

Measuring recovery from extreme weather events

▶ Paula Orr, Sian Morse-Jones, Rebecca Jones (Collingwood Environmental Planning); Christopher White, Nick Mannix (University of Strathclyde)

September 2020

DOI: <https://doi.org/10.7488/era/1240>

Executive summary

Aims

This study investigates international approaches to assessing recovery from extreme weather events, the data sources underpinning them, and their applicability to Scotland. It seeks to enable a common understanding of climate resilience and the critical components in planning for local and national recovery from extreme weather. This provides a starting point for developing a systematic approach to monitoring recovery from extreme weather events in Scotland.

A lack of national targets and data to measure recovery from extreme and/or repeated climate-related events has been identified as an area of 'high concern' in the Climate Change Committee's (CCC) assessments of the Scottish Climate Change Adaptation Programme¹ (SCCAP). The CCC's assessments note that some positive actions have taken place to improve recovery capabilities, but that barriers to efficient recovery remain: lack of national targets for recovery from extreme weather events, and a lack of evidence on the impacts of extreme weather events on people, and on the effectiveness of recovery plans.

This report aims to respond to this concern by reviewing international approaches to monitoring recovery to identify examples of best practice relevant for developing a set of indicators for Scotland. It is hoped that a systematic approach to measuring recovery will benefit resilience planning, and be part of improving how well and how quickly communities recover.

We focused on systems used in other parts of the UK and Europe, North America and Australia and New Zealand, as these countries and regions have political structures and cultures similar to Scotland's.

In analysing these examples we consider how an indicator framework can fit in with and contribute to the National Performance Framework² (NPF), Preparing Scotland³ and the Scottish Climate Change Adaptation Programme⁴ (SCCAP).

¹ Data gap identified in both [first](#) and [final](#) assessment of the SCCAP 2014-19

² <https://nationalperformance.gov.scot/>

³ <https://www.readyscotland.org/media/1496/preparing-scotland-hub-updated-published-version-may-2019-new-h-s-diagram.pdf>

⁴ <https://www.gov.scot/publications/climate-ready-scotland-second-scottish-climate-change-adaptation-programme-2019-2024/>

The research looks at the recovery of individuals, communities and the built environment; it does not include the natural environment⁵.

Findings

Internationally, governments and stakeholders recognise that recovery should not simply seek to rebuild physical structures but that it should pursue wider social goals such as wellbeing and resilience⁶. This fits well with Scotland's outcomes-focused NPF and with SCCAP

We identified eight examples of monitoring frameworks of potential relevance to Scotland and evaluated the extent to which they would work with the approaches set out in the National Performance Framework and the SCCAP.

Three systems were identified as particularly relevant:

- National Disaster Recovery Monitoring & Evaluation Database (and Framework), developed by the Australian Institute for Disaster Resilience (AIDR) in 2018;
- Canterbury Wellbeing Index (CWI), developed by the Canterbury Earthquake Recovery Authority in New Zealand in 2013; and
- Flood Resilience Measurement for Communities (FRMC), developed by the Zurich Flood Resilience Alliance in 2013.

In terms of measuring resilience, the FRMC tool uses 'capitals' (or capacities): social, human, physical and economic/financial⁷. We have analysed all three tools using the organising principle of 'capitals' described in the Sustainable Livelihoods Framework (DFID, 2011)⁸:

- *Social capital* includes reciprocity and supporting others; community and civic engagement.
- *Human capital* includes health and healthcare, education and its continuity.
- *Physical capital* includes buildings, land and infrastructure.
- *Economic/financial capital* includes household income, sources of recovery funding, business continuity and employment.

There is also a clear fit between these capitals and the categories of emergency impact identified in the Preparing Scotland guidance on recovery (2017).

Based on international experience, the building blocks for developing a system for monitoring recovery from extreme weather events in Scotland are:

- Framing recovery within a set of wider social goals such as wellbeing or resilience.
- An approach that establishes the different areas or recovery that need to be considered and the role the community will play in deciding the system to be used.
- A set of indicators of recovery.
- Joined-up data across different scales (national, regional/local and community) with a focus on process and outcomes.
- Relevance of the spatial scale at which data is collected and the timing and frequency of collection to the indicator.
- Drawing on existing information.

⁵ This project does not include the recovery of the natural environment as it was felt that more work has been done on indicators relating to the natural environment, e.g. on identifying indicators in the SCCAP.

⁶ United Nations Sendai Framework for Disaster Risk Reduction 2015-2030.

https://www.preventionweb.net/files/43291_sendaiframeworkfordrren.pdf

⁷ The FRMC also includes natural capital, which is out of scope for this project.

⁸ The capitals approach has also been recently used to review the impact of CV19 on Scottish economy (Scottish Government, 2020).

Within such an approach, and following a review of Scottish datasets against the three international frameworks, we propose a set of 26 possible indicators to cover the four capitals. The datasets included the Scottish Household Survey, Scottish Health Survey and Scottish Transport Statistics.

Most of the data for these indicators are already available or could be obtained from stakeholders such as utility companies. The Scottish Government would need to work with stakeholders to develop the indicators further.

Potential indicators for measuring recovery from extreme weather events in Scotland

The use of these indicators will need to be tested in different locations, to see how frequently they are collected and how relevant they are to local circumstances (e.g, grant funding indicators).

Preparing Scotland categories of impact	Capital	Indicator	Scottish data available (Y/N/Proxy)
People	Social (9)	Indicators of engagement <ul style="list-style-type: none"> • Voter turnout in elections. • Participation in volunteer activities • Community participation in extreme weather recovery 	Y Y N
		Indicators of empowerment <ul style="list-style-type: none"> • Ability to influence decision-making • Trust in authorities • Community learning from flood / extreme weather event 	Y Y N
		Indicators of community belonging <ul style="list-style-type: none"> • Regular contact with family or friends living outside the household • Feeling of a sense of community with others in the neighbourhood 	Y Y
		Indicator of mutual support	Proxy
	Human (5)	Indicators of physical and mental health and health care services <ul style="list-style-type: none"> • Self-reported health • Community members experiencing mental health stress or hardship • Access to mental health services • Appropriateness of health and social services provided 	Y Y N Proxy
		Indicator of continuity of education	Y
Economy	Economic / financial (6)	Indicators of household income resilience <ul style="list-style-type: none"> • How households are managing financially • Household income continuity • Household insurance 	Y Proxy Partial
		Indicators of access to grant funding <ul style="list-style-type: none"> • Grants for resilient repairs to homes 	N

Preparing Scotland categories of impact	Capital	Indicator	Scottish data available (Y/N/Proxy)
		<ul style="list-style-type: none"> Community Disaster Fund 	Proxy
		Indicator of business continuity	N
Infra-structure	Physical (6)	Indicators of performance of basic infrastructure and services <ul style="list-style-type: none"> Transportation performance Continuity of energy and fuel supply Communications performance Safe water 	Y N N Y
		Indicators of repairs to physical assets <ul style="list-style-type: none"> Damaged residential/commercial/industrial assets rebuilt Damaged education and health premises rebuilt 	N Partial

Glossary

Acronym	Description
AIDR	Australian Institute for Disaster Resilience; developed and maintains the National Disaster Recovery Monitoring and Evaluation Database
ANZSOG	Australia and New Zealand School of Government; developed the A Monitoring and Evaluation Framework for Disaster Recovery Programs
CCC	Climate Change Committee
CDHB	Canterbury District Health Board (New Zealand); produce the Canterbury Wellbeing Index with support of other organisations (2016 onwards).
CERA	Canterbury Earthquake Resilience Authority (New Zealand); developed and produced the Canterbury Wellbeing Index (2011-2015)
CWI	Canterbury Wellbeing Index
FRMC	Flood Resilience Measurement for Communities tool, produced by Zurich Flood Resilience Alliance
NPF	National Performance Framework (Scotland)
SCCAP2	Scotland's Second Climate Change Adaptation Programme
ZFRA	Zurich Flood Resilience Alliance; producers of the Flood Resilience Measurement for Communities (FRMC) tool

Contents

Executive summary.....	1
Glossary.....	5
1 Introduction.....	7
1.1 Context.....	7
1.2 Aims and objectives.....	10
2 Method.....	11
3 International systems for monitoring recovery from extreme events.....	11
4 Applicability in the Scottish context.....	14
5 How is recovery measured?.....	18
5.1 Social capital.....	20
5.2 Human capital.....	21
5.3 Economic/financial capital.....	22
5.4 Physical capital.....	22
5.5 Fit with Preparing Scotland's guidance on recovering from emergencies.....	23
6 Identification of relevant Scottish data sets.....	24
7 Measuring recovery from extreme weather events in Scotland.....	29
7.1 How does the capitals approach fit with SCCAP2?.....	29
7.2 Types of indicators.....	30
7.3 Scale and frequency of data collection.....	31
7.4 Proposed indicators for measuring recovery from extreme weather events in Scotland.....	32
7.5 Applying the indicators of recovery from extreme weather events.....	41
8 Conclusions.....	46
Appendix 1: Summary of international monitoring systems.....	48
Appendix 2: Rationale for assessment criteria.....	51
Appendix 3: Case studies of international monitoring systems.....	52
Case study 1: Australian Institute for Disaster Resilience (AIDR) National Disaster Recovery Monitoring & Evaluation Database.....	52
Case study 2: Canterbury Wellbeing Index.....	55
Case study 3: Zurich Flood Resilience Alliance Flood Resilience Measurement for Communities ..	59
Appendix 4: International examples' use of capitals or domains in relation to recovery.....	63
References.....	67

1 Introduction

Emergency planning for extreme weather events is well established in Scotland, and processes are being put in place to support continuous improvement in emergency response and to improve community resilience. However, there is a need to better understand the full recovery process from the impacts of extreme weather and/or repeated weather-related extreme events on community infrastructure, health and wellbeing.

A lack of national targets and data to measure recovery from extreme weather events was identified as an area of 'high concern' for building climate resilience in the Climate Change Committee's second Independent Assessment of the Scottish Climate Change Adaptation Programme (SCCAP) (CCC, 2016).

The CCC assessments note that some positive actions have taken place to improve recovery capabilities, but that there is a lack of national targets for recovery from extreme weather events and a lack of evidence on the impacts of extreme weather events on people, and the effectiveness of recovery plans.

This report aims to respond to this concern by reviewing international approaches to monitoring recovery to identify best practice examples that provide relevant evidence for developing a set of indicators for Scotland. It is hoped that a systematic approach to measuring recovery will benefit resilience planning, and be part of improving [how well and how quickly communities recover](#).

Practitioners interviewed for this project note that there is rarely a clear point when response ends and recovery begins, and resilience guidance suggest both should take place concurrently: '*The recovery process should commence from the moment the emergency begins*', Scottish Government (2017). This can make monitoring and evaluation of recovery as a distinct phase more difficult. For this study we do not discuss this distinction, nor at what point the response phase ends and recovery begins.

The research reviews international approaches to monitoring recovery to identify best practice examples that provide relevant evidence for developing a set of indicators for Scotland. It examines the data needed for these indicators and to what extent this data is available. Finally, it looks at the ways the approaches identified could be integrated into wider frameworks for monitoring and assessing national outcomes in Scotland.

1.1. Context

The Scottish Government seeks to build resilience at all levels of society. Resilience is defined as '*the capacity of an individual, community or system to adapt in order to sustain an acceptable level of function, structure and identity*' (Preparing Scotland, 2016)⁹. Being resilient means anticipating and assessing risks, taking preventative action, and planning for coordinated activity to manage and **recover from emergencies** such as extreme weather events when they do occur.

⁹ Note that a different definition of resilience is given in Preparing Scotland (2017), p.4, where resilience is described as the ability, '*at every relevant level to detect, prevent and, if necessary, to handle and recover from disruptive challenges*'. Here the focus is on the emergency management aspect of resilience rather than its outcomes.

Scotland's National Performance Framework (NPF) establishes the outcomes the country seeks to achieve and its core values (Scotland's NPF, undated). One of the outcomes, or desired goals, is the resilience of communities¹⁰: *'Our communities are inclusive, empowered, resilient and safe'* (ibid, undated).

Focusing on outcomes supports cross-cutting action and encourages collaboration across sectors (Scottish Government, 2019). Regional Resilience Partnerships support multi-agency collaboration between local authorities and other statutory emergency response organisations. There are currently three of these regional partnerships (in the North, East and West of Scotland) which each bring together a number of local resilience partnerships (Preparing Scotland, 2016, p8).

The Scottish Climate Change Adaptation Programme (Scottish Government, 2019) is a five-year programme to prepare Scotland for the challenges the country will face as the climate continues to change. The programme sets out policies and proposals to prepare Scotland for the challenges resulting from a changing climate. It takes an outcomes-based approach, derived from both the UN Sustainable Development Goals and Scotland's NPF. The link between the NPF outcomes and SCCAP2's Communities outcomes, which include recovery from extreme events, is shown in Figure 1.

¹⁰ The headings are: Children and young people, Communities, Culture, Economy, Education, Environment, Fair work and business, Health, Human rights, International, Poverty

Figure 1: The Second Scottish Climate Change Adaptation Programme’s relationship to the UN Sustainable Development Goals and Scotland’s National Performance Framework (Scottish Government, 2019, p22)



Community-level recovery from emergencies such as extreme weather events is important to achieving national outcomes. There are different understandings of what recovery means and its level of ambition:

- 'Bounce back': ensuring communities 'sustain an acceptable level of function, structure and identity' and can return to their pre-event condition (DFID, 2011).

- 'Bounce back better': enabling communities to improve their level of functioning and strengthen their capacities to deal with future extreme weather or shocks (DFID, 2011).
- Adaptation: the process of recovery facilitating continued adaptation of community structures and functions to cope with changing risks, for example, as a result of climate change, as reflected in SCCAP2's Vision: '*We live in a Scotland where our built and natural places, supporting infrastructure, economy and societies are climate ready, adaptable and resilient to climate change*' (Scottish Government, 2019, p22).

Recovery from emergencies is addressed as an integral part of the Scottish Government's Preparing Scotland guidance on planning for and responding to emergencies, including extreme weather events. Experience of emergencies in Scotland has shown the importance of community involvement in the recovery process, and the guidance stresses that effective communication and support for self-help activities are important considerations for responders. The approach to recovery addresses the human, physical, environmental and economic impact of emergencies, and considers recovery an integral part of the combined response as actions taken at all times can influence the longer term outcomes for communities. The guidance describes how recovery should be a partnership between members of affected communities, the Resilience Partnership and the many agencies with a part to play (Scottish Government, 2019a).

While recovery from extreme weather events is formally included under SCCAP2's Outcome 1: Communities, it is also relevant to three other SCCAP2 outcomes:

- Outcome 2: Climate justice 'The people in Scotland who are most vulnerable to climate change are able to adapt and climate justice is embedded in climate change adaptation policy'. This outcome has two sub-outcomes:
 - 2.1 '*The most vulnerable to climate change in Scotland are engaged and empowered and able to adapt to climate change*' (p.67). One example of actions being taken is support for the Scottish Flood Forum's Flood Recovery Services which assists those in greatest need; need is determined by a number of factors including disadvantage.
 - 2.2 Scotland's health and social care is ready and responding to changing demands as a result of the changing climate.
- Outcome 3: Economy. '*Scotland's inclusive and sustainable economy is flexible, adaptable and responsive to the changing climate*' (p.92). This includes, among other examples, recovery of businesses and the wider economy to climate-related disruptions, such as flooded business sites, loss of infrastructure, reduced access to capital.
- Outcome 4: Supporting systems. 'Our society's supporting systems are resilient to climate change'. '*Recovery from climate impacts is improved*' is included as a sub-outcome monitoring theme (Scottish Government, 2019, p.144).

1.2. Aims and objectives

The aim of this study is to enable a common understanding of climate resilience and the critical components in planning for local and national recovery from extreme weather events.

This study has three main objectives that support this aim:

1. To identify and assess the applicability to Scotland of recovery monitoring systems used in the rest of the UK and internationally.
2. To propose datasets to include in analysis of recovery from extreme weather events.
3. To consider how monitoring of recovery from extreme weather events can fit in with, and contribute to, the National Performance Framework, Preparing Scotland and the Scottish Climate Change Adaptation Programme.

2 Method

The method involved three interrelated steps:

- A literature review (supported by discussions with stakeholders) to identify UK and international examples of the use of systems or sets of indicators to monitor recovery from extreme events, especially extreme weather events. The focus for the examples was on the rest of the UK and Europe; North America (United States and Canada); and Australia and New Zealand. These countries have political systems, administrative arrangements and cultures that are similar to Scotland's. Criteria were developed to assess the applicability of the international recovery monitoring systems to Scotland.
- Identification of Scottish datasets which could potentially be used to provide indicators for monitoring and assessing recovery from extreme weather events, focusing on the international systems and indicators prioritised in the previous step. Scottish datasets were reviewed to provide descriptions of the data, frequency of collection and geographic scale.
- Interpretation of the link with, and contribution of, monitoring of recovery from extreme weather events to key frameworks and programmes in Scotland.

The scope of the research is limited to the recovery of individuals, communities and the built environment (infrastructure, houses and other buildings). This project does not include the recovery of the natural environment as it was felt that more work has been done on indicators relating to the natural environment, e.g. in identifying indicators in SCCAP2. Other capitals (particularly social and human capitals) have been given less attention. The natural environment should be included as a capital, and recovery indicators for the natural environment identified as part of the implementation of the monitoring system.

3 International systems for monitoring recovery from extreme events

At the international level, the Sendai Framework for Disaster Risk Reduction (2015-2030) shifted the emphasis from prevention to increasing resilience to disasters of all kinds¹¹. Priority 4 of the Framework sees preparedness, response and recovery as

¹¹ United National Office of Disaster Risk Reduction: <https://www.undrr.org/implementing-sendai-framework/what-sf>

contributing to resilience, specifically to ‘*Build Back Better*’ in recovery, rehabilitation and reconstruction.

Despite the scale of investment in recovery programmes internationally, there has been limited work to monitor or evaluate the performance of disaster recovery programmes (Horney et al., 2016). This may reflect the fluid nature of recovery, which starts as a part of emergency response and may turn into a long-term development or regeneration process (Cabinet Office, 2013).

Based on cases where the performance and progress of a disaster recovery programme has been evaluated (e.g. Ryan et al., 2016, Horney et al., 2016), evaluations are typically done in an ad-hoc manner, as part of operational debriefs, post-action reviews or programme wrap-ups, with the findings often inconsistently recorded and only disseminated later in summary reports which can be difficult to access.

The potentially broad remit of recovery also makes it hard to monitor comprehensively. Much of the focus of guidance on recovery is on the activities carried out, rather than on their outcomes. There are few examples of the use of frameworks for describing the capitals or capacities that are required for community resilience¹² being applied systematically to recovery. A systematic approach to recovery would focus on restoring and strengthening the most important capacities and resources which communities need to be able to cope and thrive. Using indicators of recovery in these areas would allow those involved to monitor change and to improve their practice.

