funder: Deep South Challenge's Living With Uncertainty programme
- Purpose: This project evaluates the performance of various simple alternatives to real options analysis (ROA) when making decisions about adapting to climate change
- Motivation:
  - Real options analysis delivers optimal investment decision-making but is resource intensive
  - For smaller projects, the cost of performing ROA may outweigh its benefits
  - We need simpler decision-making rules than ROA that capture some/most of its benefits
- Approach:
  - Develop theoretical framework that includes (i) climate change, (ii) evolving uncertainty about climate change, and (iii) volatile economic conditions
  - Use full ROA to calculate maximum achievable welfare
  - Compare with welfare achieved using simple alternative rules
- Simple rules considered:
  - Standard CBA at fixed intervals
  - Rules of thumb: adjustments to BCR threshold and/or social discount rate
  - Approximating the value of waiting
    - "Sliding CBA"
    - Ignoring new climate or economic information

- Optimal decision-making depends on volatility of payoffs from different actions
- We need to untangle different types of uncertainty/volatility:
  - Weather outcomes are random variables (due to natural variation in weather cycles), so realised project benefits are random variables ⇒ average over weather events
  - Distribution of weather events changes over time due to climate change ⇒ **average benefits are volatile**
  - Uncertainty about climate change means that our beliefs regarding the distribution change over time as we learn about climate change (even if the distribution itself does not change) ⇒ **average benefits are volatile**
  - Economic benefits of project also fluctuate over time ⇒ **average benefits are volatile**
- These three sources of volatility affect . . .
  - . . . optimal investment decisions
  - . . . the performance of simple rules for making investment decisions
- High-level summary of results:
  - CBA performs better if projects are evaluated less frequently
  - Increasing discount rate by 5% can capture 90%+ of overall welfare
  - Sliding CBA performs even better
  - Ignoring effects of climatic **or** economic volatility gives superior performance, but is more complicated than the other rules
  - Simple rules are not as effective if the economic factor has higher volatility and a smaller expected growth rate, or the climate signal contains less noise
- Sources
  - "Optimal adaptation to uncertain climate change." Available at SSRN: https://ssrn.com/abstract=4215115
  - "Climate change adaptation: Evaluating simple alternatives to real options analysis," in progress

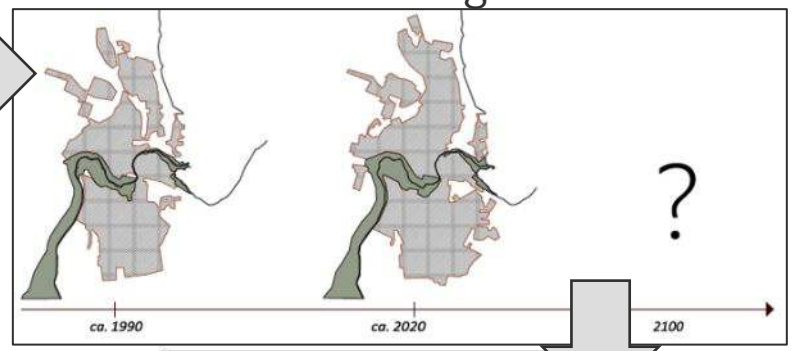
Climate Change Adaptation in Skive, Denmark

