Table 3: Summary of commonly used prioritising / sorting and valuation approaches.

Tool	Philosophy and approach	Common uses	Complexity (L,M,H)	Example in practice	Tips and traps
Prioritising / sorting approaches					
Scenario planning / analysis	A foresighting tool to engage a diverse range of stakeholders in a strategic planning or thinking exercise, with the aim of examining knowledge and beliefs and mapping pathways. Useful when a systems approach to decision-making is required.	Very useful for mapping potential (good or bad) future scenarios such as impact of population growth and development on natural systems or potential impact of coastal hazards on the built and natural environments. Can be used at multiple points along a decision pathway as a mechanism to incorporate new information and inform options and trade-offs.	Low-high	A 2012 Tasmanian study used scenario planning to engaged local community to explore a range of adaptation pathways (bundles of options) to inform the local planning scheme. Pathways were explored along a spectrum from 'letting nature take its course and retreat' through to 'protect existing development and permit future development as long as possible'. Pathways were examined against a range of criteria such as credibility, desirability, cost effectiveness, flexibility, fundability and modes of failure (SGS Economics and Planning 2012)	• Systematic yet highly flexible participatory approach that forces reflection at individual and collective levels (International Institute for Environment and Development n/d). • Scenario planning sessions need to be well-guided by a facilitator. • Very useful tool for incorporating professional judgement or expertise in a qualitative format. • 'Public good' can often be overlooked or underrepresented in matters relating to shoreline development. • Scenarios that are too broad or too narrow can be easily dismissed leading and care needs to be taken to define legitimate options for consideration. • Oversimplification can be a risk.
Multi-criteria analysis (MCA) / Multi criteria decision analysis (MCDA)	Where relevant (i.e. non-trivial) values are unable to be monetised yet may change the priority or choice of alternatives under consideration, or where satisfactory values have not been derived but which are nevertheless important for a decision (United Kingdom Government 2009). MCA establishes preferences between options based on a specified set of objectives and measurable criteria, and assessment is undertaken through a collective decision-making process.	When multiple, potentially competing criteria or trade-offs need to be made. Enables individual members of the decision-making group to make distinct and identifiable judgements while at the same time enabling a joint and clear outcome.	Medium	A 2012 study reports on the results of an MCA process that was used to prioritise adaptation options for 26 localities in the Townsville local government area. Decision criteria (e.g. effectiveness, climate uncertainty, social and environmental impacts, complexity and cost) were developed through a working group and later refined and then a weighted scoring approach and sensitivity analysis was applied. Preferred options were presented as 'retreat', 'defend', 'accommodate' or a combination of these (GHD 2012).	• Relies on sound experience and judgement of decision-making team. • Preferred over informal judgement as scores and weights are explicit, and auditable. • Provides a mechanism for experts to inform / influence decision-makers. • Focus is on inputs and outputs rather than outcomes. • Doesn't provide structured information on the significance or value associated with different types of outcomes (Hatfield-Dodds 2005). • Not well suited to assessing the desirability or net benefits of a given target or outcome (Hatfield-Dodds 2005).
Bayesian Belief Networks (BBN)	BBNs are statistical models that integrate knowledge and information from multiple sources into a single assessment. This is achieved by describing (in a probabilistic manner) the cause and effect relationships between different factors.	BBNs are well suited to the rapid scoping and graphical representation of relationships (McCann et al. 2006). This utility has allowed BBNs to be used to support a broad range of risk management and decision support processes, including natural resource management. BBNs are	Low-high	A 2012 NSW study used BBNs in the evaluation and optimisation of coastal adaptation options based upon stakeholder assessments of the performance of different options against multiple criteria. BBNs were used to provide greater granularity and better understanding of the flow of information for a decision-making process. In this context, a BBN was used in conjunction with an MCA process (Preston et al. 2012)	• BBNs need discretisation of variables which may reduce accuracy • The way that beliefs and knowledge are collected requires careful consideration • Not all types of interactions can be described, i.e. no feedbacks • Need to consider model users familiarity with probabilities • Integrated data are often of variable quality which demands careful judgment on behalf of the analyst