Our review of international evidence focused on countries expected to have similar approaches to managing extreme events as Scotland: these were English-speaking countries (UK, Australia, New Zealand, United States, Canada) and European countries.

We identified eight examples of monitoring frameworks for recovery from extreme events of potential relevance to Scotland¹³:

- *National Disaster Recovery Monitoring & Evaluation Database (and Framework)*¹⁴ - developed by Australian Institute for Disaster Resilience (AIDR) in 2018
- *Canterbury Wellbeing Index (CWI)* – developed by the Canterbury Earthquake Recovery Authority (CERA) in New Zealand in 2013 and published annually since then¹⁵; it is applied in Greater Christchurch in New Zealand
- *Community Recovery Checklist* - developed in 2016 and applied in US (North Carolina and New Jersey) (Horney et al. 2016)
- *New Orleans Index* – first published in 2007¹⁶ by Greater New Orleans Community Data Center and the Brookings Institution with further iterations since then; applied in New Orleans US (The Data Center, 2015)
- *Flood Resilience Measurement for Communities (FRMC)* (previously the Flood Resilience Measurement Tool) - developed in 2013 by the Zurich Flood

¹² See Twigger-Ross et al. (2015) for a review of community resilience frameworks.

¹³ These examples were identified on the basis that they: examine recovery; include measurable recovery targets, measures and indicators; are operational or have been piloted (conceptual or hypothetical recovery monitoring systems were not included); are in the geographic context of interest; cover or are potentially applicable to the types of weather event relevant to Scotland; and cover recovery of individuals, communities, infrastructure.

¹⁴ Henceforth this is referred to as the AIDR tool. See AIDR: <https://knowledge.aidr.org.au/me-recovery-outcomes-search/>; and ANZSOG (2018).

¹⁵ With the exception of 2017 when a review of the CWI was undertaken

¹⁶ The New Orleans Index originally built on The Katrina Index developed in 2005 by The Brookings Institution Metropolitan Policy Program (The Data Center, 2015).

Resilience Alliance and applied in over 110 communities in nine countries (Campbell et al., 2019; Keating et al., 2017)

- *emBRACE project Community Resilience Framework* - developed and applied by the EU emBRACE project (see Kruse et al., 2017 and Becker et al., 2015)
- *STAR FLOOD project* - developed by EU STAR FLOOD project and applied in six European countries (Belgium, England, France, the Netherlands, Sweden, and Poland) (see Hegger et al., 2016)
- *UK's Community Resilience Development Framework* - developed by the UK Cabinet Office in 2019, building on the earlier Community Resilience Framework for Practitioners (Cabinet Office, 2016)

These monitoring frameworks have a community focus for recovery, which sometimes also includes data on individuals, businesses etc. They have varying definitions of 'recovery', but all set objectives to measure the recovery against. Some cover all stages in the risk management cycle (planning, preparation, response and recovery), while others focus solely on recovery.

In the rest of the UK and Europe, we found recovery monitoring and evaluation systems embedded in wider resilience frameworks (e.g. the Zurich Flood Resilience Alliance's measurement tool and the emBRACE project's Community Resilience Framework).

In Australia, New Zealand and the United States, systems have been developed specifically for monitoring recovery. This has been fostered, in part, by the need for robust and cohesive recovery responses to significant large-scale disaster events such as Hurricane Katrina (USA) in 2005, and the Christchurch earthquake (New Zealand) in 2011.

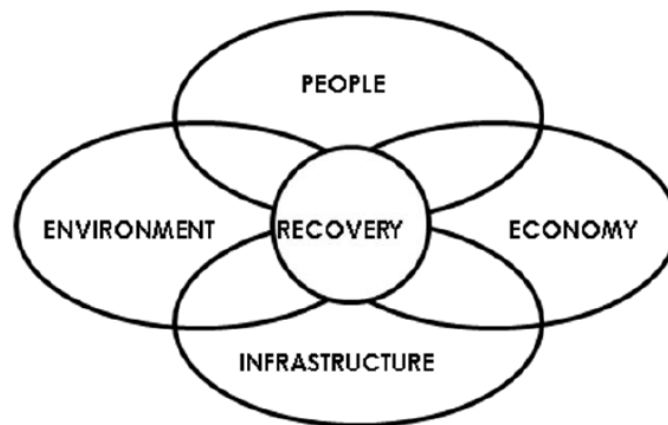
Appendix 1 has a summary description of the eight frameworks.

4 Applicability in the Scottish context

Applicability in Scotland depends on how well the frameworks fit with the governance and monitoring systems already in place, particularly in the community resilience and emergency response fields. This project looks at the extent to which the frameworks offer principles, systems and indicators that fit with the categories of impacts of emergencies to be addressed by the recovery process (Scottish Government, 2017) and with the monitoring and evaluation approach set out in the second Scottish Climate Change Adaptation Programme (SCCAP2)¹⁷.

Preparing Scotland's guidance on resilience (Scottish Government, 2019a) identifies recovery as one element of the Integrated Emergency Management system on which the development of resilience is based. Recovery is not just about repairing physical damage resulting from emergencies but is seen as covering four main areas of impact, as shown in Figure 2.

Figure 2: Framework for understanding the impact of emergencies (Scottish Government 2017, p.18)



The frameworks were evaluated on their fit with these recovery categories and on the following assessment criteria:

- Relevance to community outcomes for SCCAP2
- Relevance to the vulnerability outcome for SCCAP2 (this includes 'Changes in health and wellbeing')
- Inclusion of relevant process indicators
- Clearly identified responsibilities for data collection and monitoring
- Existence of an evaluation(s) of the performance of the system or set of indicators

Appendix 2 sets out the rationale for these assessment criteria.

The results of this assessment are summarised in Table 1.

¹⁷ The Communities Outcome includes the following five Sub-outcomes: Members of public engaged in recovery ('Engaged public'), Communities taking action on recovery ('Empowered communities'), Recovery of local infrastructure and services ('Resilient places'), Repair and restoration of local historic environment ('Resilient historic environment') and Repair and rehabilitation of buildings ('Resilient buildings').

Table 1: Summary assessment of relevance of 8 example recovery monitoring systems and/or sets of indicators

Recovery monitoring system or set of indicators (and geographic context)	Is it relevant to one or more SCCAP2 community outcomes or to health & wellbeing? (Y/N)	Does it include relevant process indicators? (Y/N)	Are roles and responsibilities for data collection and monitoring clearly set out? (Y/N)	Has the operation of the monitoring system / set of indicators been evaluated in terms of recovery?
emBRACE project Europe	YES - engaged public	Not clear what indicators (process and outcome) are used	This needs to be set out as part of recovery planning	Tested in country pilots but no full system described
STAR FLOOD project Europe	YES - engaged publics; empowered publics	Not clear what indicators (process and outcome) are used	NO - not clear how data is collected	NO
Cabinet Office UK	YES - empowered publics	Priority objectives of recovery and indicators need to be agreed as part of recovery planning	Not clear how roles and responsibilities for recovery relate to recovery monitoring	NO
ZFRA Flood Resilience Measurement for Communities (FRMC) tool 8 countries across several continents	YES - engaged public; empowered communities; resilient places; resilient buildings	YES - outcome and process indicators	YES - data collected by ZFRA partners working with members of community	YES - three evaluations (one in 2017 and two in 2018) leading to improvements in implementation

Recovery monitoring system or set of indicators (and geographic context)	Is it relevant to one or more SCCAP2 community outcomes or to health & wellbeing? (Y/N)	Does it include relevant process indicators? (Y/N)	Are roles and responsibilities for data collection and monitoring clearly set out? (Y/N)	Has the operation of the monitoring system / set of indicators been evaluated in terms of recovery?
Australian National Disaster Recovery Monitoring & Evaluation Database (AIDR tool) Australia	YES - engaged public; empowered communities; resilient places; resilient buildings, changes in health and wellbeing	YES – approx. 278 indicators include a mix of process and outcome indicators	YES – set out in Australian Institute for Disaster Resilience (AIDR) documents: <i>Community recovery checklist</i> (AIDR 2018) and <i>Emergency management arrangements</i> (AIDR 2019)	YES - reported in Australia and New Zealand School of Government (ANZSOG), 2018.
Canterbury Wellbeing Index (CWI) New Zealand	YES - engaged public; empowered communities; resilient places; resilient buildings, resilient historic environment changes in health and wellbeing	YES - 57 indicators include a mix of process and outcome indicators	YES – co-ordinated by Canterbury Earthquake Recovery Authority (CERA) (New Zealand. Canterbury Earthquake Recovery Act 2011; CERA, 2013)	YES - reported in CERA, 2014, and Canterbury District Health Board (CDHB), 2016
'Community Recovery Checklist' USA	YES - engaged public; empowered communities; resilient places; resilient buildings, changes in health and wellbeing	YES - 79 indicators include a mix of process and outcome indicators	Partially	YES - reported in Horney et al., 2016
New Orleans Index' USA	YES - engaged public; empowered communities; resilient places; resilient buildings, changes in health and wellbeing	YES - 32 indicators include a mix of process and outcome indicators	Not clearly set out	YES - reported in The Data Center, 2015

Note: highlighted rows indicate the three systems assessed as most relevant to Scotland.

Three systems scored highly across all the criteria:

- National Disaster Recovery Monitoring & Evaluation Database (and Framework) (AIDR tool)
- Canterbury Wellbeing Index (CWI)
- Flood Resilience Measurement for Communities (FRMC) tool

Each of the three example systems has been developed to meet different needs and in different geographical and institutional contexts. This contextual information is summarised below as it is important for understanding the systems:

- *Purpose:* Both the AIDR tool and the FRMC tool have an objective of encouraging wider use of the monitoring systems to improve recovery monitoring and practice. The purpose of the CWI focuses exclusively on monitoring long-term recovery from the Christchurch earthquake in Canterbury.
- *Scale:* All three of the systems can be used at the local community scale. However, the FRMC tool is design specifically for the community scale and some of the indicators would be difficult to scale up. The AIDR tool has a large number of indicators; it would potentially be possible to gather data on these at higher geographical or administrative levels, depending on data availability. The data for the CWI indicators are collected at different levels (individual, community, city, regional, national). It is not clear how feasible it would be to scale data up or down - this would need to be looked at for each indicator.
- *Roles and responsibilities for data collection and monitoring:* The three systems have clearly set out roles and responsibilities for data collection. The systems involve different stakeholders and give them different roles.
 - The AIDR tool is intended to be used by people working on recovery at a range of levels. The tool includes a knowledge hub to encourage the sharing of practice. It is not clear to what extent the AIDR can assure the quality of the monitoring and evaluation based on its templates and guidance, or the way that this is used to improve recovery processes.
 - The CWI draws on existing as well as specially commissioned data. It appears that this is collected by professional staff from agencies with technical expertise on the relevant topics.
 - The FRMC tool is used by staff from local offices of the ZFRA member organisations who work with local communities to develop indicators and are responsible for gathering the data. These members of staff participate in regular training and learning activities so that they can improve their own skills and contribute to improving the tool and its implementation.
- *Tools and guidance for users:* All three systems provide guidance and tools for users as well as a set of indicators and information on how to collect the data for them. However, it appears that the information about the indicators for the CWI is published to help users understand the evidence on which the Index is constructed, rather than to enable them to collect relevant data.

The three frameworks are described in detail in Appendix 3.

5 How is recovery measured?

The three example systems that scored highly across all the criteria (detailed above) include recovery-focused systems as well as systems that monitor recovery within a wider resilience framework:

- *National Disaster Recovery Monitoring & Evaluation Database (and Framework) (AIDR tool)*. The Database and Framework was published in 2018 and aims to provide a resource for people developing recovery monitoring programmes. The database includes approximately 278 indicators across 56 clusters. Outcome indicators are organised under the domains: economic, social, built, environment and a fifth, resilience and sustainability, for outcomes which overarch across the other domains. The AIDR tool promotes a 'pick and mix' approach to monitoring disaster recovery, which enables users to select tried and tested indicators which are seen as relevant to their own contexts and needs and cover a range of recovery situations. These include indicators of restoration of the community's resources and capacities, as well as indicators of adaptation to prepare for future climate change.
- *Canterbury Wellbeing Index (CWI)*. Developed by the Canterbury Earthquake Recovery Authority (CERA) in New Zealand in 2013, the CWI monitors wellbeing and resilience in the context of recovery from an earthquake. It has developed and refined a set of indicators of recovery which measure changes in conditions and capitals or resources over a long period of time after the earthquake event. It focuses on improvement rather than adaptation. The Index tracks recovery against 57 indicators, grouped into 10 domains. All indicators look at recovery with a focus on recovery of social and human capitals.
- *Flood Resilience Measurement for Communities (FRMC) (previously the Flood Resilience Measurement Tool)* - developed in 2013 by the Zurich Flood Resilience Alliance and applied in over 110 communities in nine countries (Campbell et al., 2019; Keating et al., 2017). The FRMC measures community resilience to flooding; recovery is one aspect of resilience. The tool measures changes over time in communities' underlying capitals or resources. It uses 44 sources of resilience indicators which look at how well the community can cope with and recover from flood events when they occur. The tool also includes 29 indicators of post-event outcomes. The focus is on building resilience through strengthening capacities and also developing understanding of climate risks and impacts to adapt to future climate change.

The AIDR tool and CWI specifically focus on recovery from disasters. The AIDR tool includes a range of natural disaster events at different scales (local to regional), including flooding and severe storms, with relevant indicators to be applied on a case-by-case basis. The CWI focuses on measuring recovery from earthquakes which may differ from extreme weather events in Scotland in terms of their scale and types of impact. The CWI is however still relevant as the index and the indicators used are not event specific. The FRMC is aimed at supporting community resilience to flooding. It covers preparing for, responding to, and recovering from floods. Although it has been applied in the US, it has mainly been tested in developing countries, and the evidence about its use relates to these countries. Some of the indicators may not be directly applicable to a Scottish context.

There are similarities across the three systems in the underlying factors identified as contributing to resilience or wellbeing and recovery. We have looked at the resilience / wellbeing factors identified in the AIDR tool and CWI systems in relation to the FRMC tool's

'capitals' or capacities for resilience: social, human, physical, and economic/financial^{18,19}. These come from the Sustainable Livelihoods Framework (DFID, 2011) which is well-established in development and sustainability literature.

The capitals approach has recently been used to review the impact of CV19 on Scottish economy (Scottish Government, 2020). The authors argue that it 'enables us to take a holistic view of our national balance sheet in a progressive manner that is entirely consistent with the barometer that is the National Performance Framework.' (Scottish Government, 2020:2). The report combines physical and economic capital into one, whereas here we have considered them to be separate capitals.

Table 2 shows the underlying factors of resilience used in each system (relevant to recovery) and how these relate to four of the capitals adopted by the FRMC tool. (Further details on each system and examples of indicators are presented in the case studies in Appendix 3).

Table 2: Dimensions of recovery in the three example recovery monitoring systems and how these relate to the four capitals

FRMC ²⁰	CWI	AIDR	Notes
Social capital expressed as trust, reciprocity, collective action, information sharing, and participation. Includes community safety. Themes: <i>Social norms, Governance</i>	Social capital Civic engagement	Social domain Resilience and sustainability	For AIDR, relevant elements of <i>Social domain</i> include ability to manage needs, support others, knowledge etc. Relevant elements of <i>Resilience and sustainability</i> include civil society engagement.
Human capital expressed as creativity, health, social skills, education, leadership skills, and memories. Themes: <i>Life and health, Governance, Livelihoods</i>	Education Wellbeing Health Safety	Social domain	For FRMC <i>Governance</i> includes learning from events and <i>Livelihoods</i> includes education For CWI, <i>Safety</i> includes physical and emotional safety. <i>Education</i> includes young people not in education, employment or training and is relevant to skills, creativity and mental health. For AIDR, <i>Social domain</i> includes health needs, education, safety, access to appropriate income structures, food, drinking water, not experiencing stress or hardship etc.
Financial capital including income, savings, remittances, investments, safety nets, loans or the ability to use assets to get loans. Themes for Financial capital are: <i>Assets and Livelihoods</i>	Income Housing Employment	Economic domain Resilience and Sustainability	For FRMC <i>Housing</i> can be an asset, and <i>Livelihoods</i> includes income stability, insurance payments etc. For CWI, <i>Housing</i> includes the impact of housing costs on household income. For AIDR, <i>Economic domain</i> , includes financial and banking, business, not-for-profit services,

¹⁸ FRMC use financial capital, however, we use this more broadly to include economic and financial capital.

¹⁹ FRMC includes a fifth capital, natural capital, which was considered to be outside the scope of the current research, hence we do not expressly comment on how this features in, or is factored into the example frameworks.

²⁰ FRMC has two types of indicators: sources of resilience (measured pre-event and ongoing) based on the five capitals and resilience outcomes (measured during and after a flood event) which can be grouped by seven themes.

FRMC ²⁰	CWI	AIDR	Notes
			business insurance, community access to financial workforce skills. <i>Resilience and sustainability</i> include community access to insurance
Physical capital expressed in infrastructure, equipment, improvements in crops, and livestock. Themes for Physical capital are: <i>Assets, Lifelines/supporting structures</i>	Safety Housing Environment	Built domain Environmental domain Resilience and sustainability	For CWI, <i>Safety</i> includes physical safety which is relevant to physical capital. <i>Environment</i> includes Built environment (e.g. community facilities, roads, railway tracks, etc) For AIDR, <i>Environmental domain</i> includes restoration of cultural heritage

5.1 Social capital

Social capital is expressed as the ‘*social relationships and networks, bonds that promote cooperation, links facilitating exchange of and access to ideas and resources*’ (ZFRA, 2019a, p2). People’s connections to their communities are important, particularly in recovery after disaster (CDHB, 2016). Social capital is known to increase in the immediate aftermath of an extreme event or disaster but can deplete entirely over the period of recovery. For example: ‘*Communities themselves may be resistant to how their communities are being rebuilt if solutions are imposed on them without listening to the communities themselves*’ (Baxter, 2020, p.1).

We have selected relevant elements of social capital from the international recovery monitoring systems reviewed. Table 3 lists these elements and shows selected indicators or outcomes from the international case studies.