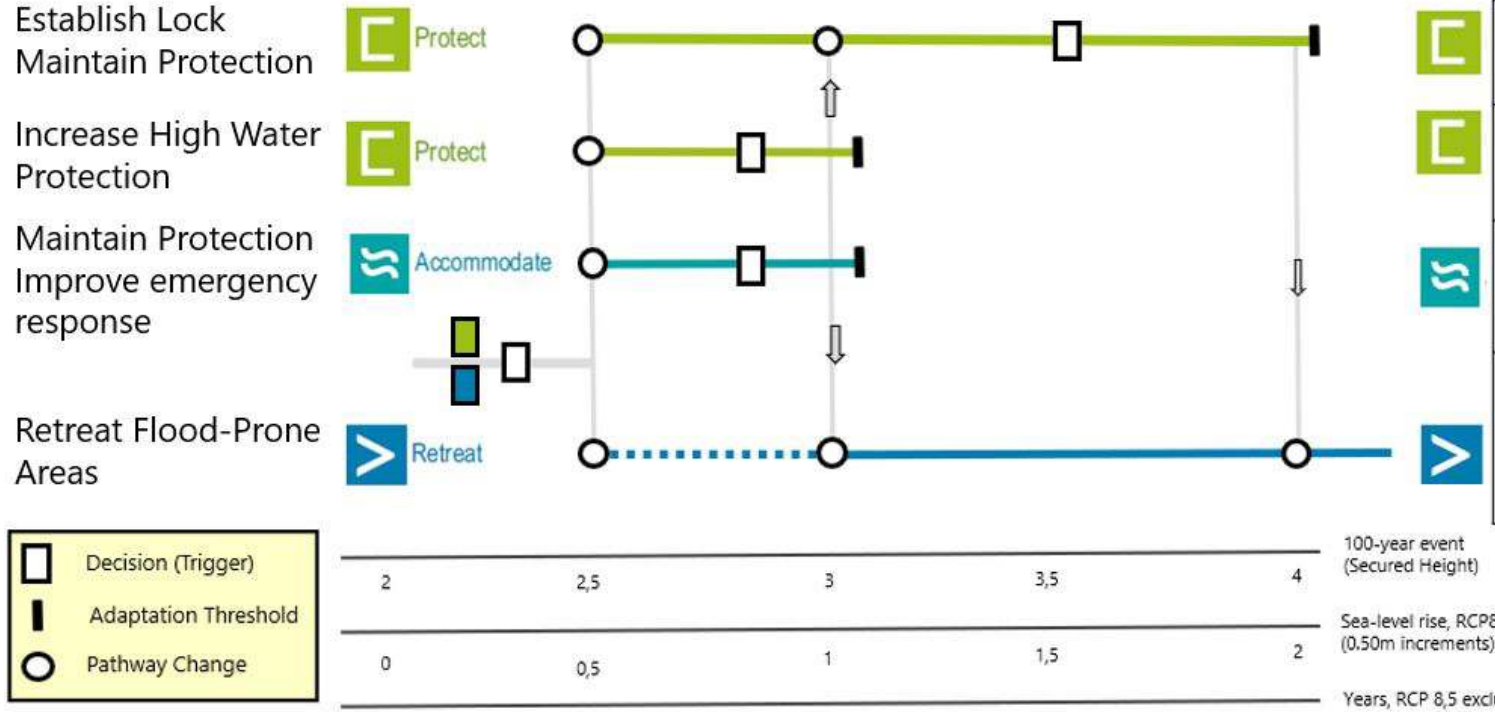
Climate Changes



Workshops

Land Use Changes





Implications for Urban Development	
Outside Existing high-water protection	Inside Existing high-water protection

52

Challenges:

- Difficult for Stakeholders to get familiar with pathway maps (politicians vs municipality)
- Integration of compatible land use changes and development for different pathways
- Uncertainty, and understanding the necessity to move from a static to dynamic approach
- Keep People involved throughout the project once pathways are drafted
- Agreement on failure conditions and long term vision

Enablers / Method Application/ Lessons Learnt:

- Break the process down into small steps. In general start from the familiar, initial situation, discuss thresholds and then work backwards with different actions. Give some initial ideas(visualize) to discuss among the stakeholders
- Current and future climate scenario illustrations during the co-production processes to in/exclude different development scenarios and associated decision points. Make it visual and area-specific
- Prepare adaptive mindset throughout the project by keeping stakeholders involved to facilitate uptake when the project finishes
- Conditional pathways need a timeframe(Preferably multiple) to make them comprehensible for stakeholders
- Focus on defining understandable thresholds for pathways. When too many actions are suggested, aggregate them into logical portfolios for stakeholders to work with.
- Extending the knowledge of other stakeholders (e.g. architects) involved to gain an understanding of the solution space for climate change adaptation improved the involvement in the process
- For integration with urban planning it is important to distinguish spatially between pathways where land use considerations are matched with mutually applicable pathways

