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Climate**Ready**Clyde

Glasgow City Region Climate Adaptation Strategy and Action Plan

Annex 4: Multi-Criteria Analysis of Potential Interventions

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Introduction

The development of Glasgow City Region's Adaptation Strategy and Action Plan can be considered in terms of the **adaptation policy cycle**, as shown in the European Environment Agency (EEA) Climate-ADAPT Adaptation support tool¹.

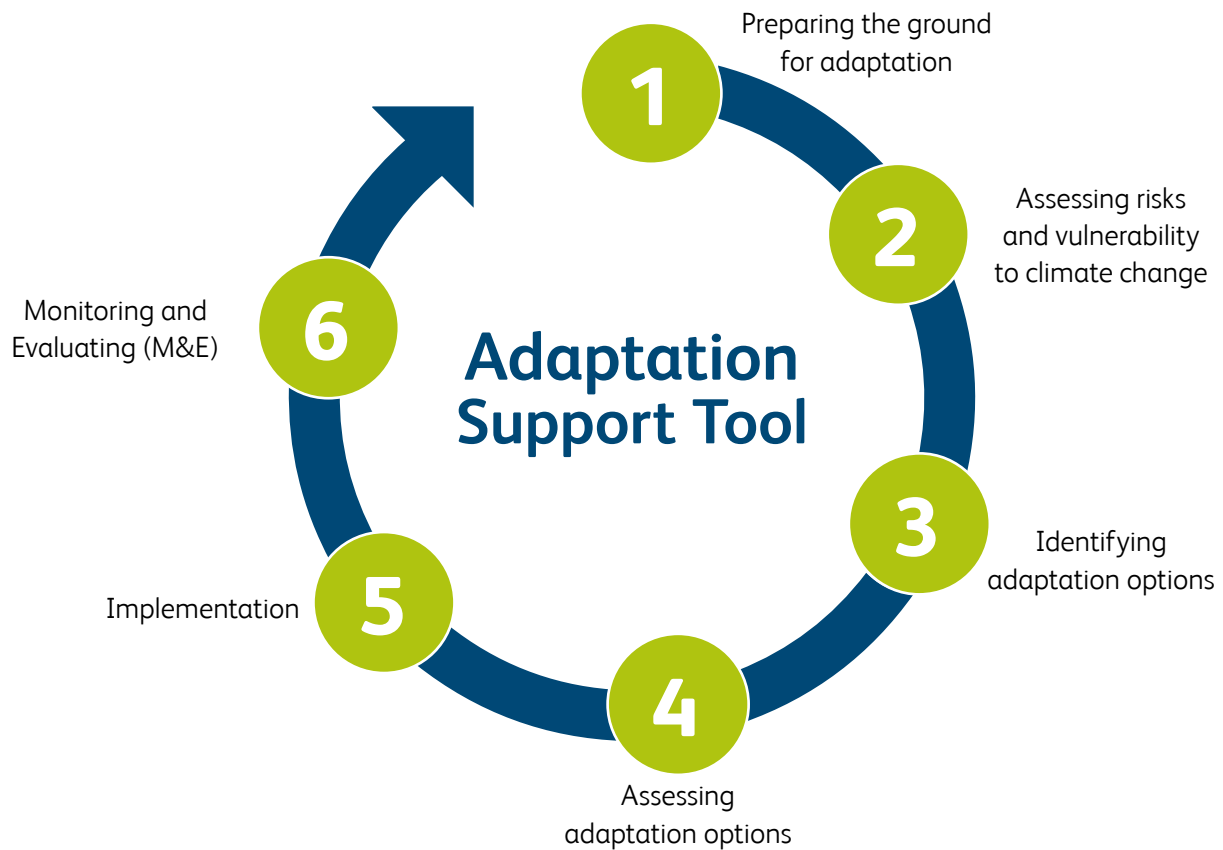


Figure 1 Adaptation Policy Cycle. Source EEA.

As part of the cycle there is a need to identify adaptation options, in step 3 and assess these options, in step 4. The latter involves some analysis of comparative assessment, such as through the use of decision-support tools, to help prioritise adaptation options.