Table 3: Key elements of social capital for recovery from extreme weather events

Element of social capital	Selected relevant international indicators or outcomes
Reciprocity, supporting others (FRMC, AIDR, CWI)	Mutual support (CWI); having someone to turn to for support outside the household (AIDR) Contact with family and friends providing social support, connection and help (CWI) Having social networks (AIDR)
Community identity (CWI)	Having a sense of community / Having a sense of belonging and acceptance (CWI) Trust in others (CWI)
Participation, governance, civic engagement, civil society engagement (FRMC, AIDR, CWI)	Community participation in flood related activities (FRMC) Participation in volunteer activities (AIDR) Participation in public decision making (e.g. voter turnout) (CWI) Ability to influence decision-making (CWI) <i>Process:</i> Community representative bodies (FRMC) Community awareness of disaster recovery processes and ability to express recovery needs (AIDR) Is the community learning from the flood and putting lessons into practice? (FRMC)

Campbell et al. (2019) comment that *'the relatively high number of social capital sources is due to the fact that social capital tends to be less tangible and therefore more indicators are needed to help proxy the measurement and also because social capital also includes aspects of governance or what might be termed 'political capital' (p4).*

5.2 Human capital

Human capital encompasses the knowledge, education, skills, health of the people in the community, including aspects such as creativity, social skills, leadership skills, and memories (ZFRA, 2019a). For example, for rural communities, food security during and after flood events can be significant issues (Laurien et al. 2019). Importance is also placed on considering different groups such as those more vulnerable, *'Moreover, greater emphasis is needed on designing interventions for poor and struggling rural communities with very low coping capacity.'*⁵ (Laurien et al. in review, cited in Laurien et al. 2019, p8).

Table 4 lists the most important types of human capital for recovery from extreme weather events and gives examples of international indicators or outcomes.

Table 4: Relevant types of human capital for recovery from extreme weather events and selected international indicators

Types of human capital	Selected relevant international indicators or outcomes
Health	Continuity of healthcare (FRMC, AIDR) Self-reported health (CWI) Community members experiencing mental health stress or hardship (AIDR, CWI) <i>Process</i> Access to mental health counselling (AIDR) and services (CWI) Community members have the knowledge, skills, and resources for dealing with health issues related to the disaster (AIDR)
Education	Continuity of education (FRMC) School drop-out rates due to impacts of event (FRMC)

Morgan et al (2015) explain the importance given to self-reported health indicators in the CWI: *"During the process of developing the Index it became evident that self-reported wellbeing data formed a large gap in the available datasets. Available recovery literature confirmed that gathering such data is necessary in order to monitor the social progress of recovery."* (Morgan et al, 2015, p.99). Milosevic et al (2017, p,1) note that: *"In the UK for many years studies of the health impacts of flooding have mainly drawn on self-reported evidence"*.

Health inequalities are not addressed in depth in any of the three frameworks reviewed. The focus of all three frameworks is on vulnerability rather than inequality:

- One of the FRMC's four objectives is to: "Measurably enhance flood resilience in vulnerable communities" (Zurich Flood Resilience Alliance, 2018, p.15).
- CWI measures changes in vulnerability over time: as a long-term study it differentiates between pre-existing vulnerability and new vulnerable populations but does not refer to inequalities.
- AIDR's intended outcomes include ensuring that the needs of vulnerable groups are addressed in disaster recovery (ANSZOG, 2018, p12).

5.3 Economic/financial capital

Economic/financial capital encompasses the ‘*level, variability and diversity of income sources and access to other financial resources that contribute to wealth*’ (ZFRA, 2019a). This includes income, savings, remittances, investments, safety nets, loans or the ability to use assets to get loans. The importance of economic/financial capital to recovery is widely recognised: ‘*From self-reports of past post-flood financial recovery time, we can show that the sources of resilience most highly associated with faster financial recovery are in the financial and physical capital categories. After a flood, having a household income continuity strategy was particularly important for recovery.*’ (p8) (Campbell et al. 2019 cited in Laurien et al. 2019).

Table 5 lists the key types of economic/financial capital for recovery from extreme weather events and gives examples of international indicators or outcomes.

Table 5: Relevant economic/financial capital for recovery from extreme weather events and selected international indicators

Economic/financial capital	Selected relevant international indicators or outcomes
Household income	Household income levels (CWI) and stability (FRMC) Satisfaction with how households are managing financially (CWI) <i>Process</i> Having a household income continuity strategy Access to credit (FRMC)
Sources of recovery funding	Households with adequate insurance (FRMC/AIDR) People awarded grants to undertake resilience-building repairs to homes (AIDR) Community satisfaction with financial support received (AIDR) <i>Process</i> Community Disaster Fund (FRMC)
Business continuity	Businesses remaining in operation (FRMC, AIDR) <i>Process</i> Organisations with continuity plans and resilience plans (AIDR)
Employment	Employment, unemployment and underemployment rates (CWI) Labour force participation and job satisfaction (CWI)

5.4 Physical capital

Physical capital includes infrastructure (transport, roads, vehicles, secure shelter and buildings, water supply and sanitation, energy, communications), tools and technology (tools and equipment for production, seed, fertiliser, pesticides, traditional technology) (ZFRA, 2019a).

Table 6 presents important types of physical capital for recovery from extreme weather events and gives examples of international indicators or outcomes.

Table 6: Physical capital relevant to recovery from extreme weather events and selected international indicators

Physical capital	Selected relevant international indicators or outcomes
Private buildings and land	Damaged residential/commercial/industrial assets rebuilt (AIDR) Time taken for residents to return to homes Time taken to repair damage to private buildings (FRMC)
Public buildings and land	Damaged public/essential service type assets rebuilt and operating (AIDR) Time taken to repair and restore education / health infrastructure (FRMC)
Infrastructure services	Transportation performance (FRMC) e.g. proportion of affected roads/bridges/ferry terminals/services that have reopened (AIDR), Continuity of energy and fuel supply (FRMC) e.g. proportion of the affected electricity network restored to service (AIDR) Customers without telecommunications as identified by the relevant utility provider (AIDR) Time taken to repair and restore communications (FRMC) Time taken to repair and restore water supply (FRMC) Proportion of water supply schemes operating to regulatory standards (AIDR)
Resilient repair of private building	Amount of funds paid to support resilient repair of homes and business premises (AIDR) <i>Process</i> Funding available to support resilient repair to buildings (AIDR)

A full description of the indicators or outcomes under each of the capitals is provided in Appendix 4.

5.5 Fit with Preparing Scotland's guidance on recovering from emergencies

The Scottish Government's document 'Preparing Scotland: Recovering from emergencies in Scotland' (2017) describes the impact of emergencies under four categories:

- People
- Economy
- Infrastructure
- Environment

These four categories are not exactly the same as the four capitals identified from the analysis of the three international systems. This is because 1) the Scottish category of 'People' covers both the social and human capitals; and 2) the categories include 'Environment' which is the fifth of the capitals included in the capitals approach (DFID, 2011) but which we have not looked at in this study, as explained in the Method section (Section 2).

Using the table of examples of categories of emergency impact from the Preparing Scotland guidance on recovery (2017), there is a clear fit with the capitals approach.

Table 7: Relationship between the Preparing Scotland categories of impact of emergencies and the capitals approach

Preparing Scotland categories of impact	Examples of impacts	Capitals approach
People	Individual health Psychological impacts (personal and community) Deaths	Human capital
	Community displacement Community cohesion	Social capital
Economy	Economic and business impacts Employment	Economic capital
Infrastructure	Disruption to daily life (e.g. educational establishments, welfare services, transport system) Disruption to utilities/ essential services Damage to residential, industrial and public property and security of buildings	Physical capital
NOT INCLUDED IN THIS RESEARCH		
Environmental	Pollution and decontamination Waste Natural resources and habitats	Environment (Natural capital)

6 Identification of relevant Scottish data sets

We reviewed key Scottish datasets to see whether they could provide data variables of relevance to the indicators set out in the three recovery systems.

The datasets reviewed included the Scottish Household Survey; Scottish Health Survey; and Scottish Transport Statistics. We also found references to relevant data variables from sources on the Scottish Government statistics website²¹.

The review process involved two steps:

- an initial review of dataset content and themes to assess relevance; and
- for datasets deemed relevant, a more detailed review to identify specific data variables including, frequency of collection, geographic scale and accessibility (i.e. publicly available or not).

Table 8 provides a summary of the Scottish datasets of relevance to measuring recovery from extreme weather events, and the recovery capitals they relate to, with examples of indicators that are the same as or could be used as proxies for the international recovery indicators.

The Scottish Household Survey provides a good source of variables for each of the four capitals, including social capital and aspects such as social inclusiveness, belonging, trust. Both the Scottish Household Survey and the Scottish Health Survey provide a good source of data on community and health variables. The Scottish House Condition Survey provides useful variables for measuring both financial and physical capital. The Annual Business Survey also

²¹ <https://statistics.gov.scot/home>

provides a number of variables related to economic/financial capital. Human capital seems to be well covered with various data sources including National Records of Scotland, Scottish Exchange of Education Data (ScotXed), NHS Information Services Division/Public Health Scotland²² and the Scottish Index of Multiple Deprivation.

It was difficult to tell from the review of the datasets whether the existing data available for Scotland is of high enough geographic resolution or collected frequently enough to be relied upon for comprehensively measuring recovery from individual extreme weather events. Data covering an area that is wider than the area affected by the event or collected a long time after the event may make it difficult to attribute changes (or no changes) in indicators to recovery from an event itself rather than to other factors. However, it may be possible to use these datasets as a baseline to assess recovery against. This would need to be explored further.

Some important factors in recovery are not covered by the publicly held data sources or would benefit from additional data. For example, confidential business data may exist on aspects of physical capital recovery such as performance of utilities (e.g. energy supply) and other critical services (e.g. tele-communications). The insurance sector holds historical data on aspects of economic/financial capital recovery, for example, flood claims data. Insurance companies use their data to develop flood models. This information is not currently publicly available in the UK. Where local post-event surveys are carried out, these may provide valuable data²³.

Involving communities in their own recovery from emergencies, as recommended by the Preparing Scotland guidance (Scottish Government, 2019a) will mean ensuring that indicators of recovery are relevant to them. The Scottish Government funded the development of a 'Community Resilience Toolkit'²⁴ to help communities evaluate their resilience. The toolkit proposes that members of the community (for example, community resilience groups) should identify indicators of resilience for their own area and collect evidence for those indicators. The indicators used in developing the toolkit were:

- How a community responds to an emergency
- Using local knowledge and strengths
- Working together to help each other out
- Community spirit

The evidence can be quite simple and quick to collect, for example by using de-briefs held after activities, photos or statements collected from social media. If it were collected regularly, this evidence would provide a baseline measure of local social capital before an extreme weather event. Community members could use the same indicators to monitor and provide evidence of the recovery of social capital over time.

As this evidence is not currently collected in a systematic way, we have not included it as a dataset in Table 8.

²² NHS Information Services Division became part of Public Health Scotland, a new agency, in April 2020.

²³ Cabinet Office non-statutory guidance on Emergency Response and Recovery (5th Edition, 2013) advises that recovery should be based on an impact assessment of local needs (section 5.1.17). A review of recovery processes in Cumbria, following extensive severe flooding in 2015-16, describes the impacts covered by the assessment (damage to housing, farms, businesses, transport infrastructure, community infrastructure (e.g. schools) and public buildings and amenities (e.g. parks). The assessment also looked at the consequences of these impacts for individuals and communities (Deeming, 2018). Personal communications to the project team suggest that this kind of detailed impact assessment is not regularly carried out to inform recovery.

²⁴ https://evaluationsupportscotland.org.uk/wp-content/uploads/2020/08/comm_res_challenge_3.pdf

Table 8: Scottish datasets of relevance to measuring recovery from extreme weather events and example indicators

Data source	Relevant to capitals	Examples of relevant indicators
Scottish Household Survey	Social capital	<p>Social support: 'In an emergency, such as a flood, <i>I would offer to help people in my neighbourhood who might not be able to cope well</i>', <i>I feel I could turn to someone in this neighbourhood for advice or support</i>'</p> <p>Community belonging: how strongly adults feel they belong to their immediate neighbourhood</p> <p>Social isolation and loneliness: percentage of adults who report feeling lonely '<i>some, most, almost all or all of the time</i>'; <i>How often did you meet socially with friends, family, neighbours or work colleagues in the past week?</i></p> <p>Perceptions of neighbourhoods as places where e.g. most people can be trusted, people can meet up and socialise, local people take action to help improve the neighbourhood</p> <p>Volunteer activities: Giving up time (over last 12 months) to help groups, clubs or organisations in an unpaid capacity e.g. local community or neighbourhood, <i>I can influence decisions affecting my local area</i></p> <p>Safety: feeling safe walking alone at night or at home alone</p> <p>Trust in authorities²⁵ e.g. <i>My local council designs its services around the needs of the people who use them, my local council is addressing the key issues affecting the quality of life in my local neighbourhood, my council is good at listening to local people's views before it takes decisions</i></p>
	Human capital	<p>Educational qualifications (e.g. levels of achievement) and employment (e.g. employment/ unemployment rates, occupation etc.)</p> <p>Satisfaction with local health services and schools</p>
	Economic/financial capital	<p>Household income and employment levels</p> <p>How well a household is managing financially: whether the household has enough money to save regularly and can access funds for unexpected, but necessary, expenses; whether household has home contents insurance</p> <p>Households in receipt of Crisis Grant from Scottish Welfare Fund in last 12 months</p> <p>Affordable housing: how much does your household pay each month in mortgage payments, excluding any contents or buildings insurance or mortgage protection? How much is the total rent for your</p>

²⁵ The Scottish Household Survey also include questions about trust in Scottish Government e.g. How much do you trust the Scottish Government to work in Scotland's best interests?

Data source	Relevant to capitals	Examples of relevant indicators
		household's accommodation? In the last 12 months, have you had any difficulties in paying your mortgage/rent?
	Physical capital	Satisfaction with local services: public transport, schools, health services, council libraries, council museums and galleries, council sport and leisure facilities, maintenance of road etc.
Scottish Health Survey	Human capital	Various indicators of population health including general health, mental wellbeing based on Warwick-Edinburgh Mental Wellbeing Scale (WEMWBS), self-assessed health, physical activity Food insecurity e.g. have people worried about running out of food, eaten less than they should have, or had actually run out of food in the last 12 months Current smokers and obesity count
Data and Intelligence (Public Health Scotland)	Human capital	Hospital admission statistics Quarterly statistics on inpatient and day case activity; outpatient activity; and beds statistics. This includes activity by age/sex, Scottish Index of Multiple Deprivation, by Health Board, council area and hospital. GP practice prescribing activity – monthly statistics. Pharmacy-level dispensing activities – quarterly statistics. Other local health data information may be available, e.g. prescribing data, health service use. Use of these would need to be explored with relevant NHS and Public Health Scotland (PHS) stakeholders.
Scottish House Condition Survey	Economic/financial capital	Difficulties in paying mortgage/rent
	Physical capital	Various housing condition satisfaction indicators: is the dwelling structurally stable? Is the dwelling substantially free from rising or penetrating damp? Has the dwelling an effective system for the drainage and disposal of foul and surface water? Is the dwelling satisfactorily insulated? Proportion of households with disrepairs to their dwelling
Scottish Transport Statistics	Physical capital	Passenger journeys (a) on local bus services (b) by region for local bus services Road network condition and average daily traffic flows Rail punctuality (public performance measures), and passenger satisfaction survey
Scottish Exchange of Education Data (ScotXed)	Human capital	School attendance, absence and exclusion rates, achievement of curriculum levels, early learning & childcare - number of children requiring support because of interrupted learning
	Physical capital	Local authority schools' condition, suitability and capacity
Scottish Index of Multiple Deprivation	Human capital	Access to healthcare (mean travel time)
	Economic/financial capital	Income indicators and number of people who are employment deprived

Data source	Relevant to capitals	Examples of relevant indicators
	Physical capital	Number of people in households that are overcrowded Transport infrastructure (mean travel time to key services)
National Records of Scotland e.g. population records, pupil census etc.	Human capital	Numbers of deaths registered by cause. Young people Not in Employment, Education or Training, school attendance rates, school leavers count Local population and electoral statistics e.g. voter turnout
Annual Business Survey (Business, Enterprise and Energy)	Economic/financial capital	Financial and employment data by broad industry by year Number of business units, registrations etc.
Drinking water quality regulator (DWQR) for Scotland Annual Report	Physical capital	Annual data on water quality in public and private supplies across Scotland including water quality events and incidents and other reports
Recorded Crimes and Offences	Social capital	Number of crimes and offences

7 Measuring recovery from extreme weather events in Scotland

In this section we use the findings from the preceding sections as building blocks to suggest indicators for measuring recovery from extreme weather events in Scotland and discuss options for how they may be applied.

7.1 How does the capitals approach fit with SCCAP2?

The SCCAP2 outcomes of relevance to recovery from extreme weather events can be broadly linked to the capitals approach. Table 9 lists the four relevant SCCAP2 outcomes and sub-outcomes and the capitals these link to. These can be broadly described as follows – though there is an overlap:

- *Outcome 1: Communities* (*‘Our communities are inclusive, empowered, resilient and safe in response to the changing climate.’*) This outcome includes the ‘social aspects of community’ including ‘the ways in which communities can be equipped with the knowledge and tools’ to become informed, engaged and empowered (Scottish Government, 2019, p10). This relates closely to **social capital** which includes information sharing, collective action and participation and **human capital** which encompasses the knowledge, education, and skills (including leadership skills) of people in the community (ZFRA, 2019a). The outcome also focuses on the ‘physical aspects of community, including the built and historic environment, and all the spaces in between’ (Scottish Government, 2019, p10), including resilient residential and non-residential properties and places which links to **physical capital** (e.g. buildings and shelter).
- *Outcome 2: Climate justice* (*‘The people in Scotland who are most vulnerable to climate change are able to adapt and climate justice is embedded in climate change adaptation policy.’*) This outcome promotes the concept of climate justice, that those most vulnerable should be engaged and empowered. This again draws on **human** (and social) **capital** for similar reasons to Outcome 1 but with emphasis on those vulnerable within society. The outcome also focuses on health and social care which relate to human capital in terms of the health of people in the community, for example, recovery of emotional safety is relevant to mental health; and to **physical capital** related to health and social care infrastructure, for example, recovery of buildings such as GP premises.
- *Outcome 3: Economy* (*‘Our inclusive and sustainable economy is flexible, adaptable and responsive to the changing climate.’*). The natural resources component of the economy is outside of the scope of this research) covers the contribution of business and industry to the economy, and in particular the importance of capital, labour and supply chains and distribution networks to Scotland’s manufacturing services and wider economy, and innovation. This draws on **economic/financial** resources (e.g. capital, loans, funds).
- *Outcome 4: Support systems*. (*‘Our society’s supporting systems are resilient to climate change’*) encompasses the infrastructure that delivers essential services or lifelines to communities and businesses across Scotland through for example, supply of energy, water, communications, road and rail, emergency services and government. This outcome ties in with the concept of **physical capital**, which includes health and social care infrastructure though these are mainly covered in Outcome 2.