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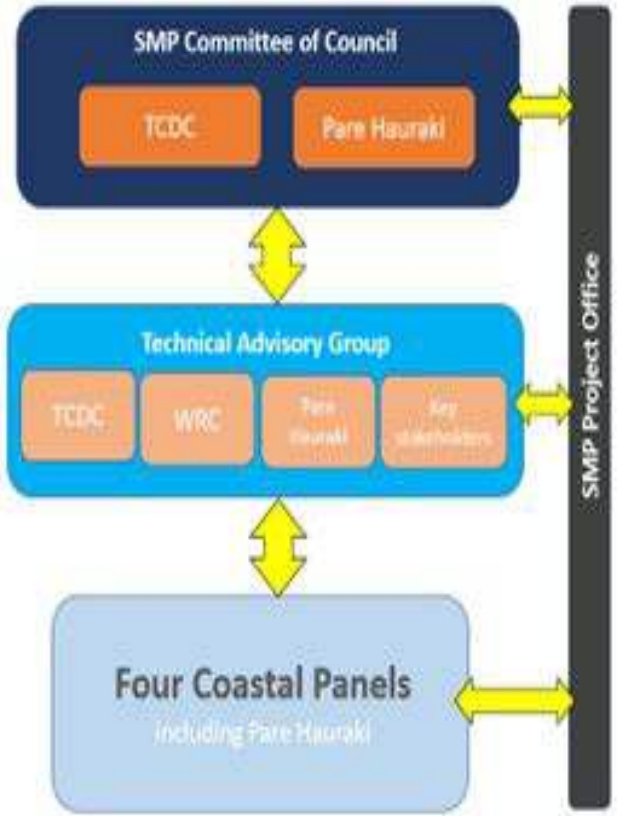
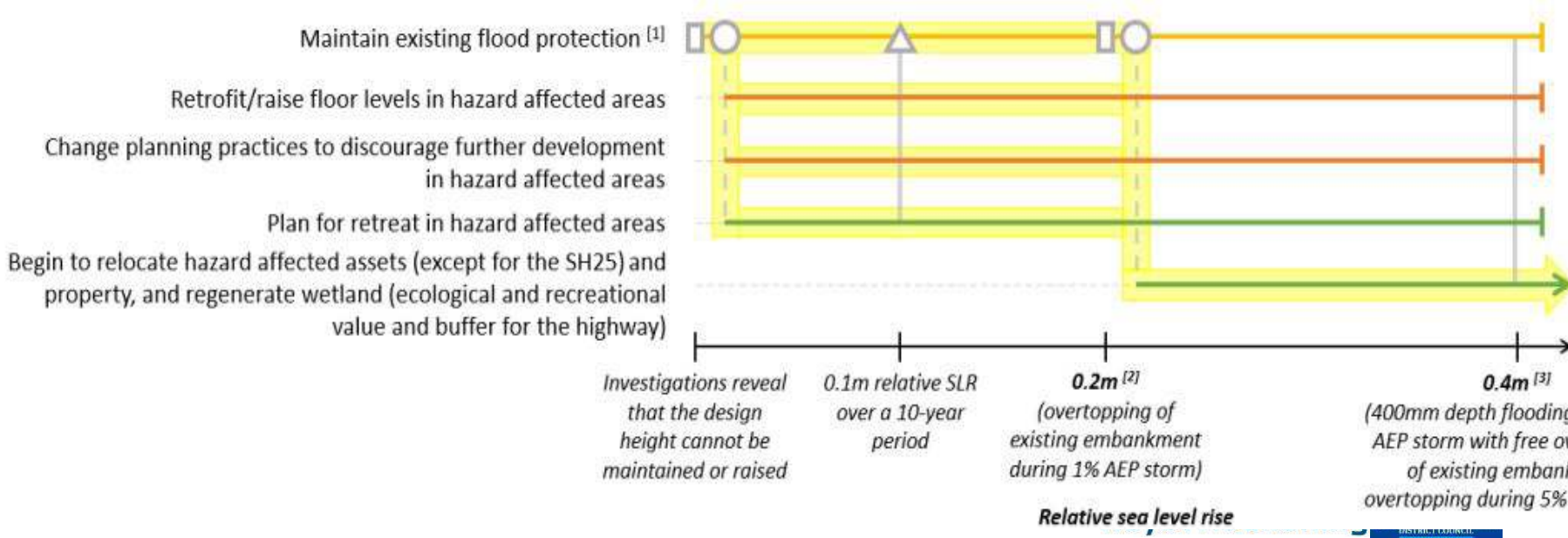
TCDC Shoreline Management Pathways