For a strategic level adaptation plan, as in the development of Glasgow City Region's Adaptation Strategy and Action Plan, this requires some scoping or high-level screening of options². This document sets out the method and results of the screening of options undertaken, that supported the choice of the interventions in the plan.

Method and Approach

The appraisal of options is a standard part of all policy and project analysis, and there are existing guidelines and decision support tools to help in the prioritisation and ranking of options. However, the appraisal of adaptation options involves several methodological challenges. These relate to the varied spatial and sector contexts, as well as the high uncertainty involved with future climate change and thus adaptation. As a result, the most common techniques used in appraisal (and decision support) have limitations in coping with the uncertainty associated with climate change (e.g. see Mediation, 2012³). There is therefore a growing consensus that the appraisal of climate change adaptation should incorporate uncertainty, and that this requires extended analysis within existing elements in existing tools or new decision methods that more fully capture uncertainty. As a result, a number of different decision support methods have been developed to help assess adaptation options. These are summarised below.

Decision support methods

Cost benefit analysis	Analysis of project benefits versus project costs, with sensitivity testing (or switching values) for key parameters
Cost effectiveness analysis	Analysis of benefits (non monetary) using a common metric, expressed per unit cost, to allow least cost analysis
Multi-criteria analysis	Analysis of project using wide range of criteria (monetary and non-monetary) to rank projects

Decision making under uncertainty

Adaptive management adaptation route-maps	Using iterative framework of monitoring, research, evaluation and learning to improve future strategies	Learning, flexibility
Real Options Analysis (ROA)	Allows economic analysis of future option value and economic benefit of waiting / future information / flexibility	
Robust Decision Making (RDM)	Identifies robust (rather than optimal) decisions under deep uncertainty, by testing large numbers of scenarios	Hedging / diversification
Decision scaling	Identifies key performance indicators and stress tests many future scenario, to identify options that are robust	
Portfolio Analysis (PA)	Economic analysis of optimal portfolio of options by trade-off between return (NPV) and uncertainty (variance)	Minimising / maximising regrets / choices
Rule based decision support	Minimax: minimise the maximum regret; Maximax: opt for highest outcome; Maximin maximise minimum outcome	

Figure 2 Adaptation Decision Support Tools. Source Watkiss et al., 2019⁴

These different methods have different applicability for scoping and analysis of the Adaptation Strategy and Action Plan, as compared to detailed project appraisal. The potential for applying these methods was considered in the study, based on guidance in the literature (Mediation, 2012), and as the focus is on scoping analysis, the most appropriate tools for Glasgow City Region's Adaptation Strategy and Action Plan was identified to be some type of multi-criteria analysis.

Multi-Criteria Analysis

One of the tools widely recommended for early adaptation prioritisation is Multi-Criteria Analysis (MCA). MCA is an approach that allows consideration of both quantitative and qualitative data in the ranking of alternative options. It provides a systematic method for assessing and scoring options against a range of decision criteria, some of which are expressed in physical or monetary units, and some which are qualitative. The various criteria can then be weighted to provide an overall ranking of options. These steps can be undertaken using expert input and/or stakeholder consultation.

MCA has been widely applied in the adaptation domain and has relevance. Criteria can be included to consider uncertainty or various elements of good adaptation, and the approach brings the flexibility to work with qualitative information, which is particularly useful given there are often data gaps. There are different forms of MCA. These were identified in the recent DG Clima study on Adaptation Modelling (2021⁵).