Table 9: Summary of the links between relevant SCCAP2 outcomes and the capitals approach

SCCAP2 relevant outcomes and sub-outcomes	Capitals
<p>Outcome 1: Communities</p> <p>People in Scotland's diverse communities are informed, empowered and adapting to climate change</p> <p>Scotland's buildings and places are adaptable to climate change</p>	<p>Social</p> <p>Physical</p>
<p>Outcome 2: Vulnerable people</p> <p>The most vulnerable are engaged, empowered and able to adapt to climate change</p> <p>Health and social care is ready and responding to changing demands as a result of the changing climate</p>	<p>Human</p> <p>Physical – health infrastructure</p> <p>Social</p>
<p>Outcome 3: Economy</p> <p>Scotland's manufacturing, services and wider economy are informed and adaptable to climate change</p> <p>Scotland's economy is innovative and harnesses the opportunities created as a result of climate change</p>	<p>Economic/financial</p>
<p>Outcome 4: Support systems</p> <p>Scotland's support systems are resilient to climate change</p>	<p>Physical</p>

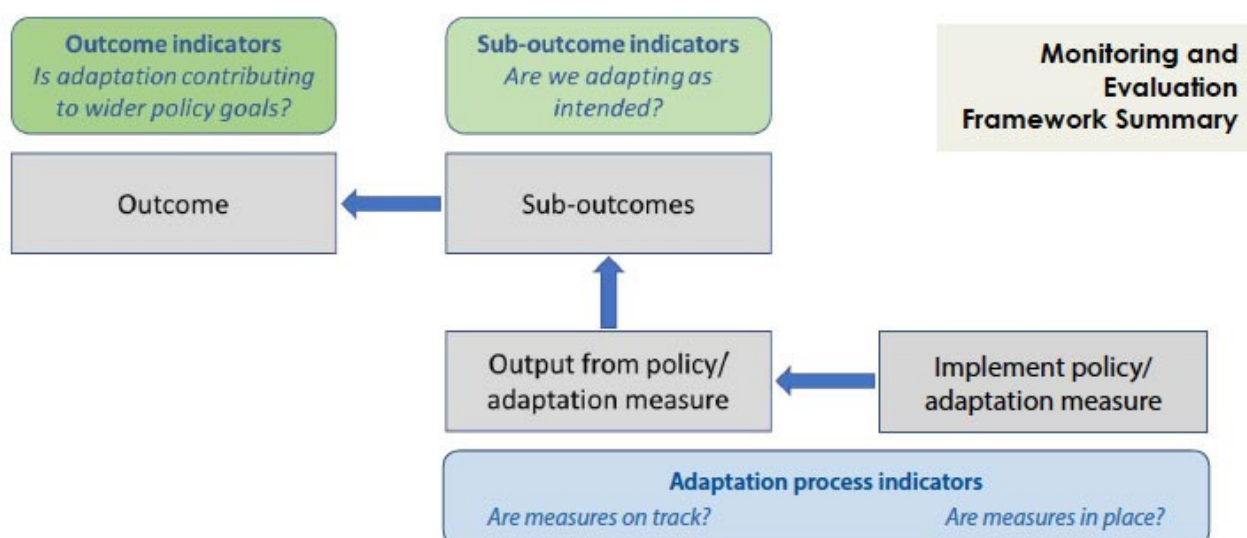
Note: capitals in bold indicates the main capital of relevance

7.2 Types of indicators

A recovery monitoring system that includes both process and outcome indicators is likely to be most valuable and relevant to Scotland's wider performance frameworks.

The SCCAP2 monitoring and evaluation framework uses process indicators as well as outcome indicators, as shown in Figure 3. **Process** indicators look at the measures being taken to make progress towards the desired outcome: they are used to assess what is being done and whether this is being adequately implemented (Scottish Government, 2019, p26). Process indicators are valuable for monitoring the direction of change over time. **Outcome** indicators are used to assess the contribution towards wider government goals and to show if the actions taken are working.

Figure 3: Summary of SCCAP2 monitoring and evaluation framework (Scottish Government, 2019, p.26)



All three international recovery monitoring systems include both process and outcome indicators. Relevant **process** indicators for measuring recovery from extreme weather events in Scotland may include, for example, having social networks to help support and coordinate community recovery (social capital), access to health services (human capital), availability of funding, insurance cover and access to credit to support recovery of homes and business (all economic/financial capital). Changes in these indicators reflect whether and how - well these processes have worked and encourage those involved to ask whether anything could be improved. Relevant **outcome** indicators may include, for example, self-reported health (human capital), community satisfaction with financial support received (economic/financial capital), and the time taken to repair damages to buildings (physical capital).

7.3 Scale and frequency of data collection

Recovery from extreme weather events is a multifaceted process, it *'is more than a simple remedial activity, replacing what has been destroyed, or recuperation for those affected. It is a complex social and developmental process'* (Preparing Scotland, 2017, p.5).

As shown in section 6, Scotland has a range of public datasets that provide information relevant to recovery from extreme weather events. Comprehensive and effective measurement requires data with national coverage (as events may happen in different places) which is available at a local (spatial) resolution. This may draw upon data which is collected through national mechanisms (such as the Scottish Household Survey; see section 6) and which can be disaggregated to at least the local authority level (or the local Health Board level in the case of health statistics). Where possible, more granular data about specific communities would also be valuable, for example, whether or not a community has a recovery plan in place, in order to understand the resources available, the recovery measures taken and their outcomes.

To both measure and understand recovery from a specific weather event it is helpful to have data on indicators prior to and after the event. For example, FRMC collects community-level data every two years which means that there is always a relatively up-to-date baseline describing the condition of the capitals (note that these are also sources of resilience). The FRMC approach then collects data after the event to understand the impacts and the factors which influence recovery and resilience outcomes (ZFRA, 2019b). FRMC suggests that most of the data about the impact of the flood event can be collected within one to two months after the flood when the recovery phase is usually underway (ZFRA, 2019b). This information can be

used to monitor how quickly and effectively the community returns to pre-flood conditions (bounce-back) and how far the recovery process results in an increase in community capital and the capacity to recover more quickly from a future event (bounce-back better / adaptation).

Providing data at the right geographical scale and frequency for monitoring some aspects of recovery is likely to be a challenge in Scotland. For example, while the Scottish Health Survey has been designed to provide national results annually, Health Board level data is provided every four years. National level data is at too high a scale to pick up local differences in impacts and response which are central to understanding to what extent and how health recovers from extreme weather events. Data sets at the Health Board scale offer a more appropriate level of resolution but the four-year gap between each round of collection means the data is often too old to provide a robust baseline of health conditions at the time of an extreme weather event and if it is up to date, the next round of data collection may happen too long after the event to be able to see what changes happened as part of the recovery process.

However, given the complexity of the recovery process, for some indicators measuring recovery is likely to require longer-term monitoring and/or may be understood through asking affected individuals about their perceptions towards the expected timescale for recovery (see ZFRA, 2019b). For example, while transport services may be relatively quick to recover from a flood or storm (e.g. within one month depending on the extent and severity of damage), repairs to damaged homes or recovery of mental health may take far longer (e.g. 12 months or longer). Differences in the recovery time frames for the underlying factors of wellbeing should be taken into account to ensure each indicator is monitored over an appropriate time horizon.

As well as measuring recovery in relation to specific weather events, it can be helpful to track progress over longer time frames, in particular, to help monitor how recovery from extreme weather events is contributing to 'building back better' to improve capacity to respond to future events, or reflecting measures to adapt to climate change. For example, the CWI has been looking at recovery over an eight-year period and FRMC suggests periodic assessments every one or two years to assess whether resilience has changed (ZFRA, 2020b).

7.4 Proposed indicators for measuring recovery from extreme weather events in Scotland

Table 10 presents a set of indicators of recovery which could form the basis of a system for monitoring recovery from extreme weather events in Scotland. This builds on learning from international experience of measuring recovery and takes account of the characteristics of extreme weather events in Scotland.

Where Scottish data sources have been identified these may not currently be collected at a level and at intervals that would suit different recovery scenarios. The list includes process and outcome indicators.

An important gap in the indicator set proposed is the absence of indicators of recovery from extremes of cold and heat, and from drought. The international recovery monitoring systems reviewed in this study focused on events that cause breakdown across individual, social, economic, physical and environmental systems²⁶. Typically, these were flood, storms and bushfires (e.g. events that can cause widespread and prolonged impacts). We did not find any practical examples of monitoring recovery from temperature-related extreme events (e.g. extreme cold or heat) or from drought events. This may be because these 'events' are often experienced as stressors, characterised by a period of response or coping rather than setting in motion a process of recovery.

While Scotland has experienced maximum temperatures well above the norm in recent years, these are not high enough to represent emergencies. By the middle of this century, hot summers are likely to become common (Scottish Government, SCCAP2, 2019, p17) and it is possible that these or prolonged periods of drought might have severe impacts in certain places such as major cities, or on economic activities such as agriculture or construction. We found little discussion of recovery from extreme heat or drought in the international literature and have not included indicators for recovery from these extreme weather events. However, their inclusion may become more relevant in the future.

Given the gaps identified and specific needs in Scotland, in each community, the indicators should be considered a framework for developing relevant local measures based on variables like population profile and weather event characteristics.

Table 10: Indicators for measuring recovery from extreme weather events in Scotland by capital

Capital	Indicator	Scottish data available (Y/N/Proxy)	Notes on Scottish data sources
Social (9)	Voter turnout in local government elections/general elections (CWI). Outcome indicator. Data required for each election event (local, national, UK Parliament elections).	Proxy	National Records of Scotland: Local population and voter registration statistics. Annual. Available by regional, constituency, council area and ward.
	Participation in volunteer activities (e.g. frequency, type, etc.) (AIDR) (Process and outcome indicator). Outcome data required for before the extreme weather event, immediately after and up to two years after. Process data required during recovery.	Y	Scottish Household Survey data on 'giving up time to help groups, clubs or organisations in an unpaid capacity' e.g. local community or neighbourhood. Available on a two-year basis. Available nationally and by local authority, although the small sample sizes for each local authority mean there can be large variability in SHS volunteering data year-on-year.
	Community participation in extreme weather recovery activities (FRMC) (Process and outcome indicator). Outcome data required for before the extreme weather event, immediately after and up to two years after. Process data required during recovery.	N	Data may potentially be available through Scottish Flood Forum.
	Ability to influence decision-making (e.g. proportion agreeing or strongly agreeing they are able to have enough say in what central and local government agencies do) (CWI)) Data required for before the extreme weather event, immediately after and up to two years after.	Y	Scottish Household Survey data on proportion agreeing or strongly agreeing 'I can influence decisions affecting my local area'. Annual. Available at the national level and by local authority.
	Trust in authorities (e.g. proportion agreeing or strongly agreeing that central and local government agency decisions are in the best interests of their city or district) (CWI)Data required for before the extreme weather event, immediately after and up to two years after..	Y	Scottish Household Survey data on trust in authorities e.g. proportion agreeing or strongly agreeing with 'My local council designs its services around the needs of the people who use them'. Annual. Available at the national level and by local authority.
	Community learning from flood (FRMC) / extreme weather events	N	If no proxies can be found, it would be worth considering collecting this additional data

Capital	Indicator	Scottish data available (Y/N/Proxy)	Notes on Scottish data sources
	Data required for before the extreme weather event, immediately after and up to two years after.		
	People who have regular contact with family or friends living outside the household (AIDR) Data required for before the extreme weather event and up to two years after.	Y	Scottish Household Survey 2018 question on social contact ('How often did you meet socially with friends, family, neighbours or work colleagues in the past week?') matches the international indicator. Annual. Available at the national level and by local authority. A second alternative is the SHS survey question on the percentage of adults who report feeling lonely 'some, most, almost all or all of the time' in the last week. This also links to the NPF indicator: 'Loneliness is an indicator in the National Performance Framework. [...] Loneliness is a subjective feeling experienced when there is a difference between the social relationships we would like to have and those we have.' (SHS, 2019, p.105). Annual. Available at the national level and by local authority.
	Community belonging: extent to which people feel a sense of community with others in the neighbourhood (AIDR). Data required for before the extreme weather event and up to two years after.	Y	Scottish Household Survey data on how strongly adults feel they belong to their immediate neighbourhood. Annual. Available at the national level and by local authority.
	Mutual support: how community members support each other during and following the flood (e.g. whether formal and informal networks in the community help support people, and if all groups in the community are part of networks) (FRMC) (Process and outcome indicator) Data required for before the extreme weather event, immediately after and up to two years after.	Proxy	Scottish Household Survey question on involvement with other people living in the neighbourhood following an extreme weather event: 'I feel I could turn to someone in this neighbourhood for advice or support' Annual. Available at the national level and by local authority. Note that the FRMC measure is multi-faceted, it is not a single measure. The SHS indicator is a single measure. Collecting qualitative data on different aspects of this question could be a means of supplementing the SHS data.
Human (5)	Self-rated health (CWI) ²⁷	Y	Scottish Health Survey: Self-assessed health

²⁷ Milosevic et al (2017) suggest that there is a lack of clinical data in the UK on mental health after flood events. Their study found that prescription records for drugs used in the management of common mental disorder among primary care practices located in the vicinity of recent large flood events in England, 2011–2014 showed an increase in prescribed antidepressant drugs in the year after flooding in primary care practices close to major floods, although the study was not detailed enough to demonstrate that this increase was actually concentrated in those flooded. Further consideration should be given to the feasibility and value of using this measure in Scotland.

Capital	Indicator	Scottish data available (Y/N/Proxy)	Notes on Scottish data sources
	Data required for before the extreme weather event, immediately after it and up to two years after.		Every 2 years at the national level. Every 4 years at the local authority or Health Board level.
	Community members experiencing mental health stress or hardship as a proportion of the whole community (e.g. proportion indicating that they experienced stress that has had a negative effect sometimes, most of the time or always in the past 12 months) (CWI) (Process and outcome indicator) Data required for before the extreme weather event, immediately after it and up to two years after.	Y	Scottish Health Survey: Mental wellbeing - self assessment using the WEMWBS. Every 2 years at the national level. Every 4 years at the local authority or Health Board level.
	Appropriateness of health and social services provided (AIDR) (P) Data required for period immediately after an extreme weather event and up to two years after.	Proxy	Scottish Household Survey data on satisfaction with local health services Annual. Available at the national level and by local authority.
	Continuity of education (e.g. attendance, absence, classes not running, drop-out rates) (FRMC) Data required for before the extreme weather event, immediately after it and up to two years after.	Y	Scottish Exchange of Education Data (ScotXed) and National Records of Scotland (e.g. pupil census) Annual. Available by local authority.
	Proportion of the population accessing mental health services (CWI) (P) Data required for immediately after the extreme weather event and up to 2 years after.	N	Data potentially available from National Health Scotland.
Economic / financial (6)	How households are managing financially: proportion satisfied or very satisfied that household income meets everyday needs (CWI). Data required for period before and immediately after an extreme weather and then up to 2 years after.	Y	Scottish Household Survey data on perceptions on how well the household is managing financially. Annual. Available at the national level and by local authority.
	Proportion of households having a household income continuity strategy (FRMC) Data required to be updated every year.	Proxy	Scottish Household Survey data on whether household can access £500 for an unexpected, but necessary, expense. Annual. Available at the national level and by local authority.

Capital	Indicator	Scottish data available (Y/N/Proxy)	Notes on Scottish data sources
	% of households with adequate insurance (FRMC/AIDR) Data required immediately after an extreme weather event and up to 2 years after.	Partial	Scottish Household Survey contains data on whether households have home contents insurance, but this may not include building insurance and does not comment on adequacy of cover. Insurance companies may have additional data. Annual. Available at the national level and by local authority.
	People awarded grants to undertake resilience-building repairs to homes (AIDR) (P) Monthly or quarterly data required for full period of operation of the grant system and total number of grants awarded.	N	Grant schemes to fund post-event resilient repairs are a relatively new development. As these will generally be set up by central government, we recommend that the Scottish Government require that those who administer the schemes provide records of the number and amount of grants paid monthly and the total number and amount paid under the scheme.
	Community Disaster Fund (FRMC) (P) Data required annually.	Proxy	Scottish Household Survey contains data on households in receipt of Crisis Grant from Scottish Welfare Fund. This is one example of funding, but there may also be other relevant funds which should be monitored. Annual. Available at the national level and by local authority.
	Organisations/businesses with continuity plans and resilience plans (AIDR) (P) Data required annually.	N	
Physical (6)	Transportation performance (FRMC) (e.g. proportion of affected roads/bridges/ferry terminals/services that have reopened (AIDR), proportion of affected rail network restored to service (AIDR), proportion satisfied or very satisfied with their ease of access to suitable transport to daily activities (CWI)) Data required immediately after event and for entire period of reinstatement of infrastructure.	Y	Scottish Transport Statistics data on bus journeys, road network condition, rail punctuality etc – specific indicators would need to be selected. Further data may also be available. Scottish Household Survey data on satisfaction with local services - public transport, and maintenance of roads. Annual. Available by transport sector.
	Continuity of energy and fuel supply (FRMC) (e.g. interruptions to services, reliability, quality and accessibility (FRMC), customers without electricity / gas as identified by the relevant utility provider (AIDR), affected homes and businesses where power was restored (AIDR); proportion	N	Data potentially available from energy network providers (e.g. SSE, Scottish Power) and Ofgem. For example, data on customer interruptions, customer minutes lost etc. Specific indicators would need to be selected.

Capital	Indicator	Scottish data available (Y/N/Proxy)	Notes on Scottish data sources
	of the affected electricity network restored to service (AIDR)) Data required immediately after event and for entire period of reinstatement of infrastructure.		
	Communications performance (e.g. interruption/ restoration of services, coping with potential increased demand /load (FRMC), customers without telecommunications as identified by the relevant utility provider (AIDR), households with internet access (AIDR)) Data required immediately after event and for entire period of reinstatement of infrastructure.	N	Data may potentially be available from communications companies.
	Safe water (e.g. interruptions and time to restore drinking water (FRMC), proportion of water supply schemes operating to regulatory standards (AIDR)) Data required immediately after event and for entire period of reinstatement of infrastructure.	Y	Drinking water quality regulator (DWQR) for Scotland Annual Report data on water quality including events and incidents and other reports. Further data may be available from Scottish Water.
	Damaged residential/commercial/industrial assets rebuilt (AIDR) Data required immediately after event and for entire period of reinstatement of infrastructure.	N	Scottish House Condition Survey has various housing satisfaction indicators and proportion of households with disrepairs to their dwelling. None of these indicators measure the recovery of damaged housing and business premises following extreme weather events.
	Damaged public/essential service type assets rebuilt and operating – education and health premises (AIDR) Data required immediately after event and for entire period of reinstatement of infrastructure.	Partial	ScotXed pupil census has school establishment and condition data. Similar data would be needed for health establishments and may be available from Public Health Scotland. Annual

Notes: (P) indicates a process indicator

7.4.1 Comments on the indicators

There are nine social capital indicators. These cover participation, empowerment, community belonging and social contact and mutual support. These mirror three of the themes in the sub-outcomes of SCCAP2's Communities outcome (Outcome 1): Engaged Public; Empowered; and Resilient Places. They also link to some of the indicators in the Ready Scotland Community Scotland Toolkit which explores, among other things, working together to help each other out and measuring community spirit (see section 6).