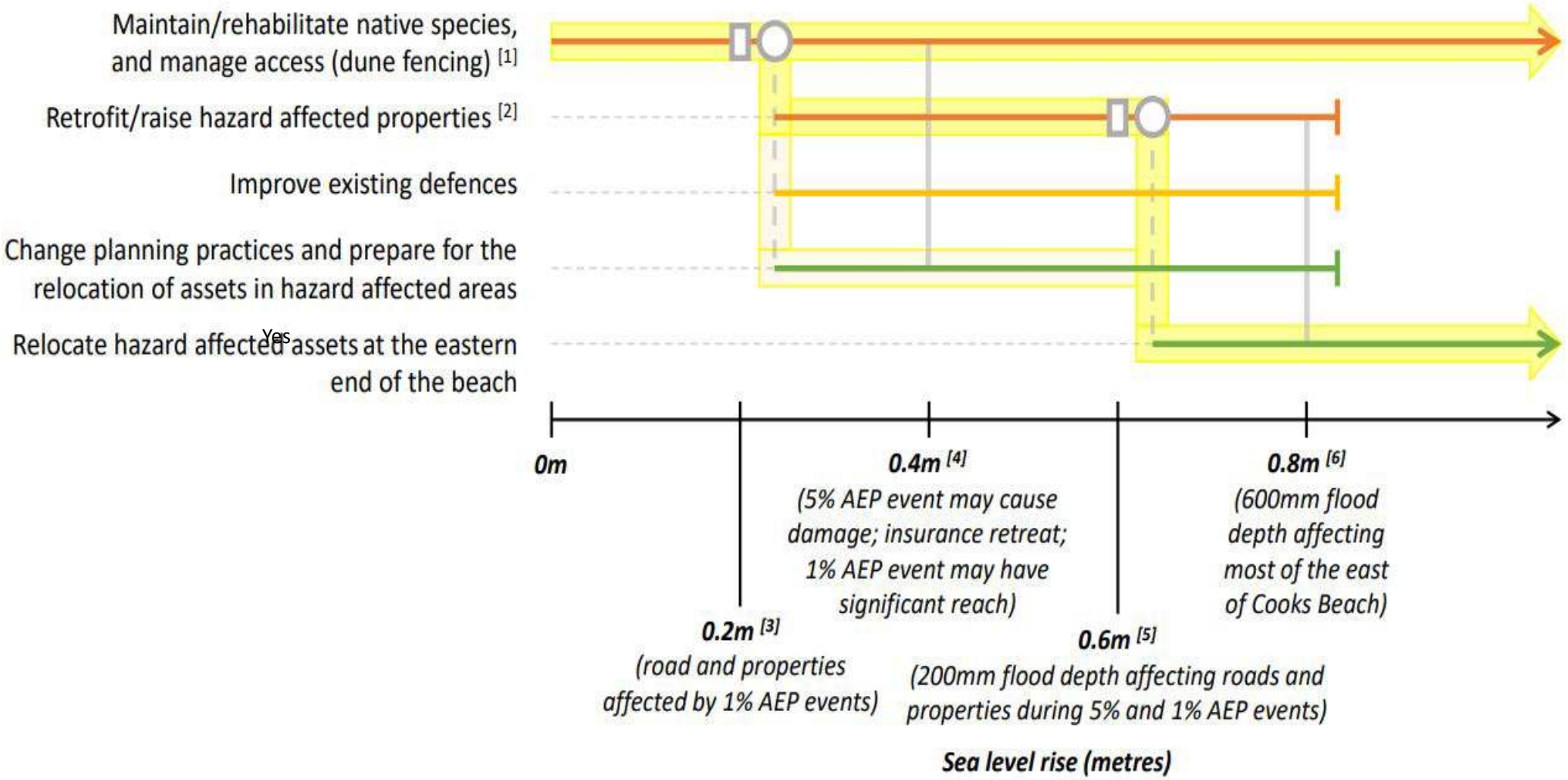


Royal HaskoningDHV
Enhancing Society Together

- Over 400km, many communities
- Community engagement has been a focus
- 3yr journey and 100yr time scale
- 138 pathways



Cooks Beach – Adaptation Pathway with Triggers



Royal Haskoning

THAMES COROMANDEL DISTRICT COUNCIL

Learnings and Reflections

- The scale – over 400 km, many communities – too big?
- Balancing the big picture with specific
- An integrated agency approach pros and cons
- The value of Coastal Panels
- An educational journey for many
- Uncertainty, being adaptive and flexible
- Pathways and triggers need to be clear and easily interpreted
- Risk that the emotive during/post storm can override plans
- Briefing elected members before DAPP before an event is valuable
- Not the end but the end of the beginning

DAPP tools and the impact of scale

"Change almost never fails because it's too early. It almost always fails because it's too late." – Seth Godin

Scale	Example	Description
National	Marshall Islands, National CCRA	National climate adaptation pathways provide a good basis for assessing the scale of the problem and magnitude of costs under different responses. However, lack detail on nuances of individual areas which is reflected in cost uncertainty
Regional / Single Asset Class	Regional council areas, KiwiRail, NZTA	Oversight from single agency or government region. Allows for an assessment of whole life costs and interdependencies between different areas and pathway options. Development of detailed site specific pathway options often cost/time prohibitive as part of initial assessment
Discrete Site/ Single Asset	Single Community, Landfill Site	Often most detailed in terms of pathway option design, cost estimates and engagement of community and asset owners. However, uncertainty in national and regional policy and funding options, including responses in adjacent areas, which can make the selection of viable pathways difficult

Discussion and lessons learned

Historically early use of coastal adaptation pathways in New Zealand was primarily centred around single assets, or small areas, with specific climate change drivers and hazards. The creation of these would benefit from a top down approach with national work to further define policy and funding constraints. Followed by regional assessments to build on engagement with communities and asset owners, and define interdependencies and regional policies, which provides a decision making framework for local sites.

Multiple hazards – Pathways are often dependent on the evolution of multiple hazards overtime, whereby the trigger for moving to a new option may be the result of several drivers (e.g. coastal erosion, inundation, groundwater, fluvial/pluvial flooding). This can necessitate multiple triggers that reflect the uncertainty on how each risk will evolve over time.

Non-hazard driven triggers – Often the trigger for changing to a different pathway option may not be risk based. For example, a beach nourishment scheme may become unviable due to exponential increases in cost, limited availability of source material, or failure to renew a consent at the extraction site.