Method	Description
Linear additive models	Most MCA approaches use this model. It shows how an option's values on the many criteria can be combined into one overall value. This is done by multiplying the value score on each criterion by the weight of that criterion, and then adding all weighted scores together. Pre-condition: criteria must be mutually preference independent. This is applicable when uncertainty is not incorporated into the MCA model.
Multi-attribute utility theory	This is a normative model for decision making that accounts for uncertainty risk within its mathematical model. It also evaluates several criteria and incorporates this within the decision support model. This option does not necessarily assume that the options are preferentially independent.
The analytical hierarchy process	Also develops a linear additive model, however the weights of the different criteria and performance scores for the different alternatives are based on pairwise comparisons. This means that this method addresses: 'How important is criterion A relative to criterion B?'
Multi-criteria decision analysis	A form of MCA (both an approach and a set of techniques) which provides a ranking of options, from the most to least preferred. The options may differ in the extent to which they achieve several objectives, and no single option is obviously optimal for achieving all objectives. A trade-off is usually evident amongst the objectives: for example, options that are more beneficial are also usually more costly. It is ideal to assess complex problems that are characterised by a mix of monetary and non-monetary objectives.
Outranking methods	Outranking seeks to eliminate alternatives that are 'dominated'. One option outranks another if it outperforms the other on enough criteria of sufficient importance, as reflected by the sum of the criteria weights. It indirectly captures some of the political realities of decision making and can be useful to explore how preferences between options can be derived.
Qualitative data inputs	The key characteristic is that the information within the performance matrix or application of preference weights consists of qualitative judgements. One method approximates the linear additive model which requires extra assumptions for greater output precision. An alternative uses outranking method, especially design for qualitative valuations. The performance of options and the weight of criteria are qualitatively evaluated through classifying them into categories.
Fuzzy sets	Attempt to capture the impreciseness of language, for example, 'fairly attractive' or 'rather expensive'. These methods tend to be challenging due to their complex theoretical underpinning.

Table 1 Different approaches for MCA.

For this analysis, a simple form of MCA is used, which developed criteria, and then assesses and score options against these. All criteria were given an equal weighting for the overall addition and score.

A key issue was to develop criteria for this analysis. To do this, the analysis reviewed existing MCA guidance and case studies (De Bruin et al., 2009⁶; CCRA1, 2012⁷; Van Ierland et al., 2013⁸; UNFCCC⁹; DG Clima, 2021). This was used to create a long-list of criteria. These were subsequently filtered down to a set of key criteria based on expert and stakeholder input, discussed at an Appraisal workshop as part of Climate Ready Clyde's Adaptation Strategy and Action Plan working group in August 2020.

It is stressed that one innovative approach that has been used in this MCA is that the criteria are changed depending on the type of intervention. This classifies intervention first, using the approach used in the UK Climate Change Risk Assessment 3 (Watkiss and Betts, 2021¹⁰). This sets out focus areas for identifying early adaptation priorities, using a portfolio or 'building block' approach, that can still pass an 'economic test' for three areas:

- Address any current adaptation gap by implementing 'no-regret' or 'low-regret' actions to reduce risks associated with current climate variability as well as building future climate resilience, or to enhance opportunities.
- Intervene to ensure that adaptation is considered in near-term decisions that have long lifetimes, such as major infrastructure developments, in order to avoid 'lock-in'. This can include the use of decision making under uncertainty (DMUU) concepts (i.e. flexibility, robustness).
- Fast-track early adaptive management activities, especially for decisions that have long lead times or involve major future change, including planning, monitoring and research. This can enhance learning and allows the use of evidence in forthcoming future decisions, for either risks or opportunities.