- Indicators of engagement include generic civic engagement (% people voting in elections), engagement in volunteering and engagement specifically in recovery activities. There is no Scottish indicator for engagement in community-level recovery from extreme weather events, but relevant data may be being collected, for example by the Scottish Flood Forum.
- Indicators of empowerment include ability to influence decisions, trust in authorities (reflecting a belief that authorities act in the interests of the individual or the community) and learning from extreme weather events. There is no Scottish indicator of whether communities have learned from their experience of extreme weather events: this would need to be developed.
- Indicators of community belonging and loneliness include sense of identification with the community where one lives and subjective experience of loneliness. The indicator of loneliness is one of the indicators for the NPF communities' outcome: 'Our communities are inclusive, empowered, resilient and safe'.
- One indicator of mutual support and the existence of networks of support during recovery. We have not found an exact match for this indicator in the Scottish datasets although a possible proxy has been identified.

There are five human capital indicators. These focus on the second sub-outcome of SCCAP2's Climate Justice outcome (Outcome 2): Health and social care is ready and responding to changing demands as a result of the changing climate.

- Three indicators of health: self-reported health, community members experiencing mental health stress or hardships and percentage of people who describe the overall care provided by their GP practice as Excellent or Good.
- One indicator of educational provision: this relates to children's health and wellbeing. Children have been found to be especially following disasters as both their home and school environments may be disrupted (Walker et al., 2010).
- One process indicator relating to access to mental health counselling.

The first sub-outcome of the Climate Justice Outcome relates to the engagement and empowerment of vulnerable people. The Equalities Act 2010 identifies protected characteristics²⁸ which should be taken into account in all areas of public policy development and implementation. We believe that this means that data should be collected for each of the recovery indicators in such a way that makes it possible to differentiate outcomes for people with protected characteristics from those for the population as a whole (see section 7.5.3). The data for the proposed indicators may not currently allow this differentiation.

²⁸ Protected characteristics are: age, gender reassignment, being married or in a civil partnership, being pregnant or on maternity leave, disability, race including colour, nationality, ethnic or national origin, religion or belief, sex and sexual orientation.

In developing the human capital indicators further it is also worth bearing in mind the lack of indicators in the international frameworks on the impact of extreme weather events on health inequalities, and how these impacts may relate to recovery.

There are six economic or financial capital indicators. Only one of these focuses on the business sub-outcomes of the SCCAP2 Economy outcome (Outcome 3):

- A process indicator looking at the number of businesses that have flood emergency action plans. Having a plan is recognised as a good indicator of businesses' capacity to recover quickly from emergencies like flooding.

The remainder of the indicators relate to community-level economic recovery:

- Three indicators of household capacity to recover from emergencies like extreme weather events:
 - How well households are managing economically
 - Whether households have income continuity strategies (i.e. are they able to find alternative ways of generating income if they lose their usual income source). The Scottish Household Survey includes a question about household savings which offers a possible, though limited proxy for having an income continuity strategy.
 - The number of households with insurance cover. The Scottish Government collects data on households with contents insurance. It should be possible for the insurance industry to provide data on the number and percentage of properties covered by building insurance, both nationally and by local authority area.
- A process indicator on community access to funding for disaster recovery. The Scottish Household Survey includes a question about whether households have received a Scottish Welfare Fund Crisis Grant which offers a possible proxy²⁹, however, this represents only one example of funding, and there may also be other relevant funds which should be monitored.
- An indicator of the number of homes receiving grants to undertake resilient repairs.

There is no ongoing dataset in Scotland covering the last indicator as the data will only be collected where a grant scheme is put in place as part of a recovery process.

There are six indicators for physical capital which cover the sub-outcomes for SCCAP2's Supporting Systems outcome (Outcome 4):

- Four indicators relating to the time taken to repair and restore the infrastructure providing basic services of transport, energy, communications and water. Indicators of performance are available for the transport and water sectors. It is likely that these are also available for the energy and communications sectors but we were unable to identify sources.
- One indicator relating to the time taken to repair and restore education and health infrastructure. We found data for refurbishment of education sector assets. We were unable to identify a similar dataset for health sector assets; National Health Scotland may have this data.

²⁹ The Crisis Grant helps to support low income people with the living costs of an emergency, such as, a flood at home: <https://www.mygov.scot/scottish-welfare-fund/crisis-grants/>

- One indicator of rebuilding of damaged residential, commercial and industrial assets. No Scottish data was found for this important indicator.

All of the indicators of physical capital are short term indicators of ‘bounce back’ to the pre-event conditions. There is a need for indicators to be developed to measure how far recovery is ensuring that infrastructure is built back better or adapted to take account of likely future climate events.

7.5 Applying the indicators of recovery from extreme weather events

7.5.1 Who will use data on recovery from extreme weather events?

Recovery involves the combined efforts of organisations and institutions at different level. The kinds of organisations that are going to be using the data on recovery are primarily the relevant local authority and resilience partnerships³⁰ who co-ordinate organisational response and recovery to extreme weather events. They need to monitor how well and how quickly recovery happens in individual locations and across the whole area for which they are responsible, to make their support as effective as possible. Good information will enable them to assess whether affected locations have returned to their pre-event level of functioning, and the extent to which recovery has made the locations more prepared for and resilient to future events.

When an extreme weather event happens, the local authority(ies) will normally be the lead on recovery within the resilience partnership as they mobilise many of the social services needed by people affected. As part of planning and managing the recovery effort, the local authority(ies) and other partners will need to gather relevant information and put in place a system for monitoring recovery. This will involve determining: what relevant data is available from existing data sets to provide a baseline for the pre-event conditions in the affected area; what data is needed about the impact of the event on resilience capitals at an appropriate scale for the area affected; and what information will be needed about the recovery process and its outcomes.

The Scottish Government’s Resilience Division works with responders to support them in response and recovery. The Resilience Division needs information on recovery from extreme weather events across the country to achieve its aim of ensuring inclusive, empowered and resilient communities who can bounce back from disruptive challenges³¹.

Local communities are another important actor in recovery. There are over 300 community emergency groups around Scotland³². The Scottish Flood Forum (SFF) has helped community resilience groups to set up in flood risk areas throughout Scotland. Community resilience groups could use information about flood recovery in their areas to plan their resilience efforts and increase their capacity to deal with future emergencies.

Enabling community-led action on recovery can contribute to building capacities, and facilitate or improve the recovery process. To ensure that communities can participate effectively, authorities will need to work with community groups to find out what sort of information they need to support their efforts.

Along with working out what data is needed, partnerships and the relevant local authority(ies) will also need to assess and decide how this data can be accessed and by whom. The international case studies indicate that there are different approaches to data management and sharing:

³⁰ Resilience partnerships bring together the “emergency services” (police, fire and ambulance), local authorities and other authorities such as the NHS/Public Health Scotland, as well as voluntary groups such as British Red Cross and the Scottish Flood Forum which assist the responder agencies..

³¹ Ready Scotland website: <https://ready.scot/how-scotland-prepares/about-us>

³² Scottish Government. 2020. Guide to emergency planning for community groups

- Data for the Canterbury Wellbeing Index is compiled by the Community and Public Health division of the Canterbury District Health Board (CDHB) with support from other organisations. Statistics are available to review and download online.
- For the FRMC, staff from local offices of the ZFRA member organisations are responsible for working with local communities to develop indicators and for gathering and assessing the data. The supporting website is private and only accessible for trained users from the ZFRA. The data is used to produce information on different aspects of resilience and recovery.

7.5.2 Options for drawing on international experience of using indicators

In this section we consider options for applying international experience of using indicators in Scotland, focusing on three levels of application: national (strategic), resilience partnership / local authority and local community.

a) National level

National datasets on their own will not provide information at the resolution needed to monitor and assess recovery from extreme weather events. Many extreme events such as flooding are localised, i.e. they affect only a few streets or buildings. Where events cover a wider area, socio-economic, cultural, geographical and historical differences mean that recovery processes may vary widely. A study of the long-term impacts of flooding on two communities in Aberdeenshire that were affected by winter flooding in 2015-16 found that different past experiences of flooding as well as differences in how long power cuts lasted affected the local community's experience of flooding and people's ability to start the recovery process³³.

National datasets for recovery from extreme weather events could still be valuable in several ways:

- The set of indicators could be used as a guide for data collection at the local level. Collecting local data for the same indicators will provide more detailed evidence to supplement and compare with national evidence. If the same approach is used for all extreme weather events, this will ensure that data is consistent across the country, allowing robust comparison and learning.
- Local or community-level evidence can be collected to supplement the wider national picture. This will contribute to gradually develop a more nuanced national measure of recovery which recognizes difference between places and change over time. This is particularly relevant for data on social and human capital.

Data from national surveys (e.g. the Scottish Household Survey or the Scottish Health Survey) are based on population samples and cannot be further analysed to provide information for spatial scales below the local authority or Health Board level. Even if responses to survey questions could be traced back to smaller spatial units, the low number of responses would not provide an adequate sample for analysis. In cases where the data for indicators is not based on samples it could potentially be further disaggregated down to smaller spatial units if the full database were made available. The data sources which might be disaggregated in this way are shown below.

Social capital:

- Voter turnout in elections (data available down to ward level)

Human capital:

- Continuity of education (assuming that the national data on pupil attendance is based on records for each educational establishment – this would need to be confirmed)

³³ Currie, M., Philip, L. and Dowds, G. (2020). Long-term impacts of flooding following the winter 2015/16 flooding in North East Scotland: Summary Report. CRW2016_02. Scotland's Centre of Expertise for Waters (CREW).

- Proportion of population accessing mental health services (assuming this is based on records of patients accessing mental health services at service provider level – this would need to be confirmed)

Economic capital:

- Percentage of households with contents and building insurance (insurance companies have details of number of households with insurance cover by postcode areas – the Scottish Government would need to discuss with the insurance sector how relevant data could be accessed)
- People awarded grants to undertake resilient repairs to their homes (organisations responsible for disbursing payments should have data by property postcode and amount of grant)
- Community Disaster Fund / Crisis grants awarded from Scottish Welfare Fund (organisations responsible for disbursing payments should have data by property postcode and amount of grant)

Physical capital:

- Evidence about the performance of physical capital immediately after an extreme weather event and subsequent repair or reinstatement of infrastructure is likely to be available in reports by infrastructure providers to national government
- Data on performance of infrastructure services is likely to be available from service providers and may be available by geographical location (e.g. for transport; energy and fuel supply; communications networks; and safe water)
- Damaged public/essential service type assets rebuilt and operating (data is available for educational establishments; data may also exist for health service assets).

This is an area of work which could be led by the Scottish Government's Resilience Division as it would also be relevant to recovery from other emergencies and to wider resilience.

b) Resilience Partnerships / local authority level

Resilience partner and local authorities would be well-placed to gather local data on social, human and economic/financial capital to supplement data from national surveys. The FRMC gathers local evidence every two years, to ensure that data on the condition of capitals before the emergency event (baseline) is sufficiently up to date. Some local authorities may already collect relevant data to inform strategic planning and other activities. Partners in the local Resilience Partnership may have information on whether outcome data is collected on indicators, and whether this is collected frequently enough to allow robust assessments of recovery. This would primarily be relevant for social capital. Local authorities may collect supplementary data on ability to influence decision-making; trust in authorities; proportion of people who have regular contact with friends and family; community belonging; mutual support.

Local authorities / resilience partners should also collect data on process indicators, i.e. factors which reflect the speed, effectiveness and extent of the recovery process. These include social, human and economic/financial indicators:

- Recovery of community functioning: participation in voluntary activities; mutual support.
- Health recovery: self-rated health; community members experiencing mental health stress or hardship; appropriateness of health and social services provided
- Individuals and communities receiving funding for recovery and homes receiving grants to undertake resilient repairs.

Ensuring that data collected is joined up with national data sets as well as other local authority / emergency service users will be critical to making this information accessible and useful.

c) Community level

Collecting community level data and involving communities in developing evidence on recovery can be part of building community capacity and develop resilient communities.

The FRMC tool offers one option for developing community-level data. The design of the data collection starts from an assessment of local response to a flood event. For example, a variety of information is collected for outcome indicator 'O24: *Mutual support*', including '*Did formal or informal networks in the community help people support each other during and following the flood?*', '*Were all groups in the community included in social networks for support during and following the flood?*'. This data is collected through focus group discussion, key informant interview, or secondary source data (ZFRA, 2019b)³⁴. Using the answers to these questions, a grade is assigned to the indicator, from A '*Strong formal and informal social networks shared information and provided substantial support and assistance to community members during and after the floods. All community members were part of these networks of mutual support*' though to D '*No formal or informal social networks were in place to share information or provide support and assistance to community members during and after floods.*' (ZFRA, 2019b, p66-67).

The experience of the FRMC indicates that it is possible to identify indicators of resilience at the local level and to collect relevant evidence before and after extreme weather events such as flooding. This kind of evidence can enable the community to monitor its own recovery. If locally generated data on social capital were to form part of a national recovery monitoring system, this approach would need to be applied systematically across Scotland. The Scottish Government will need to determine the investment that this would require and assess the feasibility of including this kind of evidence.

Note the structured character of the FRMC model, supported by NGO capacity and resilience funding. Some elements of this are present in Scotland, e.g. Scottish Flood Forum is a well-established and credible organisation supporting flooded communities.

The FRMC approach is resource-intensive and is likely to be most appropriate where established community organisations or flood groups have the capacity to work with local authorities to determine data needs. Another option is for national authorities to establish the potential for using existing datasets to provide localised data. This would require working with those responsible for the datasets and ensuring that the data is suitable for use, e.g.:

- Information is collected about the location and/or characteristics of respondents (this will be needed to be able to look at recovery in relation to small areas and groups in the population)
- Consider frequency of collection and any variance in frequency in relation to scale at which data is collected: for example, the Scottish Health Survey collects national data annually but Health Board level data only every four years.

Once this information has been clarified, the detailed descriptions of the indicators would need to be reviewed with potential users, potentially including the Government's Resilience Division, statutory responders, the Scottish Resilience Partnership, the Resilience Advisory Board for Scotland and the three Regional Resilience Partnerships. The purpose would be to ensure that the proposed indicators meet the needs of the resilience community and to consider how best the data could be used to deepen understanding of the recovery process and improve outcomes. A useful lesson from the FRMC experience is the need for stakeholders to review the information collected to understand the extent and way in which recovery processes and outcomes, as measured by the indicators, have impacted on recovery performance, and learn lessons to improve future practice.

³⁴ For source of resilience data which is collected pre-event (i.e. in 'normal' times), FRMC suggests data can also be collected via household survey.

7.5.3 Lessons for monitoring of recovery

The following lessons can be drawn from international experience:

- Use existing data where possible, to make the most efficient use of resources and avoid duplication. Data for the indicators shown in Table 10 is in many cases included in national datasets or could be obtained from national stakeholders, such as utility companies.
- Ensure that data is fit for purpose and meets the needs of those who will use it. National and local authorities need information on recovery from extreme weather events for different purposes. Scottish Government datasets generally provide data disaggregated to the local authority level (or the local Health Board level in the case of health statistics). This data will be useful for looking at the wider impacts of extreme weather events. Local authorities and communities need granular data on recovery in the area affected by the extreme event to supplement the information available in national data sets.
- Impacts from extreme weather events can be very localised. In these cases, data for a whole local authority area may not reflect either the impacts of the weather event or the changes occurring as part of the recovery process and local data will be required.
- Involving local people in determining what data the community needs to monitor and promote recovery from an extreme weather event can contribute to building community capacity and aid recovery (bounce back better or adaptation).
- Timescales for recovery vary as a result of factors, including: extent or severity of the event, existing levels of vulnerability in the area affected, access to support of different kinds. The FRMC tool looks at periods of two years after flooding. The Scottish Flood Forum suggests that recovery from flooding can take from 6 – 18 months and does not end when physical capital has been restored.

7.5.4 Learning and adapting to future climate change

The FRMC combines process and outcome indicators, similar to the approach used to assess SCCAP1 and proposed for SCCAP2. The FRMC's outcome indicator O22 Learning from flood is a composite measure, based on different kinds of information such as: *'What action has the community taken to understand the causes and impacts of the flood?'* (a process indicator), *'How strong is the community's interest and investment (within their means) in understanding the causes and impacts of the flood?'* and *'Has the community's understanding of the causes and impacts of the flood resulted in any changes or enhancements to flood risk management?'* (an outcome indicator) (ZFRA, 2019b, p62).

The evidence used is both qualitative and quantitative and relies on research methods such as interviews and workshops with local practitioners, stakeholders and communities.

This is an ambitious step which could use the evidence generated by the recovery monitoring system to facilitate a discussion between stakeholders about the lessons coming out of the practice of recovery and how to apply these to increase resilience to future risks. The evidence generated would provide valuable process data to feed into the monitoring and evaluation of SCCAP2.

8 Conclusions

Based on international experience, the building blocks for developing a system for monitoring recovery from extreme weather events in Scotland are:

- **Framing recovery within a set of wider social goals such as wellbeing or resilience.** This fits well with Scotland's outcomes focused NPF. Recovery from extreme weather events is an activity within SCCAP2 which in turn contributes to NPF's Communities outcome (*We live in communities that are inclusive, empowered, resilient and safe*). Recovery is one element of Preparing Scotland's Integrated Emergency Management approach, which focuses on resilience.
- **An approach that establishes the different areas or recovery that need to be considered and the role the community will play in deciding the system to be used.** The capitals approach recognises five broad capitals that communities and societies need to be sustainable (social, human, economic/financial, natural and physical capitals). A recovery monitoring system should use indicators that cover all these capitals³⁵. This fits well with Preparing Scotland's four categories of impacts of emergencies which need to be addressed in the recovery process, as the 'People' category covers both social and human capital.
- **A set of indicators of recovery.** We have suggested a set of 26 indicators (see Table 10) that covers the four capitals considered in this study, and reflects the aspects of recovery from extreme weather events that are most important in Scotland, e.g. rebuilding of damaged residential/commercial/industrial assets, access to mental health services, etc.
- **Joined up data across different scales (national, regional/local and community) with a focus on process and outcomes.** This would acknowledge and support the combined efforts of organisations and partnerships involved in recovery, and could be facilitated by national datasets such as the Scottish Household Survey which allow for disaggregation of data to the local level. Data collection at a community level and with community involvement could generate localised data appropriate to the level at which impacts from the extreme weather event has occurred.
- **Relevance of the spatial scale at which data is collected and the timing and frequency of collection to the indicator** (e.g. data on community involvement in voluntary activities) needs to be at a scale which allows the community(ies) affected by the extreme weather event to be differentiated from others, and be collected frequently enough to reflect the reality of the community shortly before, during or after the extreme weather event.
- **Drawing on existing information.** It is beneficial to use existing public datasets, where data is available or proxies can be found. This will save time and money as well as highlighting linkages between recovery outcomes and other public goals. Scottish Government data or proxy data has been found for 16 of the proposed indicators. Partial data is available for a further two indicators with possible sources suggested for the missing elements. Data was not found for eight indicators. However, possible sources have been identified for five of these. One challenge for the use of existing data is the

³⁵ This scope of this project did not include indicators for the recovery of the natural environment. This is because it was felt that more work had been done on indicators covering the natural environment (e.g. in SCCAP2), and that other capitals (particularly social and human capitals) have been given less attention. We expect the natural environment will be included as a capital and recovery indicators for the natural environment identified as part of the implementation of the monitoring system.

relevance of the scale and frequency at which data is collected. For example, national data for the Scottish Health Survey is collected annually while Health Board level data is collected every four years. The surveys are unlikely to provide data suitable for measuring impacts over short time scales and in local areas. Local authority surveys or community evidence gathering could be used to fill data gaps.