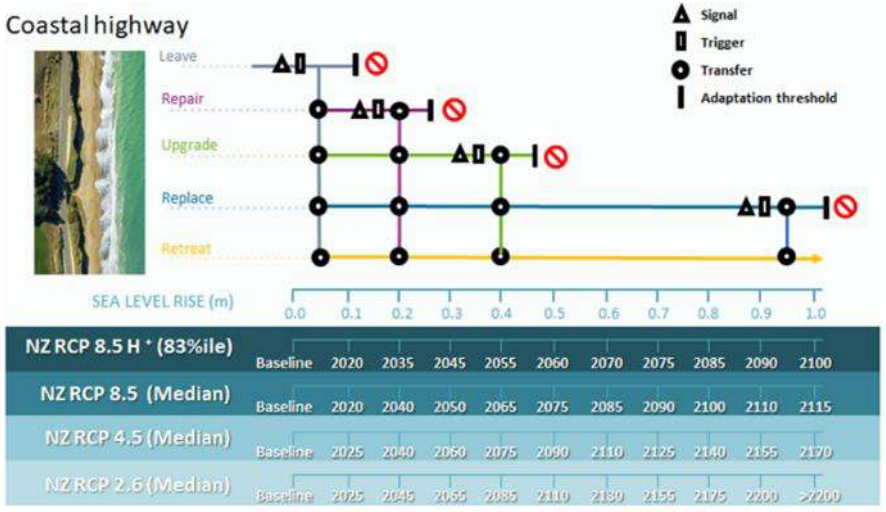
Monitoring – Option cost profiles and consenting feasibility/policy alignment should also be monitored over time, not just the onset of hazard drivers.

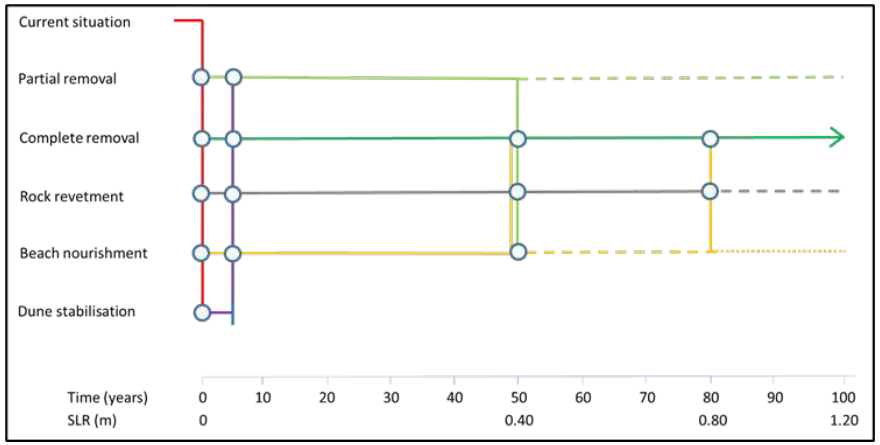
Implementation – Pathway diagrams notionally show a point in time where changing to a new option occurs. In reality the change is often a staged process that can occur over years

Presentation of pathways – Standard adaptation pathway diagrams are often applied to national, regional and local assessments. It would be more beneficial to include increased detail (in terms of options, timing and triggers) as you move down the scales.

End users - Outputs should be tailored towards the end user, diagrams should be developed that reflect this. (e.g. those presented in a community consultation document vs one to be used by a local council operations department)

Contact: jclarke@tonkintaylor.co.nz





Clifton to Tangoio Coastal Hazards Strategy

Project commenced prior to MfE Guidance – DAPP came in part way through

Oversite by a Joint Committee – Tangata Whenua, Hawke's Bay Regional Council, Napier City Council, Hastings District Council

Hazards in scope: coastal erosion + coastal inundation

Bottom-up approach – 2 community panels developed recommendations for the Joint Committee for long term adaptive plan

DAPP and Multi Criteria Analysis (MCA) utilised collaboratively with community panels

DAPP provided the framework for thinking about and planning for coastal hazards

MCA was used to choose between possible pathways

Currently working through implementation

Cell	Unit	Short term (0 - 20 years)	Medium term (20 - 50 years)	Long term (50 - 100 years)
Southern Cell	Clifton	Status quo	Sea wall	Managed Retreat
	Te Awanga	Renourishment + Groynes	Renourishment + Groynes	Renourishment + Groynes
	Haumoana	Renourishment + Groynes	Renourishment + Groynes	Managed Retreat
	Clive / East Clive	Status quo	Renourishment + Groynes	Retreat the Line / Managed Retreat
Northern Cell	Ahuriri	Status quo	Sea wall	Sea wall
	Pandora	Status quo	Storm surge barrier	Storm surge barrier
	Westshore	Renourishment	Renourishment + Control Structures	Renourishment + Control Structures
	Bay View	Status Quo / Renourishment	Renourishment + Control Structures	Renourishment + Control Structures
	Whirinaki	Status Quo / Renourishment	Renourishment + Control Structures	Sea wall