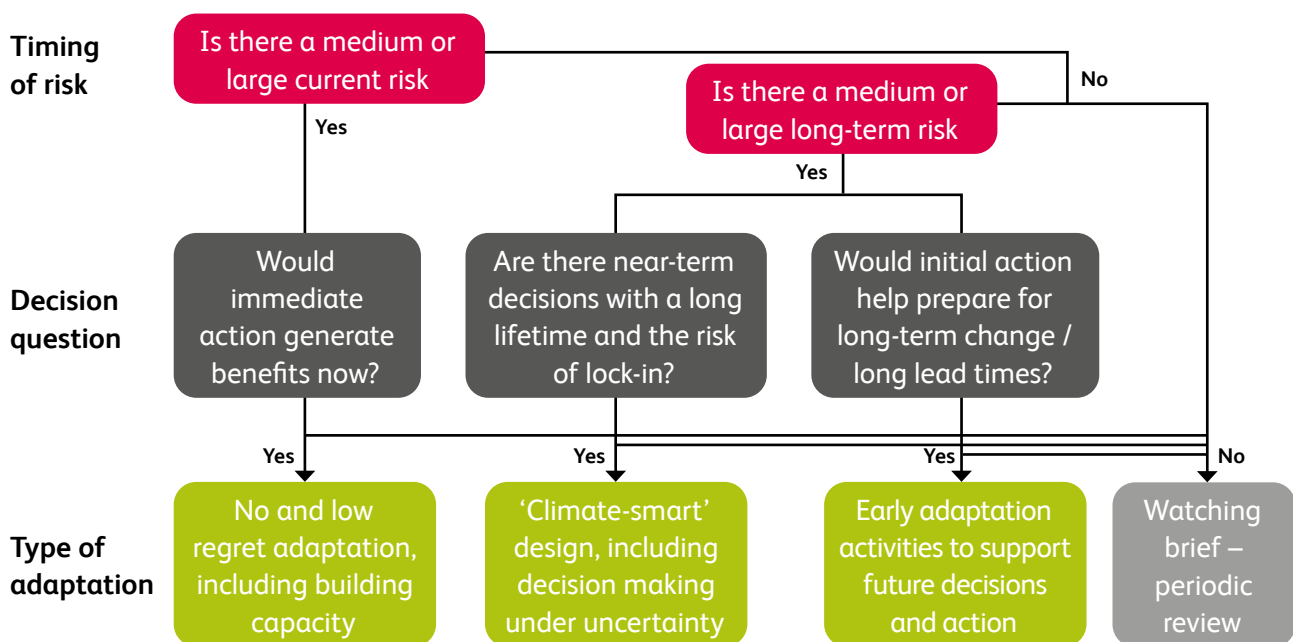


Figure 3 Early adaptation priority framework. Source: CCRA3 Method Chapter Authors updated from CCRA2 (Watkiss and Betts, 2021).

The criteria are shown in the table below.

Decision type	No/Low regrets	Early decision / climate-smart decision making	Iterative / Long Term / Transformative
Focus	Short term characteristics	Dealing with uncertainty	Planning for the long term / systemic, transformative shifts
Common Criteria	<ul style="list-style-type: none"> • Implementation Costs (low to high) • Societal Benefits (effectiveness and efficiency) • Acceptability / legitimacy / Deployability • Mitigation synergies (net zero) • Co-benefits (win wins) 		
Additional criteria	<ul style="list-style-type: none"> • Low regret characteristics (good under current climate) • Urgency • Practicality • Equity 	<ul style="list-style-type: none"> • Robustness (performs well over long term) • Flexibility • Urgency • Practicality 	<ul style="list-style-type: none"> • 'At scale' system change • Transformative characteristics • Persistent, future focus • Domain of change (Inclusive / wider sustainability)

Table 2 Criteria Used for the Analysis

The Interventions

The Interventions in the Adaptation Strategy and Action Plan considered are shown below.