Within such an approach, and following a review of Scottish datasets against the three international frameworks, we propose a set of 26 possible indicators to cover the four capitals, see Table 10, covering the areas that existing research shows are important for sustainable recovery. Once a monitoring framework is developed further, the evidence provided by the data gathered should be reviewed to enable local resilience partners and community organisations to suggest additional factors that appear to influence the speed, effectiveness and extent of recovery. This could provide a flexible framework that can be adapted to the particular circumstances following an extreme weather event, and ensure that indicators are relevant to local people and stakeholders.

Data is currently not available in public datasets for three indicators. These each relate to elements of social capital (community learning from recovery processes), economic/financial capital (number of homes receiving grants to undertake resilient repairs) and physical capital (rebuilding of damaged residential, commercial and industrial assets). If no proxies can be found for these, it would be worth considering collecting this additional data. The Scottish Government would need to work with stakeholders to develop the indicators further.

Appendix 1: Summary of international monitoring systems

Table 11 presents a summary of the key examples of existing international monitoring system identified through the evidence review.

Table 11: Summary of existing international monitoring systems identified

Name of monitoring system	Country(ies) and source of evidence	What extreme weather events are covered?	What impacts are covered?	Whose recovery is considered?	How is 'recovery' understood?	Are targets and objectives identified?	What systems exist for monitoring recovery?
National Disaster Recovery Monitoring & Evaluation Database (AIDR tool)	Australia (AIDR, 2018)	All extreme weather and natural disasters	social economic built environment	All, with focus upon community	'Bounce back better' and adapt for future.	Yes. 278 indicators presented.	Template for use by anyone involved in recovery, including government and community. No requirement to use system
Canterbury Wellbeing Index	New Zealand (Canterbury District Health Board (CDHB), 2016)	Earthquake, but could be used for other types of event	Health mental wellbeing and social connectedness safety economic wellbeing housing knowledge and skills	All, with focus upon community	'Bounce back better' and adapt for future.	Yes. 57 indicators presented.	Compiled bi-annually by CERA & CDHB (up to 2016); now compiled by Greater Christchurch Psychosocial Governance Group
Community Recovery Checklist	USA (Horney et al., 2016)	All extreme weather and natural disasters	social public sector financial process (quality of the recovery process)	All, with focus upon community	'Bounce back better' and adapt for future.	Yes. 79 indicators presented.	Template for use by anyone involved in recovery, including government and community. No requirement to use system

Name of monitoring system	Country(ies) and source of evidence	What extreme weather events are covered?	What impacts are covered?	Whose recovery is considered?	How is 'recovery' understood?	Are targets and objectives identified?	What systems exist for monitoring recovery?
New Orleans Index	USA (The Data Centre, 2015)	Coastal storm (hurricane), but could be used for other types of event	Inclusion quality of life economic growth sustainability	All, with focus upon community	'Bounce back better' and adapt for future.	Yes. 32 indicators presented	Compiled by The Data Centre annually
Flood Resilience Measurement for Communities (previously the Flood Resilience Measurement Tool)	Multiple countries including USA (Campbell et al., 2019; Zurich Flood Resilience Alliance, 2018; Keating et al., 2017)	Flooding	Human social physical natural financial	individual community	Focus on resilience as: return to pre-event levels of functioning risk reduction in the next cycle	Yes: reduce losses from flooding reduce recovery time	Indicators to measure 88* sources of resilience developed by ZFRA members with local communities. Measurement and analysis done by partners.
emBRACE project Community Resilience Framework	EU emBRACE project deliverables, especially Kruse et al. (2017) Becker et al., (2015)	Natural hazards	3 core domains of resilience resources and capacities actions learning	community	Focus on resilience as: coping with a hazardous event maintaining essential function, identity, and structure maintaining the capacity for adaptation, learning, and transformation	Broad objective of the emBRACE project was to build resilience to disasters amongst communities in Europe	System based on 68 indicators of resilience, of which 14 are 'core' indicators. Key indicators can be used, but do not all have to be used in every circumstance; those decisions remain context dependent. (Becker et al. 2015, p.68).
European STAR FLOOD project	EU STAR FLOOD project deliverable: Hegger et al. (2016)	Flooding	3 resilience capacities: Capacity to resist	Not specified	The ability of a flood-affected system to remain functioning,	Timely implementation of effective	Reviews indicators used to monitor recovery in six European countries:

Name of monitoring system	Country(ies) and source of evidence	What extreme weather events are covered?	What impacts are covered?	Whose recovery is considered?	How is 'recovery' understood?	Are targets and objectives identified?	What systems exist for monitoring recovery?
			Capacity to absorb and recover Capacity to transform and adapt.		respond to a flood, and recover (without shifting to a different system state).	measures in the following areas: Flood awareness Flood mitigation Insurance systems Forecasting and warning systems Crisis management	Belgium, England, France, the Netherlands, Poland, and Sweden.
UK Cabinet Office	UK (Cabinet Office, 2019; London Resilience Partnership, 2016)	All extreme weather events classified as emergencies ³⁶	Social health financial	individual business community networks voluntary organisations	Not clearly specified Differentiates between short-term activities (including health wellbeing) and long-term planning / implementation.	Yes: faster recovery reduced social, financial and health impacts	Reference tool for developing community resilience, including recovery. Does not establish a monitoring system.

³⁶ An emergency is defined as 'an event or situation which threatens serious damage to human welfare in a place in the UK, the environment of a place in the UK, or the security of the UK or of a place in the UK.' (Cabinet Office, 2013, cited in Cabinet Office, 2019, p.2)

Appendix 2: Rationale for assessment criteria

Taking the examples of recovery monitoring systems or sets of indicators identified (see Appendix 1), we used a set of criteria to assess and prioritise the recovery monitoring systems that would be most helpful for developing a system for measuring recovery from extreme events in Scotland.

The criteria used were:

- *Relevance to community outcomes for the second Scottish Climate Change Adaptation Programme (SCCAP2).* Rationale: the immediate driver for developing a recovery monitoring system for Scotland was the Climate Change Committee's critique of the lack of any means of measuring or evaluating recovery from extreme weather events. SCCAP2 locates recovery from extreme weather events under the Community Outcome. International frameworks that see similar community outcomes as SCCAP2 are more likely to have relevant indicators.
- *Relevance to the vulnerability outcome for SCCAP2 (this includes 'Changes in health and wellbeing').* The rationale for this criterion is similar to the rationale for the previous one: SCCAP2's second Outcome relates to the ability of the most vulnerable people to adapt to climate change and it covers the provision of health and social care. International frameworks that look at the recovery of vulnerable people and include health and social care provision as an important element of recovery are more likely to have relevant indicators.
- *Inclusion of relevant process indicators.* The SCCAP2 evaluation and monitoring approach is based on the use of process indicators as well as outcome indicators. Process indicators look at the measures being taken to make progress towards the desired outcome and are valuable for monitoring the direction of change over time. Recovery monitoring systems that include process indicators are likely to be more relevant to Scotland.
- *Clearly identified responsibilities for data collection and monitoring.* The rationale for this criterion is that it is important to understand which organisations or institutions (public, private, academic, not-for-profit, etc.) are responsible for these tasks in other countries in order to assess how feasible this would be in Scotland.
- *Existence of an evaluation(s) of the performance of the system or set of indicators.* The existence of an evaluation demonstrates that the system or set of indicators has been used and provides some indication of what elements or aspects performed well or less well, which is valuable for thinking through how it could be applied in Scotland.

Appendix 3: Case studies of international monitoring systems

This appendix provides more detailed description of the three systems assessed as most relevant for developing a system for measuring recovery from extreme events in Scotland.

Case study 1: Australian Institute for Disaster Resilience (AIDR) National Disaster Recovery Monitoring & Evaluation Database

Context

The [National Disaster Recovery Monitoring & Evaluation database](#) was developed by Australian Institute for Disaster Resilience (AIDR) in 2018. The database is a key tool for implementation of Australia's National Monitoring and Evaluation Framework for Disaster Recovery Programs (ANZSOG, 2018).

The database (and framework) focuses on recovery and is designed to be applied to a range of extreme weather and natural disaster events at a range of scales (local to regional).

Overview of system

The database includes template activities, outcomes and indicators of recovery, developed from the evaluation of previous disaster recovery programmes.

The searchable database gathers and presents past recovery evaluations (activities, indicators, resources), made available to assist in the design of future disaster recovery programs.

Indicators are clustered under a large number of areas so that users can find relevant and appropriate indicators. There is a focus on community / social indicators, as this is in line with the Australian Government's community recovery ethos, however infrastructure, system and service indicators are also included.

The framework and database are applicable across all types of extreme weather and natural disaster events, with relevant indicators to be applied on a case by case basis.

AIDR stresses the importance of setting 'target' levels and standards to accompany each outcome indicator to define what successful recovery looks like. Target levels and standards are not presented in the guidance, as these are set on a case by case basis depending upon local conditions and requirements (Australia and New Zealand School of Government, 2018). A number of factors can be taken into account when selecting appropriate target levels and standards, including pre-disaster state and ongoing community needs assessment. It is not clear what data is used to assess these factors.

Indicators

The AIDR recovery database includes 278 indicators in 56 clusters. The indicators are a mix of process and outcome based.

The outcome indicators are grouped into five domains: economic, social, built, environmental, and resilience and sustainability. The resilience and sustainability domain contains overarching outcomes that affect more than one of the other four domains (ANZSOG, 2018).

The list of outcomes in the database each has a number of different possible metrics. For example, there are five suggested metrics for the outcome 'Households, families, and individuals are enabled to affect their own recovery through appropriate income sources':

- Can afford food on time
- Comparison of income sources to recovery needs
- Continuity of income for people receiving Centrelink payments

- Employment rate by age, sex, and other demographic characteristics
- Households receiving hardship income support or other disaster-related payments

These metrics draw on different types of data (e.g. data from public Centrelink records, self-reporting by households of their ability to access food on time) and allow authorities to select metrics which are most relevant to the type of disaster and contextual factors such as the existence of hardship funds providing income support.

Data

It is the ambition of the creators that the database will gather resources from recovery monitoring on an ongoing basis. Example datasets and usage information from this system are not currently available.

How it works

The database is used as a supporting tool to assist authorities to design their own disaster recovery programmes drawing on knowledge gained from past recovery evaluations.

There is a user guide to help users search the database for activities and indicators for recovery programmes and to find evaluations of past recovery programmes and other relevant resources. This will facilitate better programme design and evaluation in the future.

Evaluation

As part of developing the framework, the indicators from past recovery monitoring programmes were evaluated.

Relevance to Scotland

The AIDR outcome domains largely cover the four SCCAP2 outcome areas, as shown in Table 7.

Potential application to Scotland

A significant number of the indicators can be matched against data routinely collected in Scotland through Government Departments and initiatives. However, it is noted that the data available for Scotland may not be of high enough geographic resolution, or collected frequently enough to be relied upon for comprehensive recovery.

It is expected that primary data collection would be necessary to fully investigate recovery in a small geographic area.

Table 12: Correspondence between AIDR outcome indicators and SCCAP2 outcomes

SCCAP2 outcomes	Relevant AIDR outcome indicator domains	Notes on AIDR domains
Communities (Outcome 1) Engaged public Empowered communities Resilient Places Resilient Historic Environment Resilient Buildings	Social domain Built domain Environmental domain Resilience and sustainability domain	For AIDR: <i>Social domain</i> includes ability to manage needs, support others, knowledge etc. <i>Built domain</i> includes private and public infrastructure <i>Environmental domain</i> includes restoration of cultural heritage <i>Resilience and sustainability</i> includes community awareness of risk and ability to express needs
Climate Justice and Health (Outcome 2) Engaged Empowered Health and social care infrastructure Health effects	Social domain Economic domain Resilience and sustainability	For AIDR: <i>Social domain</i> includes health needs, education, safety. <i>Resilience</i> includes needs of vulnerable groups <i>Economic domain</i> , includes vulnerable groups not being further disadvantaged by e.g. employment prospects
Economy (Outcome 3)	Economic domain Resilience and sustainability	For AIDR: <i>Economic domain</i> , includes financial and banking, business, not-for-profit services, business insurance, community access to financial workforce skills <i>Resilience and sustainability</i> includes community access to insurance
Supporting systems (Outcome 4)	Built domain Resilience and sustainability	For AIDR: <i>Built domain</i> includes infrastructure that delivers essential services e.g. electricity, transport, telecoms. <i>Resilience and sustainability</i> include government engagement

Case study 2: Canterbury Wellbeing Index

Context

The Canterbury Wellbeing Index was developed by the Canterbury Earthquake Recovery Authority (CERA), a department created by the New Zealand Government following the February 2010-2011 earthquakes. Data was compiled by CERA up to 2016, it is now compiled by the Community and Public Health division of the Canterbury District Health Board (CDHB) with oversight by the Greater Christchurch Psychosocial Governance Group and support from other organisations, with statistics available to review and download online. The last data set available is 2018: <https://www.canterburywellbeing.org.nz/>.

The Index covers the administrative area of greater Christchurch City (made up of the Territorial Authorities of Christchurch City, Selwyn District and Waimakariri District).

Overview of system

The Index was established to track the progress of social recovery from the Canterbury earthquakes sequence of 2010-2011 in greater Christchurch and to inform decision-making by a range of public agencies. While it has been used to look at recovery from a series of earthquakes, the indicators and methods are not event-specific and could be applied to extreme weather events.

Data shows annual statistics for the Canterbury area and for New Zealand as a whole, allowing users to:

- 1) View change year on year since 2011 in the affected area
- 2) View Canterbury statistics and changes against New Zealand national averages

In the published reports, 'positive / negative' change under each indicator is presented in a results 'wheel', colour coded with green and red arrows (see Figure 2). Targets are not explicitly set, although it is clear that they aim to be at least at the level of the New Zealand national averages or above.

Indicators

The Index tracks recovery against 57 indicators, grouped into 10 clusters or domains³⁷. All indicators look at recovery with a focus on recovery of social and human capital.

Data

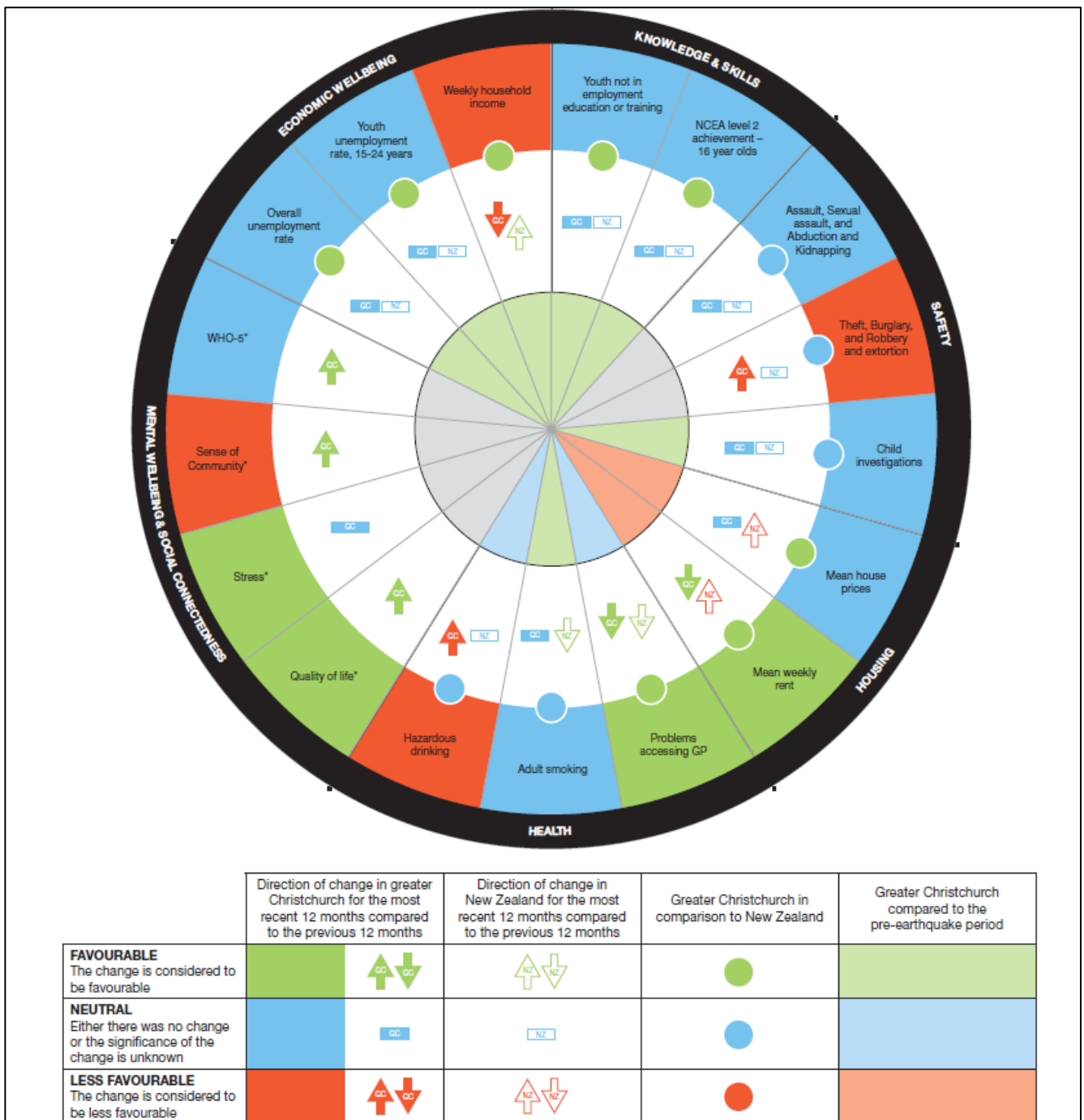
Seventeen of the indicators use data from the 'Canterbury Wellbeing Survey', an annual survey established to gather primary data for recovery in this area. Most of this data is quantitative (number or % of people) although it reports subjective assessments (people's perceptions and feelings), e.g. 'Proportion of those aged 18 years and over reporting feeling lonely or isolated'.