Tool	Philosophy and approach	Common uses	Complexity (L,M,H)	Example in practice	Tips and traps
		suitable for analysing problems with significant uncertainties and can be used in conjunction with other tools and approaches, such as MCA.			
Valuation approaches					
Cost-benefit analysis (CBA) / Scenario-based CBA	Estimates the strengths and weaknesses of alternatives against a set of criteria and based on a common unit of measurement – economic efficiency. CBA approaches can vary significantly, from straightforward infrastructure assessments through to broader (and more time consuming and expensive) 'social CBA', where costs and benefits beyond the immediate market are also considered and some measure of 'value to society' is included in the assessment e.g. impact on marginal groups, broader environmental impacts. Scenario-based CBA simplifies the CBA process by limiting the scope of a CBA investigation, allowing for a less costly and more rapid CBA to be undertaken.	When a decision about the economic efficiency of two or more options is required, and all costs and benefits have been monetised.	Low-medium	A CBA was completed in 2013 that reviewed the impact on the timing of decisions to upgrade or remove seawall structures based on an economic perspective. The study focused on examining the costs and benefits of associated with adaptation options in response to climate change projections, in locations where there is an existing coastal protection structure, but this structure was deemed to be insufficient to purpose over the design planning assessment period (Anning and Griffith Centre for Coastal Management 2013).	• Requires all costs and benefits to be identified and valued in monetary terms over the life of the investment. • Attractive because it purports to consider gains and losses to all members of the class under consideration. A limitation of CBA is that, on the basis of economic efficiency criterion, the test is whether net benefits are generated or not, and not whether there are winners and losers. It may be worth extending CBA to include actual compensation if it is play a more useful role in decision support for adaptation. • There is a tendency to overlook both positive and negative impacts if they cannot or have not been evaluated in monetary terms, in particular those that occur at system level. • Non-market values can be highly subjective and care needs to be taken around sensitivity analyses.
Cost effectiveness analysis (CEA)	Compares the relative costs and outcomes (as opposed to financial benefits only) of two or more courses of action. CEA is most often used when benefits are unable to be monetised.	Not commonly used in adaptation (but more common in mitigation). When there are significant social or environmental considerations e.g. if the cost of building a hospital is $100 and this investment is predicted to save 10 lives then the benefit would be expressed as 1 life saved for every $10 spent. Differences in outputs are compared subjectively with differences in costs.	Medium-high	A 2013 investigation in Finland looked into the impacts of climate change on grassland biodiversity, using grassland butterflies as a key indicator species. The study evaluated alternative options to enhance the adaptation of grassland biodiversity under future climate scenarios and whether alternative adaptation measures (e.g. habitat corridors, species translocation) were needed to maintain biodiversity (Tainio et al. 2014).	• Useful for ranking options within a program or choosing between programs. • Can be used to develop counterfactuals. • Sensitivity analysis must be undertaken to test the robustness of results. • Careful consideration must be given to appropriate metrics. • Consideration of relevant outputs or outcomes is important when making comparisons. • Analysis must be inclusive initially or decision-makers run the risk of overlooking important factors (Better Evaluation n/d).
Portfolio analysis (PA)	An examination of the performance of a range of portfolios or options that are likely to be effective under different circumstances, which allows a decision-	The consideration of portfolios of options rather than single (best) options is appealing when operating	High	A 2008 study reports on the use of portfolio selection to to select an optimal set of seed sources to be used in regenerating forests of white spruce in an environment of multiple,	• Resource intensive – either existing or new data required for analysis, including climate projection data. • PA likely to me most useful where a suite of

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	maker to offset risks across a portfolio of investments over the longer-term. Can be used to examine the performance of a suite of assets or investment portfolios under different climate change scenarios in order to reduce risk – providing guidance on the 'highest possible expected return for a given risk, or the lowest degree of risk for a given rate of return', depending on a decision-makers appetite for risk (Hunt and Watkiss 2013).	under conditions of uncertainty, and can be undertaken in a structured manner using both monetary and non-monetary metrics (but must be quantitative).		equally plausible future climates (Crowe and Parker 2008).	adaptation investment options are complementary – both sequentially and in parallel. • Expert judgement will form an important part of this analysis. • Will be more useful in situations where there is good climate data (Hunt and Watkiss 2013). • Can be used in conjunction with deliberative approaches such as scenario planning.
Real Options Analysis (ROA)	Originally developed for financial markets, where someone would hold the right but not the financial obligation to buy or sell a particular stock at a point in time for a specified price. The same approach has been transferred to government and other users who seek to maximise the benefits of an investment by retaining the right but not the obligation to make certain investments. These rights have values as they are used to assess financial options and risk transfer (ACIL Tasman 2012; Watkiss et al. 2013).	Useful when considering the value of flexibility of investments as it can inform how a project adapts, expands or scales back in response to unfolding events (Watkiss et al. 2013). Preferred over NPV analyses because it seeks the optimal time to invest in a way that maximises value and is able to incorporate uncertainty (in some cases this is limited).	High	A 2012 study reports on the results of a ROA investigation to identify coastal adaptation pathways in the Peron-Naturaliste region of Western Australia. The study commenced with a regional economic analysis, and then focused on specific options for four localities, each different in kind. The approach/model used future climate outcomes to derive future scenarios for assets at risk. Optimal responses are determined across a series of several thousand model runs and translated into an adaptation pathway that represents the best combination of options (ACIL Tasman 2012).	• Key benefit is that ROA provides flexibility around large investment decisions by providing flexibility to introduce new economic information as uncertainties are resolved. • Complex, expensive and requires large data points around both future climate and economic inputs. • May limit the inclusion of non-market values. • Potential for more informal application of ROA through the use of decision trees and more qualitative use of information (Watkiss et al. 2013). • ROA works on the premise that uncertainty is dynamic rather than deep, and may be resolved over time as knowledge is improved (Dittrich et al. 2016)
Robust Decision Making (RDM) / Simplified RDM	Differs from ROA in that rather than seeking optimality, RDM seeks to discover decisions that perform well (but not necessarily optimally) under multiple future scenarios. With RDM, objectives and constraints are first defined, and then this is tested against future scenarios to determine the least vulnerable strategy/ pathway (Dittrich et al. 2016). Simplified RDM, a more rapid and less costly form of RDM, can be used by constraining inputs to some degree i.e. limiting possible scenarios or objectives (see Groves et al. 2013).	Useful when an iterative decision support tool is needed where there are deep uncertainties about possible futures states. In this sense it shares a core with CEA in that it can compare the relative costs and outcomes of divergent courses of action that seek a common outcome.	High	A 2012 study provided technical analysis that supported the development of a coastal masterplan for Louisiana's (USA) that was as robust as possible to uncertain future conditions. This was achieved by firstly identifying near-term investments that are likely to perform sufficiently well over a wide range of future conditions; and secondly, by identifying other investments can be implemented in the future as knowledge improves (Groves and Sharon 2013).	• Can be complex, expensive and require large data points around both future climate and economic inputs. However, can also be run in a somewhat simplified form where data is traded off by constraining policy objectives or scenarios (Dittrich et al. 2016). • RDM works on the premise that uncertainty is deep and may not be sufficiently resolved adequately over time, which may not be the case for known coastal hazards.