Panel Recommended Pathways

Criteria		Description	Scoring Guide
Technical Assessment Criteria	Manages the risks of storm surge inundation	› Reduced exposure to risks from storm surge inundation › Meets objectives over long timeframes › Proportionate to the scale and nature of risk	5 – High / Good 4 – 3 – Mid 2 – 1 – Low / Bad
	Manages the risks of coastal erosion	› Reduced exposure to risks from coastal erosion › Meets objectives over long timeframes › Proportionate to the scale and nature of risk	5 – High / Good 4 – 3 – Mid 2 – 1 – Low / Bad
	Ability to adapt to increasing risks	› Readily responds to uncertain climate outcomes › Includes measures to support future adjustments	5 – High / Good 4 – 3 – Mid 2 – 1 – Low / Bad
	Risk transfer	› Exacerbation of hazard risk in other areas › The transfer of risk to others, including future generations	5 – Low / Good 4 – 3 – Mid 2 – 1 – High / Bad
Impact Assessment Criteria	Socio-economic impacts	› Social effects e.g. › Effects on community safety › Loss of amenity value › Decline in recreational values, community facilities › Indirect economic / industry impacts (e.g. tourism, fishing)	5 – Low / Good 4 – 3 – Mid 2 – 1 – High / Bad
	Relationship of Maori and their culture and traditions with their ancestral lands, water, sites, waahi tapu, and other taonga	› Impacts on any cultural sites of significance › Maintains access to, and enables the carrying out of, customary activities	5 – Low / Good 4 – 3 – Mid 2 – 1 – High / Bad
	Natural Environments Impacts	› Impacts on natural coastal ecosystems › Impacts on the natural character of the coastal environment	5 – Low / Good 4 – 3 – Mid 2 – 1 – High / Bad

MCA Criteria and scoring guide

Some Lessons Learned

- **Start with the end in mind** – how will you implement? Consistent model needed (ideally regionally, certainly within littoral cells), roles between regional and district councils for implementing adaptive pathways need clarification - politically very challenging discussion to define these roles - political courage required to take leadership. Delays sorting this out following a community collaboration process risks loss of community good will and doesn't respect effort of participants
- **Governance** - beneficial to establish effective governance arrangements prior to starting – need ultimate decision-makers (i.e. elected representatives) engaged from the beginning
- **Tangata Whenua** – critical to the process – high interest, strong influence – but demands on Iwi organisations are massive & bandwidth to engage can be limited. Need to be smart with finding ways for effective engagement and meaningful influence in process.
- **Partnership** - regional council/territorial authority partnership crucial for adaptive planning efforts.
- **Collaboration** – collaboratively working with communities and providing a 'safe space' for deliberation assists with learning and development of relationships/trust for all participants – including Councils.
- **Big process** – it was a big process – time / costs / resources. Each project completed in NZ provides learnings and opportunities for refinement + reduce 'design time' and develop more efficient / effective approaches. But value in time spent together - provides space and time to bring communities along for the journey.
- **Managed Retreat** – very difficult for communities to understand it, engage in it, and compare it with other options. A workaround could be for a community to develop its own definition (e.g. "Planned Resettlement" as defined in the Wharekawa project) – what might it include? What can't it be? And make decisions based on that.
- **Long Term Thinking** – DAPP is powerful at lifting thinking beyond RMA / Resource Consent / Asset Life / 'what-happens-in-my-lifetime' timeframes

Reactive | Plan making | Re-thin k?

DAPP and the flow of time

A ROAD FRAUGHT WITH UNCERTANITY

Kaiaua, 2018

Event prompted Hauraki DC to start a community plan for long-term adaptation

2018

Jul 2022

The Wharekawa Coast 2120 community panel signed off on their final recommendations report.

2022

Sep 2022

TCDC completed the SMPs. Now looking to implement the outcomes of the project included in the 138 pathways.

2022

2023

Cyclone Gabrielle

Recent weather event will impact the work done to date. Communities may want to reprioritize some actions