The remaining 40 indicators use data collected through government agencies (Ministries of Health, Education, Statistics, Housing, Police) and provide data for local authority ('district') areas or Health Board regions³⁸. These data sets have been collected nationally since before the 2011 earthquake event, so allow robust comparison to pre-event conditions and conditions in other (non-affected) parts of the country. These data sets are typically compiled annually, although some are collected more frequently (6 monthly) or less frequently (every 2-3 years) depending upon the agency. These indicators are typically quantitative, giving statistics such as % of houses overcrowded, or school attendance records (for example).

³⁷ The 10 wellbeing domains are: subjective wellbeing, civic engagement, social capital, safety, education, health, environment, employment, housing, and income.

³⁸ We have not been able to establish whether the Health Board regions cover the same area as the Local authority districts as there have been changes in the health boards.

Figure 4: An example of results from the Canterbury Wellbeing Index (CDHB, 2016)



Evaluation

The Canterbury Wellbeing Survey which provides data for the indicators under eight of the ten CWI domains, was evaluated by a team involving the public bodies responsible for the Survey and university researchers. The review evaluated how effective the survey had been in achieving its objectives and assessed the cross-government collaborative process by which it was developed (Morgan et al., 2015). This review found that:

- The inclusion of quality of life survey questions enables useful comparisons to areas not directly affected by the earthquakes and to national data, so that results can be interpreted in a wider context. One example was the drop in overall self-rated quality of

life, which in context appeared to be part of a wider, national trend rather than specific to Canterbury.

- Over time, there was a decrease in the proportion of respondents reporting that they were affected by many of the stressors. This may be reflecting the recovery process.
- The quality of life questions and the application of the survey over a long period of time made it possible to identify groups for whom the stressors had a particularly negative impact. The age group 39-45 appeared to experience cumulative impacts related to their life stage: they were more likely to report negative impacts associated with home ownership, distressed children and workplace issues, for example.
- Some stressors were found to continue to have a comparatively high negative impact on wellbeing. These were: dealing with private insurance companies, the persistence of being in a damaged environment and the loss of recreational, cultural and leisure facilities.

It appears that other reviews may have been carried out more recently but no information is available on their findings.

Relevance to Scotland

Table 13 shows the CWI outcome indicator headings that can be aligned with SCCAP2 outcomes and sub-outcomes. There are many parallels in the topics covered.

Other aspects that should be noted are:

- Recovery from Extreme Events comes under SCCAP2's 'Engaged public' and 'Empowered communities' sub-outcomes. Many of the activities associated with it relate to the response side of recovery (e.g. Are We Ready Facilitators Pack and the Fire and Rescue Framework). The CWI focuses more on the regeneration aspects of recovery, including education, income and employment.
- Supporting systems (SCCAP2 Outcome 4) are only reflected to a limited extent in the CWI indicators: there are indicators for satisfaction with access to transport, with community facilities and with recreation, cultural and leisure facilities. There are no indicators for the recovery of energy, water or communications infrastructure and services.

Potential application to Scotland

This CWI system is 'outcome' focussed, allowing recovery progress to be measured as improvements are felt on the ground in the affected area, rather than tracking the completion of recovery activities. It allows comparison between the earthquake-affected area and other parts of New Zealand and monitoring of change within the Canterbury area over time. The ability to compare outcomes between areas or between areas affected by an extreme weather event and parts of the country that have not been affected would be useful in Scotland.

Over half of the data used is taken from data sets collected routinely through Government Departments. Similar data sets are available for Scotland in most areas. However, the geographical level and frequency of collection of some of the Scottish data may not be of high enough resolution or sufficient frequency to be attributable to recovery from specific weather events.

17 of the 57 indicators are collected as primary data in the affected area through the Canterbury Wellbeing Survey. It is expected that this type of primary data collection may be necessary to fully investigate recovery in a small geographic area.

Table 13: Correspondence between CWI outcome indicators and SCCAP2 outcomes

SCCAP2 outcomes	Relevant CWI outcome / indicator domains	Notes on CWI domains
Communities (Outcome 1) Engaged public Empowered communities Resilient Places Resilient Historic Environment Resilient Buildings	Civic engagement Social capital Safety Environment Housing	For CWI: <i>Safety</i> covers physical safety. Physical safety is relevant to 'resilient places'. <i>Environment</i> covers built environment.
Climate Justice and Health (Outcome 2) Engaged Empowered Health and social care infrastructure Health effects	Social capital Education Subjective wellbeing Health Safety	For CWI: <i>Safety</i> covers physical and emotional safety. Emotional safety is relevant to mental health. <i>Education</i> includes young people not in education, employment or training and is relevant to mental health.
Economy (Outcome 3)	Income Housing Employment	For CWI: <i>Housing</i> includes the impact of housing costs on household income.
Supporting systems (Outcome 4)	Environment	For CWI: <i>Environment</i> includes Built environment (e.g. community facilities, roads, railway tracks, buildings etc.). There are no indicators for supporting systems (e.g. water, energy) or for governance systems.

Case Study 3: Zurich Flood Resilience Alliance Flood Resilience Measurement for Communities

Context

The Flood Resilience Measurement for Communities (FRMC)³⁹ (previously the Flood Resilience Measurement Tool) approach was developed by the Zurich Flood Resilience Alliance (ZFRA), a cross-sector collaboration between Zurich Insurance Group, NGOs and academia, in 2013.

The FRMC focuses on flood resilience at a community scale. It has been applied in over 110 communities in nine countries including the US.

Overview of system

The FRMC is a *'decision support tool to highlight strengths and weaknesses in community resilience'*, and *'provide evidence of how resilience in a community changes over time'* (ZFRA, 2019a, p6). It comprises two parts: a framework for measuring community flood resilience and an associated online and mobile app-based tool for implementing the framework in practice.

The FRMC looks at how communities can reduce flood risks, prepare for floods, respond to floods when they do occur, recover from floods and avoid the build-up of more flood risk in the future. The focus is on resilience to flooding, though it can be applied to other extreme weather events, and on recovery of communities including individuals and businesses.

The goal of resilience is seen to be to enhance wellbeing rather than simply to manage disaster risks more effectively. Recovery is understood as return to pre-event levels of functioning, and risk reduction in the next cycle. For example, FRMC argues that financial recovery should mean returning to the same level of income as before the extreme weather event, without having any additional financial liabilities in terms of debts (Campbell et al., 2019). Financial recovery is sometimes prioritised as an enabling factor in recovery. For FRMC, individual financial recovery is described as *'returning to pre-event income levels, and paying off damage and repair costs.'* (Campbell et al., 2019, p4).

The FRMC is designed specifically for the community scale, therefore some of the indicators would be difficult to scale up. Staff from local offices of the ZFRA member organisations are responsible for working with local communities to develop indicators and for gathering and assessing the data.

Indicators

Overall, the FRMC has 73 indicators comprising:

- 44 'sources of resilience' grouped under 5 headings based on the five complementary 'capitals' or capacities: human, social, physical, natural and financial (ZFRA, 2019a, p2)⁴⁰;
- 29 linked (post-flood) resilience outcome indicators⁴¹ (ZFRA, 2019b, p8).

³⁹ <https://floodresilience.net/frmc>

⁴⁰ The five capitals cover all the things that people need to thrive: **Human** (education, skills, health). **Social** (social relationships and networks, bonds that promote cooperation, links facilitating exchange of and access to ideas and resources). **Physical** (things produced by economic activity from other capital, such as infrastructure, equipment, improvements in crops, livestock). **Natural** (natural resource base, including land productivity and actions to sustain it, as well as water and other resources that sustain livelihoods). **Financial** (level, variability and diversity of income sources and access to other financial resources that contribute to wealth). (ZFRA, 2019a, p2).

⁴¹ The outcome indicators can be looked at in different ways, for example: do they relate to the community level or to the wider context and what aspects of life ('themes') are affected (assets, livelihoods, natural environment, life and health, lifelines/support structures, governance, social norms) (ZFRA, 2019b, p8).

We have identified 43 of these indicators as being potentially relevant to measuring recovery, on the basis that they may affect the recovery process or reflect recovery outcomes. These comprise 21 pre-event ‘sources of resilience’ and 22 post-flood outcome indicators⁴². These indicators provide a mix of process and outcome indicators. It should be noted that since the full tool is not publicly available the identification of recovery relevant ‘sources of resilience’ indicators is based on a short headline description of the indicator as opposed to a full explanation, while the post-flood ‘outcomes’ indicators are more fully specified, often including a series of sub-questions.

The full software tool and supporting website is private and only accessible for trained users from the ZFRA therefore it is not possible to comment on how the indicators are presented within the tool. However, in accompanying guidance ZFRA (2020) suggests there are different ways of presenting FRMC results through the different lenses incorporated within the approach (e.g. five capitals, context, 7 themes) (ZFRA, 2020a).

Data

FRMC data can be collected from primary sources (household surveys⁴³, key informant interviews, focus group discussions) and secondary sources according to context and need. The guidance recommends using more than one source, to increase reliability (ZFRA, 2019a,b).

Data is collected pre-event to provide a baseline of sources of resilience, and after a flood to compare the assessment with outcomes. The ‘sources of resilience’ indicators can also be measured at intervals over time (e.g. every 1 or 2 years) to track progress.

For the post-flood assessment, most of the indicator data is collected within 1 - 2 months after the flood, though data for some indicators can be collected during and immediately after the flood, and others ask for information related to longer-term recovery within specific intervals after the flood. For example, post-flood illness occurring within 3 months (O11), negative impacts on Household income stability (O14) that may take up to 3 months, between 3-12 months, and more than 12 months after flood to recover; and expectations about whether repairs to damage to private (O06) or public (O07) buildings and land will be completed within 3 months, 6 months, 12 months, or longer than 12 months.

Evaluation

The FRMC has had three evaluations (one in 2017 and two in 2018) leading to improvements in implementation. As a result of the evaluation of the first phase of the tool’s development, the number of resilience sources on which data is collected was reduced from 88 to 44. Lessons learnt from measuring flood resilience include (Laurien et al. 2019):

- Users are able to track community progress on resilience over time in a standardised way
- Information from the application of the tool has been used to prioritise resilience-building measures
- At both community and higher decision-making levels, measuring resilience has provided a basis for improving the design of innovative investment programs to strengthen disaster resilience.

⁴² Seven of the post-flood outcomes indicators were excluded due to being considered out of scope for the current research: these were either related to hazard characteristics, natural environment or focused on preparation rather than recovery.

⁴³ The post-flood outcome indicators are not designed to be collected from a household survey rather it is suggested that data is gathered through group discussions, key informant interviews, and secondary sources (ZFRA, 2019b).

Relevance to Scotland

The FRMC indicator headings assessed by the research as relevant to Recovery, largely cover the four SCCAP2 outcome areas, as shown in Table 14.

Table 14: Correspondence between FRMC indicators and SCCAP2 outcomes

SCCAP2 outcomes	Relevant FRMC indicator headings ⁴⁴	Notes on FRMC headings
Communities (Outcome 1) Engaged public Empowered communities Resilient Places Resilient Historic Environment Resilient Buildings	Social capital expressed as trust, reciprocity, collective action, information sharing, and participation. Physical capital expressed in infrastructure, equipment, improvements in crops, and livestock <i>Assets</i> <i>Social norms</i> <i>Governance</i>	For FRMC: <i>Assets</i> includes damage to private and public buildings and land. <i>Social norms</i> include property crime and mutual support within communities <i>Governance</i> includes learning from events
Climate Justice and Health (Outcome 2) Engaged Empowered Health and social care infrastructure Health effects	Social capital (see above) Human capital expressed as knowledge, education, creativity, health, social skills, leadership skills, and memories. <i>Life and health</i> <i>Governance Livelihoods</i>	For FRMC: <i>Governance</i> includes learning from events <i>Livelihoods</i> includes education
Economy (Outcome 3)	Financial capital including income, savings, remittances, investments, safety nets, loans or the ability to use assets to get loans. <i>Assets</i> <i>Livelihoods</i>	For FRMC: <i>Assets</i> includes damage to business premises and land, and contents and equipment losses which can affect livelihood and income generate activities e.g. farming <i>Livelihoods</i> includes income stability, high interest credit, insurance payments, sale of productive assets
Supporting systems (Outcome 4)	Physical capital (see above) Natural capital providing goods and services (food, water, fuel, etc.). <i>Lifelines/supporting structures</i> <i>Livelihoods</i>	For FRMC: <i>Lifelines/supporting structures</i> includes communications, transport, energy and fuel supply. <i>Livelihoods</i> includes continuity of education etc.

⁴⁴ FRMC has two types of indicators: sources of resilience (measured pre-event and ongoing) based on the five capitals and resilience outcomes (measured during and after a flood event) which can be grouped by seven themes.

Potential application to Scotland

The FRMC is intended to support decision-making and provide evidence on how community resilience changes over time by being deployed at various stages of a long-term (multi-year) community resilience building programme.

The FRMC has been developed to monitor resilience more widely rather than recovery. In Scotland there are already a number of tools for measuring community resilience, specifically within the NPF 'Communities' outcomes and SCCAP2's '*resilient places*'. The need in Scotland is to ensure that the recovery element of resilience is effectively monitored and that evidence from recovery can inform decision-making. It is not clear how well measuring only the FRMC indicators assessed as relevant to recovery would work in terms of coverage of key aspects of recovery resilience (capitals, themes, contexts). Currently the indicators assessed as relevant to recovery cover many of the outcomes of relevance to SCCAP2, though it remains to be assessed whether these provide the right balance of indicators (e.g. whether these capture physical, social, human or financial capital to the correct degree).

In terms of the availability of Scottish data to support measurement of the identified recovery relevant indicators, we have found a number of potential secondary data sources. Notably, many of these provide only a proxy and/or partial picture of the intended indicator. For example, O21 Property crime may be partially informed by Scottish Household Survey data on Anti-social Behaviour but this does not capture theft and looting.

In line with the FRMC's post-flood outcomes indicators, for many indicators more than one variable from the secondary data could be used. For example, O15 Food security may be informed by data from three Scottish Health Survey questions on food insecurity, as well as questions on fruit and vegetable consumption and eating habits. However, as with other indicators, the timeliness of data sources is important, since data collected every year or even less frequently may not tell us anything about impacts of extreme weather events on access to enough and good quality food.

Some indicators could draw on the same Scottish data variable (for example, both F02 Community disaster fund and F04 Household income continuity strategy may draw on data on Scottish Welfare Fund Applications to the Crisis Grant). However, further consideration should be given to ensure there is no potential of 'double counting' progress towards recovery resilience.

Existing secondary data has not yet been identified for a number of the indicators, for example, O20 Continuity of energy and fuel supply, O26 Sale of productive assets, and O27 Risky livelihoods, among others. It may be possible to address some of the gaps in data through other secondary data sources for example, local authority data, or reports by service providers, and/or by including new additional questions in existing surveys such as the Scottish Household Survey, Health Survey or Annual Business survey.

Appendix 4: International examples' use of capitals or domains in relation to recovery

Social capital

Social capital is expressed as the *'social relationships and networks, bonds that promote cooperation, links facilitating exchange of and access to ideas and resources'* (ZFRA, 2019a, p2). People's connections to their communities are important, particularly in recovery after disaster (CDHB, 2016). Social capital is known to increase in the immediate aftermath of an extreme event or disaster but can deplete entirely in the recovery phase. For example, *'Communities themselves may be resistant to how their communities are being rebuilt if solutions are imposed on them without listening to the communities' themselves [16-18]. Therefore, planning in advance for the recovery of communities in parallel with planning for responses to different scenarios needs to be more thoroughly explored and understood.'* (Sou, 2019, Marshall, 2019, and Rossi, 2019; cited in Baxter, 2020, p. 1).

The FRMC measures many aspects of social capital recovery, including process indicators such as community representative bodies (S06), and community participation in flood related activities (S01), in order to ensure community perspectives and needs are reflected in recovery, and external flood response and recovery services (S02) to support achievement of recovery, as well as outcomes indicators on external support (O25) including whether this is available to only some or all of community. One important social capital outcome related to social norms is mutual support (O24), reflecting the capacity of communities to help each other to recover, as well as learning from flood (O22) whether the community is reflecting and learning from the flood, and putting those lessons into practice. Other social norms include community safety (S03), prevalence of property crime, such as theft or intentional damage of property.

The AIDR tool similarly includes the following key aspects of social capital recovery: ability to manage needs, support others, and recovery assistance related to trust in the community, police, doctors; community safety reflected in feelings of safety at home and from disaster; community awareness of acting to reduce impact of future events, community social indicators related to Participation in volunteer activities, trust in community, having someone to turn to for support outside the household, social networks and unity within communities and have social networks to support each other; as well as crime offences and perception of social disorder in local areas; that a community can express its diverse spiritual composition; and cultural and racial diversity is respected. Wider resilience and sustainability outcomes include civil society engagement, for example, community awareness of disaster recovery processes and ability to express changing disaster recovery needs; and that *'Government, private sector and civil society and organisations are engaged in plans for mitigation and management of the recovery'* (ANZSOG, 2018, p11).

The CWI has many indicators measuring social capital recovery including: sense of community, a sense of belonging and acceptance, trust, community spirit and emotional connections; contact with family and friends which can provide a source of social support and connection and help; loneliness and isolation is associated with poor health and therefore reducing this is important to preserving or enhancing social capital; emotional support (sympathy, encouragement, understanding etc.) from others and ease of access to this can help with managing stress and transitions; personal identity, ability to be oneself and inclusive communities enable full participation by members; conversely discrimination can negatively affect participation and wellbeing; participation and attendance in arts and sports, can assist with life satisfaction, happiness, cultural, social, educational, and health benefits; unpaid activities including unpaid work and volunteering can contribute to wellbeing, skills development and social cohesion; and confidence in agencies such as local and central government can influence engagement and participation in decision-making processes related to recovery.

CWI's civic engagement domain captures participation in public decision making (e.g. voter turnout), confidence in ability to influence decision-making and trust in public agencies and processes (CDHB, 2020a), which can provide a way to contribute to community recovery and which is important to wellbeing (CDHB, 2016).

Campbell et al. (2019) comment that *'the relatively high number of social capital sources is due to the fact that social capital tends to be less tangible and therefore more indicators are needed to help proxy the measurement and also because social capital also includes aspects of governance or what might be termed 'political capital' (p4).*

Human capital

Human capital encompasses the knowledge, education, skills, health of the people in the community, including aspects such as creativity, social skills, leadership skills, and memories (ZFRA, 2019a). For example, for rural communities, food security during and after flood can be a significant issue (Laurien et al. 2019). Importance is also placed on considering different groups such as those more vulnerable, *"Moreover, greater emphasis is needed on designing interventions for poor and struggling rural communities with very low coping capacity."*⁵ (Laurien et al. in review, cited in Laurien et al., 2019, p.8).