<p>1. Reform, reshape and expand governance mechanisms to respond to adaptation needs, nurture new leadership, and create expectations in society</p> <p>1.1 A detailed review of the new institutional landscape needed for adaptation 1.2 A broader coalition of actors mobilised to deliver the Adaptation Strategy 1.3 Adaptation leadership at all levels that is nurtured and developed 1.4 News, arts, media and cultural organisations telling stories about the climate crisis and opportunities to adapt</p>
<p>2. Develop the ability of organisations, businesses and communities to adapt</p> <p>2.1 An enhanced programme to increase awareness of the potential impacts of climate change on organisations and communities, and opportunities to adapt 2.2 Establishment of a City Region working group/forum and mentoring programme 2.3 Targeted community capacity building for adaptation</p>
<p>3. Increase adaptation finance through leverage and innovation</p> <p>3.1 Strategic use of public sector funds to attract private sector investment 3.2 A Regional Adaptation Finance Strategy and Action Plan 3.3 Mapping and measurement of regional adaptation finance flows 3.4 Piloting of new approaches to transformative adaptation finance</p>
<p>4. Enable and equip individuals and communities to participate in adaptation, focusing on the most vulnerable</p> <p>4.1 A shared understanding of how current community engagement is structured for adaptation 4.2 Increased community involvement in the region's adaptation governance, decision-making, planning and delivery 4.3 Resources, training and education for communities and young people to shape their places 4.4 Collaborations between organisations, communities, artists and cultural practitioners to stimulate creative and relevant adaptation responses</p>
<p>5. Embed reflection, monitoring, evaluation and learning into adaptation action</p> <p>5.1 Learning by doing – building in active reflection and learning process 5.2 Encourage large organisations to sign up to relevant international reporting initiatives 5.3 Alignment of planning assumptions between domestic adaptation planning and the emerging TCFD/ investor regimes 5.4 Learning and knowledge exchange with other cities and regions</p>
<p>6. Adapt the Clyde corridor for the twenty-second century</p> <p>6.1 Work through Clyde Mission to govern climate risks for the entire river corridor 6.2 An iterative adaptation pathway for the Clyde developed 6.3 The climate resilience of the river corridor reflected as a national priority</p>

7. Enhance early warning and preparedness for floods and heatwaves

- 7.1 Extension of the flood warning scheme in Glasgow City Region
- 7.2 Implementation of an integrated climate alert warning system for Glasgow City Region
- 7.3 Continued delivery of strategic Flood Risk Management activities
- 7.4 A regional property flood resilience and resistance installation programme
- 7.5 Exploration of new insurance models

8. Ensure everyone's homes, offices, buildings and infrastructure are resilient to future climate impacts

- 8.1 Adaptation embedded in Glasgow City Region's net-zero transition
- 8.2 Creation of an adaptation forum for Glasgow City Region infrastructure
- 8.3 Adaptation of existing infrastructure, with policies and regulation to require all new investment to be climate resilient
- 8.4 Strengthening of adaptation requirements in the planning system
- 8.5 Creation of a regional retrofit framework for climate resilience
- 8.6 Creation of a framework for adapting cultural heritage assets
- 8.7 Lobby UK and Scottish Governments to reform infrastructure investment frameworks
- 8.8 Evaluation of future adaptation infrastructure needs

9. Deliver nature-based solutions for resilient, blue-green ecosystems, landscapes and neighbourhoods

- 9.1 Identify regional priorities for nature-based solutions
- 9.2 Delivery of the regional Strategic Green Network
- 9.3 Creation of the Clyde Climate Forest
- 9.4 Increase investment in targeted habitat restoration
- 9.5 Roll out of large-scale blue and green infrastructure projects to demonstrate benefits to communities – either through new green infrastructure or removal of hard landscaping or public realm
- 9.6 Support for new local infill or expansion of existing nature-based solutions to strengthen the regional network
- 9.7 Develop and accelerate blue and green infrastructure financing

10. Enhance regional decision-making and establish Glasgow City Region as a global research and knowledge hub for adaptation

- 10.1 Enhanced adaptation research through open invitation to collaborate on publicly available research priorities
- 10.2 Glasgow City Region established as a living lab for climate adaptation
- 10.3 Convene an Expert Advisory Committee on Adaptation

11. Begin the transition to an economy resilient to future climate impacts

- 11.1 Adopt a climate smart regional economic development approach
- 11.2 Delivery of a just, climate resilient transition which nurtures adaptation skills
- 11.3 Climate-resilient supply chains as part of a net-zero, circular economy
- 11.4 An SME (Small and Medium Enterprise) support plan

The mapping of Interventions to each of the three categories in the Adaptation priority framework is shown below.