Te Puru, 2018

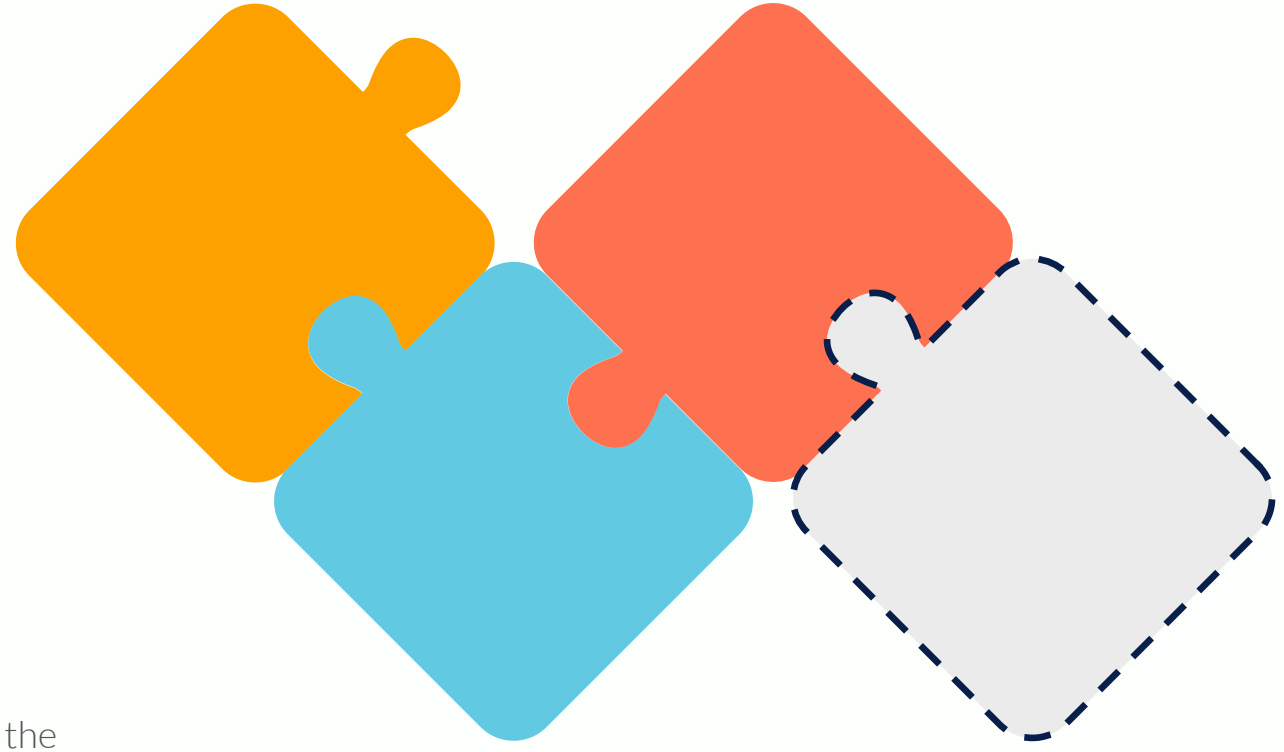
Following the storm of Jan 2018, TCDC adopted the Thames-Coromandel Coastal Management

MĀTAURANGA MĀORI

The piece we know we're missing

Hazard Assessments

We understand the underlying natural processes.



Risk Assessment

We've assessed the risk associated to natural hazards and climate change.

Community Engagement

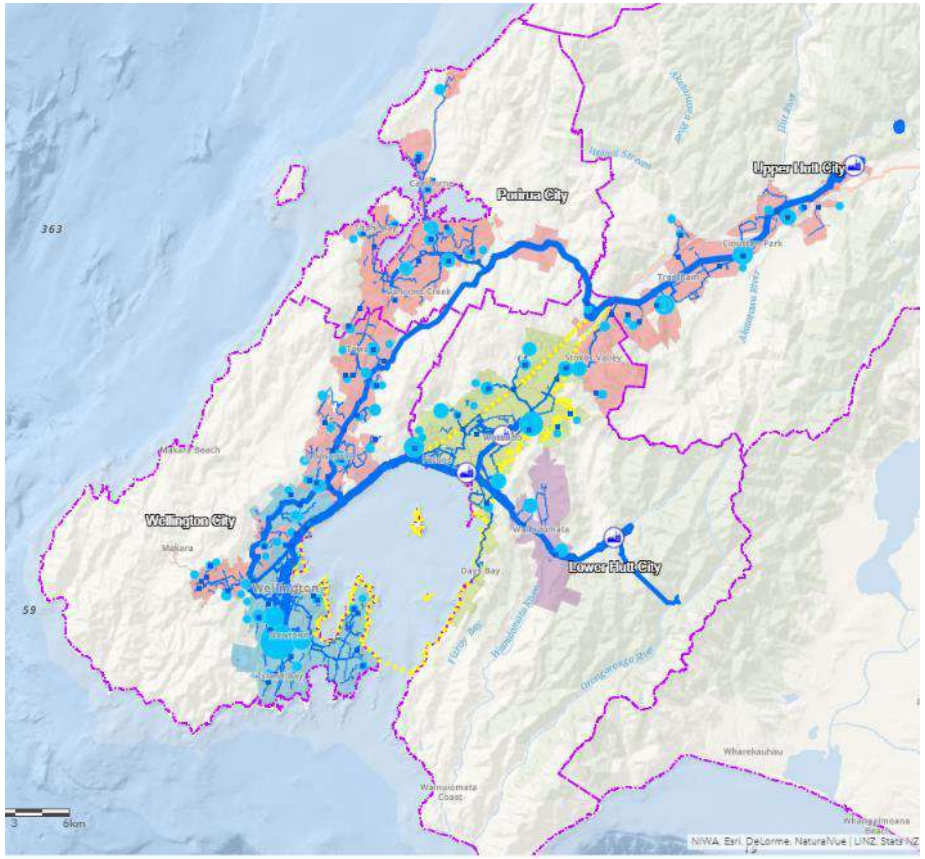
We've brought the community along for the journe

Mātauranga Māori and iwi engagement

Many long-term adaptation projects are being developed without the full benefit of mātauranga Māori.
Even though guidance is available (MfE 2021, A guide to local climate change risk), this is easier said than done.