For FRMC recovery of human capital is related to themes of life and health, governance, and livelihoods, as well as hazard traits, for example, the percentage of the community directly impacted (O03). The tool places emphasis on health and education including: post-flood illness (O11) such as illness and fatalities due to outbreaks of water- and vector-borne disease; flood healthcare continuity (O12), including nature and severity of any impacts, ability to meet needs and consequences in 3 months following the flood event; food security (O15) related to quantity and quality of food, going hungry and impacts on nutrition and calorie intake which in recovery phase may be affected by reduced sources or access to food (e.g. increased food prices or reduced incomes meaning people are unable to buy food); safe water (O18); continuity of education (O13) includes school drop-out rates due to impacts of flood. Alongside this, governance awareness (H09) may play a role in human capital recovery, for example awareness of arrangements for managing recovery.

Within its Social domain, the AIDR tool examines many aspects of human capital recovery including: access to and ensuring health needs are met, for example, community health levels are appropriate for the community profile, communities can access health services and continuity of care, psychosocial support is available such that community members not experiencing stress or hardship, communities have opportunities for creative expression that can help recovery from disaster, and community members have the knowledge, skills, and resources for dealing with health issues related to the disaster experience. Education – community members receive continuity in the education services they need, safety – community members can manage their own safety. Resilience includes that the needs of vulnerable groups are addressed in disaster recovery.

For CWI human capital recovery relates to domains of education, safety, health and wellbeing with significant emphasis on the latter two (CDHB, 2020b). Education affects employment, income and health and wellbeing, equity and fairness. Relevant aspects to measure for CWI include participation in early childhood education, levels of achievement in school leavers, and proportion of young people not in employment, education, or training. Perception and experience of safety impact strongly on wellbeing, quality of life, and participation in the community, as well as on employment opportunities and private sector investment (CDHB, 2020b). Different components of health are considered related to the status of health, for example, self-reported health, acute medical admission rates, and mental wellbeing, and also the factors that influence health status, such as behaviours e.g. smoking, physical activity, and access to health care (CDHB, 2020c). Wellbeing relates to the quality of life, emotional wellbeing, stress and sense of purpose (CDHB, 2020d).

Economic/financial capital

Economic/financial capital encompasses the ‘*level, variability and diversity of income sources and access to other financial resources that contribute to wealth*’ (ZFRA, 2019a). This includes income, savings, remittances, investments, safety nets, loans or the ability to use assets to get loans. The importance of economic/financial capital to recovery is widely recognised in the different frameworks.

The FRMC focuses on a range of aspects of financial recovery including process and outcome such as: household asset recovery (F01); community disaster fund (F02); business continuity (FO3); having a household income continuity strategy (F04) is considered particularly important to recovery; household income stability (O14), the strength of community income levels after the event or longer, including negative impacts and ability of meet basic needs; sale of productive assets (O26), a negative coping strategy which affects the potential for longer-term economic recovery; whether or not risky livelihoods (O27) are adopted to cope with economic losses which can negatively impact on wellbeing; high interest credit (O28), while access to credit can be an important coping strategy, high interest rates can have negative consequences over time; and Insurance payments (O29), whether or not households and businesses in the community have flood insurance, the comprehensiveness of cover, the speed with which insurance can help households and businesses to recover quickly, and linked to this how quickly payments are received.

The AIDR tool has many sub-categories of outcomes and indicators measuring economic/financial capital recovery including financial security (e.g. household debt levels, people with cash flow problems, community satisfaction with financial support received), business confidence (e.g. Businesses operational and remaining in business, businesses that expected to be able to expand), business resilience (perceptions of benefits from business plans in disaster recovery), economic activity (e.g. jobs by sector). The AIDR tool economic domain, includes financial and banking, business, not-for-profit services, business insurance, community access to financial workforce skills; and resilience and sustainability outcomes includes community access to insurance (covering lives, homes and other property) through insurance markets or micro-finance institutions, where appropriate and viable (ANZSOG, 2018).

For CWI recovery of economic/financial capital relates directly to domains of income, including household income levels, prevalence of low household income, and satisfaction with income; and employment, which has a strong influence on income through unemployment, employment and underemployment rates, labour force participation, and job satisfaction which provides a different perspective on economic/financial capital related to overall life satisfaction. Housing also plays factor in recovery of economic/financial capital through impacts of housing costs on household income, for example affordability of housing.

“From self-reports of past post-flood financial recovery time, we can show that the sources of resilience most highly associated with faster financial recovery are in the financial and physical capital categories. After a flood, having a household income continuity strategy was particularly important for recovery. Physical access to food markets was also found to support faster financial recovery.” (p8) (Campbell et al. 2019 cited in Laurien et al. 2019)

Physical capital

Physical capital can be described as the ‘*things produced by economic activity from other capital, such as infrastructure, equipment, improvements in crops, livestock*’ (ZFRA, 2019a).

The FRMC includes private building and land damage (O06) specifically homes and business premises includes proportion impacted, extent of damage and how long repairs may take, and likewise the same for public building and land damage (O07). A key aspect is contents and equipment loss (O08) which relates to loss or destruction of physical assets including for

households, business and livelihood/income generation activities, and public organizations. This includes physical capital related to education provision (P04) and continuity (O13); flood energy supply (P12) which provides an important lifeline to aid community recovery; transportation interruption (P07) and performance (O17); likewise communication interruption (P08) and performance (O17), for example whether transport infrastructure is quickly repaired and accessible can be critical to community recovery; access to safe water (O18) related to contamination of supply or impact on transportation/delivery of water; waste management performance (O19); continuity of energy and fuel supply (O20) for example impacts on reliability, quality and accessibility after events which may affect community ability to recover.

The AIDR's built domain includes recovery of infrastructure that: delivers essential services including water, sewerage, electricity and gas, transport, telecommunications; relates to education, health, justice, welfare and any other community infrastructure/buildings that support the community (private or public owned assets); and also private infrastructure, including residential, commercial/industrial and rural assets – and the expectation that is built to meet changing recovery needs (ANZSOG, 2018). For example, rebuilt properties with increased fire safety design, and grants to undertake resilience-building repairs to homes. Additionally, its environmental domain include recovery outcomes related to the restoration of cultural heritage (sites or assets) such that these provide values to the community. A broader sustainability outcome is for any displaced population to be able to return to community.

For CWI physical capital recovery is covered within the domains of: housing related to housing availability, affordability and quality (i.e. warm, dry, sufficient space and amenities) which may impact health and wellbeing; environment which includes the built environment and covers local community facilities, access to transport (e.g. roads, railway etc.), sports, recreational and cultural facilities; and safety which includes physical assets through '*property-related victimisation*' such as theft, burglary, and robbery (CDHB, 2020b, p10).

References

- Australian Institute for Disaster Resilience (AIDR). (2019) *Emergency Management Arrangements*. Australian Disaster Resilience Handbook Collection.
- Australian Institute for Disaster Resilience (AIDR). (2018) *Community Recovery Handbook*. Australian Disaster Resilience Handbook Collection.
<https://knowledge.aidr.org.au/media/5634/community-recovery-handbook.pdf>
- Australia and New Zealand School of Government (ANZSOG). (2018) *A Monitoring and Evaluation Framework for Disaster Recovery Programs. Version 2 - May 2018*. Australia and New Zealand School of Government Report. <https://knowledge.aidr.org.au/media/5967/a-monitoring-and-evaluation-framework-for-disaster-recovery-programs-v2.pdf>.
- Baxter, H. (2020) *When does response end and recovery begin: what can practitioners take from academic research?* Unpublished Case for research
- Becker, D., Schneiderbauer, S., Forrester, J. and Pedoth, L. (2015) *Guidelines for development of indicators, indicator systems and provider challenges*. emBRAC.E Deliverable 3.5. eprints White Rose.
- Cabinet Office. (2019) *Community Resilience Development Framework. A reference tool for the delivery of strategic approaches to community resilience development, at the Local Resilience Forum level in collaboration with non-statutory partners*. June 2019. HM Government.
https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/828813/20190902-Community_Resilience_Development_Framework_Final.pdf
- Cabinet Office. (2016) *Community Resilience Framework for Practitioners*. HM Government.
- Cabinet Office. (2013) *Emergency Response and Recovery. Non statutory guidance accompanying the Civil Contingencies Act 2004*. 5th Edition, 2013. HM Government.
https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/253488/Emergency_Response_and_Recovery_5th_edition_October_2013.pdf
- Campbell, K. A., Laurien, F., Czajkowski, J., Keating, A., Hochrainer-Stigler S., and Montgomery M. (2019) *First insights from the Flood Resilience Measurement Tool: A large-scale community flood resilience analysis*. International Journal of Disaster Risk Reduction, 40 (2019), 101257.
<https://doi.org/10.1016/j.ijdr.2019.101257>
- Canterbury District Health Board (CDHB). (2020a) *CWI: Social capital*. Community & Public Health - A Division of the Canterbury District Health Board. Downloaded from <https://www.canterburywellbeing.org.nz/our-wellbeing/social-capital/> on 26/03/2020.
- Canterbury District Health Board (CDHB). (2020b) *CWI: Safety*. Community & Public Health - A Division of the Canterbury District Health Board. Downloaded from <https://www.canterburywellbeing.org.nz/our-wellbeing/safety/> on 27/03/2020.
- Canterbury District Health Board (CDHB). (2020c) *CWI: Health*. Community & Public Health - A Division of the Canterbury District Health Board. Downloaded from <https://www.canterburywellbeing.org.nz/our-wellbeing/health/> on 27/03/2020.
- Canterbury District Health Board (CDHB). (2020d) *CWI: Subjective Wellbeing*. Community & Public Health - A Division of the Canterbury District Health Board. Downloaded from <https://www.canterburywellbeing.org.nz/our-wellbeing/subjective-wellbeing/> on 27/03/2020.
- Canterbury District Health Board (CDHB). (2016) *Canterbury Wellbeing Index 2016*. Canterbury District Health Board Report. <https://www.cph.co.nz/wp-content/uploads/CantyWellbeingIndexSept2016.pdf>
- Canterbury Earthquake Recovery Authority (CERA). (2016) *Canterbury Wellbeing Index June 2016*. Canterbury Earthquake Recovery Authority Report
- Canterbury Earthquake Recovery Authority (CERA). (2014) *Canterbury Wellbeing Index June 2014*. Canterbury Earthquake Recovery Authority Report
- Canterbury Earthquake Recovery Authority (CERA). (2013) *Greater Christchurch Earthquake Recovery Monitoring and Reporting Plan*. Canterbury Earthquake Recovery Authority Report
- Committee on Climate Change. (2016) *Scottish Climate Change Adaptation Programme: An independent assessment for the Scottish Parliament*. Committee on Climate Change.
<https://www.theccc.org.uk/publication/scottish-climate-change-adaptation-programme-an-independent-assessment-for-the-scottish-parliament/>

- Currie, M., Philip, L. and Dowds, G. (2020) *Long-term impacts of flooding following the winter 2015/16 flooding in North East Scotland: Summary Report*. CRW2016_02. Scotland's Centre of Expertise for Waters (CREW).
- Deeming, H. (2018) *A review of recovery processes following Storm Desmond's impacts on Cumbria (5th/6th Dec 2015). Final Report*. Cumbria Resilience.
- Department for International Development (DFID). (2011) *Defining Disaster Resilience: A DFID Approach Paper*. Policy Paper.
https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/186874/defining-disaster-resilience-approach-paper.pdf
- Hegger, D. L. T., Driessen P. P. J., M. Wiering, H. F. M. W. Van Rijswijk, Z. W. Kundzewicz, P. Matczak, A. Crabbé, G. T. Raadgever, M. H. N., Bakker, S. J. Priest, Larrue, C., and Ek, K. (2016) *Toward more flood resilience: Is a diversification of flood risk management strategies the way forward?* Ecology and Society 21(4):52. <https://doi.org/10.5751/ES-08854-210452>
- Horney, J., Dwyer, C., Aminto, M., Berke, P., Smith, G. (2016) *Developing indicators to measure post disaster community recovery in the United States*. Journal of Disasters March 2016
- Keating, A., Campbell, K., Szoenyi, M., McQuistan, C., Nash, D., Burer, M. (2017) *Development and testing of a community flood resilience measurement tool*. Nat. Hazards Earth Syst. Sci., 17, 77–101.
- Kruse, S., Abeling, T., Deeming, H., Fordham, M., Forrester, J., Jülich, S., Karanci, N., Kuhlicke, C., Pelling, M., Pedoth, L. and Schneiderbauer, S. (2017) *Conceptualizing community resilience to natural hazards –the emBRACE framework*. Natural Hazards Earth Systems Science., 17, 2321–2333.
- Laurien, F., Keating, A., Mechler, R., Etienne, E., Velez, S., Szoenyi, M., McQuistan, C., Ianni, F., Campbell, K., (2019) *Lessons Learned from Measuring Flood Resilience*. IIASA Working Paper. IIASA, Laxenburg, Austria: WP-19-007. <http://pure.iiasa.ac.at/id/eprint/16065/>
- London Resilience Partnership. (2016) *Recovery Management Protocol*. Version 1.0 September 2016.
- Milosevic, A., Armstrong, B. and Wilkinson, P. (2017) *Journal of Epidemiological Community Health 2017; Volume 0:1–4*. Mental health impacts of flooding: a controlled interrupted time series analysis of prescribing data in England. <http://dx.doi.org/10.1136/jech-2017-208899>
- Morgan, J., Begg, A., Beaven, S., Schluter, P., Jamieson, K., Johal i, S., Johnston, D. and Sparrow, M. (2015) *Monitoring wellbeing during recovery from the 2010–2011 Canterbury earthquakes: The CERA wellbeing survey*. International Journal of Disaster Risk Reduction 14(2015) 96–103.
- New Zealand Government. (2011) *Canterbury Earthquake Recovery Act 2011*. No. 12 (2011) New Zealand, Parliamentary Counsel Office.
<http://www.legislation.govt.nz/act/public/2011/0012/latest/DLM3653522.html>
- Ryan, R., Wortley, L., Ni She, E. (2016) *Evaluations of post-disaster recovery: A review of practice material*. Evidence Base, (4): 1-33.
- Scottish Government (2017) *Preparing Scotland: Recovering from Emergencies in Scotland*.
<https://www.readyscotland.org/media/1418/preparing-scotland-recovering-from-emergencies-published-version-september-2017.pdf>
- Scottish Government. (2019) *Climate ready Scotland: Second Scottish Climate Change Adaptation Programme 2019-2024*. September 2019. Published by The Scottish Government, September 2019. <https://www.gov.scot/publications/climate-ready-scotland-second-scottish-climate-change-adaptation-programme-2019-2024/>
- Scottish Government. (2019a) *Preparing Scotland: Scottish guidance on resilience- Philosophy, principles structures and regulatory guidance*.
<https://www.readyscotland.org/media/1496/preparing-scotland-hub-updated-published-version-may-2019-new-h-s-diagram.pdf>
- Scottish Government. (2020) *Towards a robust, resilient wellbeing economy for Scotland*. Report of the Advisory Group on Economic Recovery. Published by The Scottish Government, June 2020.
<https://www.gov.scot/binaries/content/documents/govscot/publications/strategy-plan/2020/06/towards-robust-resilient-wellbeing-economy-scotland-report-advisory-group-economic-recovery/documents/towards-robust-resilient-wellbeing-economy-scotland/towards->

[robust-resilient-wellbeing-economy-scotland/govscot%3Adocument/towards-robust-resilient-wellbeing-economy-scotland.pdf](https://www.gov.scot/publications/scotlands-people-annual-report-2018-robust-resilient-wellbeing-economy-scotland/pdf)

Scottish Household Survey. (2019) *Scotland's People Annual Report 2018*. A National Statistics publication for Scotland. Scottish Household Survey Project Team, Communities Analysis Division, The Scottish Government, September 2019.

<https://www.gov.scot/publications/scotlands-people-annual-report-results-2018-scottish-household-survey/>

Scotland's National Performance Framework. (Undated) *Our Purpose, Values and National Outcomes*. www.nationalperformance.gov.scot

The Data Center. (2015) *The New Orleans Index at Ten - Measuring Greater New Orleans' Progress toward Prosperity*. The Data Center Report.

https://s3.amazonaws.com/gnocdc/reports/TheDataCenter_TheNewOrleansIndexatTen.pdf

Twigger-Ross, C., Orr, P., Brooks, K., Sadauskis, R., Deeming, H., Fielding, J., Harries, T., Johnston, R., Kashefi, E., McCarthy, S., Rees, Y. and Tapsell, S. (2015) *Flood Resilience Community Pathfinder Evaluation. Final Evaluation Report*. London: Defra.

Walker, M., Whittle R., Medd, W., Burningham, K., Moran-Ellis, J. and Tapsell, S. (2010) *Children and young people 'after the rain has gone' - learning lessons for flood recovery and resilience*, Final project 'Children, flood and urban resilience: Understanding Children and Young People's Experience and Agency in the Flood Recovery Process'. Lancaster: Lancaster University.

Zurich Flood Resilience Alliance (ZFRA). (2020a) *The Flood Resilience Measurement for Communities (FRMC). From results analysis to intervention planning*.

<http://repo.floodalliance.net/jspui/bitstream/44111/3312/1/1026-PA-ZFRA-ResultsToEnhance-Guide-V6b-WEB-V2.pdf>

Zurich Flood Resilience Alliance (ZFRA). (2020b) *The Flood Resilience Measurement for Communities (FRMC). Project set up, study set up, data collection, and grading*.

<https://floodresilience.net/resources/item/flood-resilience-measurement-for-communities-project-set-up-study-set-up-data-collection-and-grading>

Zurich Flood Resilience Alliance (ZFRA). (2019a) *The Flood Resilience Measurement for Communities (FRMC)*. <https://www.floodresilience.net/resources/item/the-flood-resilience-measurement-for-communities-frmc>

Zurich Flood resilience Alliance (ZFRA). (2019b) *The Flood Resilience Measurement for Communities (FRMC). Post-flood study – User guide*.

<https://www.floodresilience.net/resources/item/flood-resilience-measurement-for-communities-post-flood-study-user-guide>

Zurich Flood Resilience Alliance (ZFRA). (2018) *The Zurich flood resilience program – Phase 1 from 2013-2018. Stocktaking and impact evaluation report*.

<https://floodresilience.net/resources/item/the-zurich-flood-resilience-program-phase-1-from-2013-2018-stocktaking-and-impact-evaluation-report>

© Published by Collingwood Environmental Planning, 2020 on behalf of ClimateXChange. All rights reserved.

While every effort is made to ensure the information in this report is accurate, no legal responsibility is accepted for any errors, omissions or misleading statements. The views expressed represent those of the author(s), and do not necessarily represent those of the host institutions or funders.

climateXchange

Scotland's centre of expertise connecting
climate change research and policy

✉ info@climatexchange.org.uk
☎ +44(0)131 651 4783
🐦 @climatexchange_
➦ www.climatexchange.org.uk

ClimateXChange, Edinburgh Centre for Carbon Innovation, High School Yards, Edinburgh EH1 1LZ