Intervention	Adaptation category
1. Reform, reshape and expand governance mechanisms to respond to adaptation needs, nurture new leadership, and create expectations in society	Iterative / Long Term / Transformative
2. Develop the ability of organisations, businesses and communities to adapt	No/Low regrets
3. Increase adaptation finance through leverage and innovation	Cross cutting – required to deliver the other ten interventions.
4. Enable and equip individuals and communities to participate in adaptation, focusing on the most vulnerable	No/Low regrets
5. Embed reflection, monitoring, evaluation and learning into adaptation action	Iterative / Long Term / Transformative
6. Adapt the Clyde Corridor for the 22nd Century	Iterative / Long Term / Transformative
7. Enhance early warning and preparedness for floods and heatwaves	No/Low regrets
8. Ensure everyone's homes, offices, buildings and infrastructure are resilient to future climate impacts	Early decision / climate-smart decision making
9. Deliver nature-based solutions for resilient, blue-green ecosystems, landscapes and neighbourhoods	Cross cutting
10. Enhance regional decision-making and establish Glasgow City Region as a global research and knowledge hub for adaptation	Iterative / Long Term / Transformative
11. Begin the transition to an economy resilient to future climate impacts	Iterative / Long Term / Transformative

The scoring was taken at the sub-intervention level, i.e. for the 49 actions listed earlier. The scores were then averaged for each Intervention.

The scores were derived through a process of expert judgement, with the scores averaged across experts. The maximum possible score is 45.

Table of Intervention Scores (Average of experts)

Intervention	SCORE
1. Reform, reshape and expand governance mechanisms to respond to adaptation needs, nurture new leadership, and create expectations in society	30.20
2. Develop the ability of organisations, businesses and communities to adapt	30.67
3. Increase adaptation finance through leverage and innovation	31.38
4. Enable and equip individuals and communities to participate in adaptation, focusing on the most vulnerable	31.88
5. Embed reflection, monitoring, evaluation and learning into adaptation action	29.50
6. Adapt the Clyde Corridor for the 22nd Century	35.00
7. Enhance early warning and preparedness for floods and heatwaves	31.30
8. Ensure everyone's homes, offices, buildings and infrastructure are resilient to future climate impacts	31.13
9. Deliver nature-based solutions for resilient, blue-green ecosystems, landscapes and neighbourhoods	33.57
10. Enhance regional decision-making, and establish GCR as a global research and knowledge hub for adaptation	29.50
11. Begin the transition to an economy resilient to future climate impacts	28.50

Scoring Bands	
40-45	Excellent
31-40	Very Good
21-30	Good
11-20	Poor
0-10	Very Poor

Discussion

The application of a differentiated MCA approach, with different criteria for the different types of Interventions, was beneficial because it favoured the development of an overall, complementary portfolio. If the same criteria had been used for all Interventions, the criteria chosen would have inevitably favoured low-regret and incremental options, for example, at the expense of more transformational Interventions. This is an important finding since the Adaptation Strategy and Action Plan explicitly acknowledges the needs for a spectrum of approaches from incremental to transformational approaches.

The MCA analysis demonstrates the potential attractiveness of the overall Adaptation Strategy and Action Plan portfolio, as well as the individual Interventions, and suggests that the combination does support a spectrum of approaches. All 11 Interventions were found to have scores greater than 28.5, i.e. the high end of the central score (good), and most Interventions were ranked as very good.

As the Action Plan is implemented, there will be a need for more specific adaptation options appraisal. This will be particularly important for those Interventions which involves larger costs (ranked 4 or 5 in relation to costs). This should use a more rigorous decision support tools, based on consideration of the approaches in Figure 2.

Implications for future strategies

In more traditional Adaptation Strategy and Action Plan development, MCA is employed to steer the development and selection of interventions and actions. In this case, the evaluation was undertaken ex-post, since the iterative process of Strategy development, and systems analysis, as well as practical time constraints made undertaking the MCA during the drafting of Strategy impractical.

References

- 1 European Climate Adaptation Platform Climate-ADAPT <https://climate-adapt.eea.europa.eu/knowledge/tools/adaptation-support-tool>
- 2 It is noted that as the plan moves to implementation, there will be a need for more detailed appraisal, which can include assessment of options for a specific intervention (i.e. at the project level).
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