Strategic planning for Wellington's Water supply

(supported by NIWA, Beca, WSP and Dr. Judy Lawrence)



Rapid growth in demand for water has resulted in the Wellington metropolitan water supply exceeding the drought resilience LoS. Supply/demand interventions are needed, and a review of options is in progress.

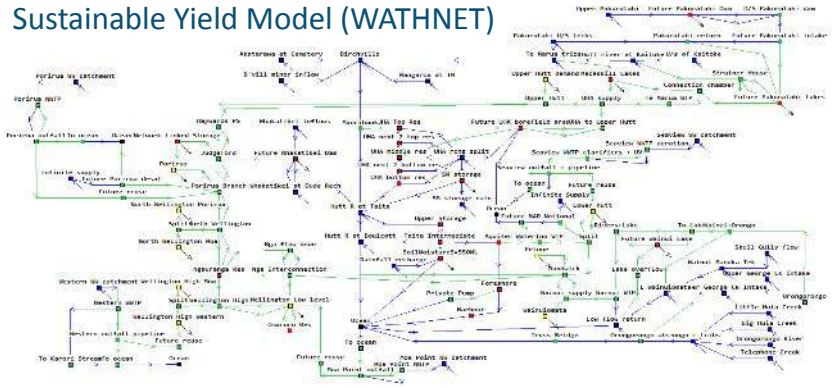
Our long-term planning includes significant uncertainty in:

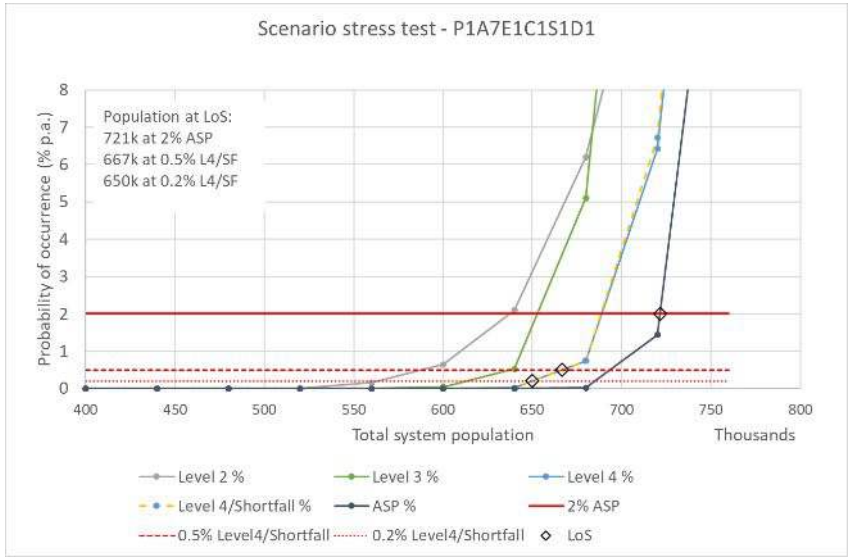
- Level of service (our drought resilience standard is low by national/international standards).
- Environmental regulation (changes are expected to progressively reduce water availability in summer over the next 50 years).
- Climate change (impacting hydrology/hydrogeology and demand for water).
- Sea level rise (reducing sustainable yield from the aquifer).
- Per capita consumption (changing over time due to external factors such as housing density, appliance efficiency, etc).
- Population growth projections (wide range over the 100-year planning horizon).

Objective setting and option long list / short list process has produced 11 potential supply/demand interventions options.

Methodology and lessons learned

Sustainable Yield Model (WATHNET)





Methodology

- Following a general DAPP process with RDM applied to option stress testing.
- Iterative approach used to sequence intervention options into 13 pathways.
- Network performance assessed using WATHNET stochastic supply/demand model.
- Pathway/action/scenario combinations quantitatively assessed to determine maximum population supported at LoS threshold.
- NIWA involvement enabled use of high-performance computing to complete huge scenario stress test (~400M years of daily supply/demand balance).
- Results currently being assessed to determine which pathways succeed the most (i.e. interventions in place before LoS exceeded).
- Robust investment strategies will be developed based on pathway performance against drought resilience and other objectives.

Lessons learned

- DAPP approach is a good fit for water supply strategic planning and represents a step improvement in maturity for Wellington Water.
- Existing WATHNET model was well suited to applying RDM.
- Use of high-performance computing was a key enabler. New processes were needed to manage model inputs/outputs.
- Providing visibility over uncertainty is challenging with huge result set (keep it simple to start with).
- Serious game potential to enhance decision-maker engagement?
- Work in progress so more lessons to come!

Te Tāruke-ā-Tāwhiri: Auckland's Climate Plan

- Mitigation and adaptation plan for Auckland Region, co-developed with mana whenua
- Takes a precautionary approach to plan for the impacts of a high emissions future
- Promotes the use of DAPP as a method for adaptation planning across council
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Chief Sustainability Office DAPP work