Disaster Loss Data Management in Scotland

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KEY MESSAGES

- Collecting and managing disaster loss data can help stakeholders to understand disaster risks, and develop strategies for managing and mitigating the impacts.
- Different frameworks for disaster loss data collection have been developed for international, regional, and European domains, with each domain facing different challenges including governance, quality, coverage, availability and accessibility of data.
- There are four main applications for collected data: calculation of data loss compensation, accounting for national loss statistics, disaster forensics to learn lessons from past events, and risk modelling.
- The authors suggest two main options for collecting and managing disaster loss data in Scotland: A unified database of Hazard Impact Loss Data (HILDA), and a Register of Hazard Impacts: Numbers and Observations (RHINO).

EXECUTIVE SUMMARY

Understanding what is currently lost or affected by disasters is a complex but essential process (Fakhruddin et al. 2017). Improving the collection and management of observed impact and loss measurements (disaster loss data) can help achieve short-term and long-term development goals and help address disaster risks. Collecting and managing disaster loss data allows stakeholders to evaluate disaster policies, identify driving factors in loss trends and enable the generation of early warning systems (Bouwer et al. 2007). The Sendai Framework for Disaster Risk Reduction: Understanding disaster risk (UNISDR, 2015) encourages countries "to systematically evaluate, record, share and publically account for disaster losses" (UNISDR, 2015 p15). Approaches to addressing this aim vary between countries, regions and organisations (Gall et al. 2009; Corbane et al. 2015a), and are dependent on a complex variety of factors including governance structures, the hazards faced, capability to address the UN-ISDR aims, and the requirements of users.

ES1 PURPOSE

The Natural Hazards Partnership (NHP) has been commissioned by the Scottish Government to develop a strategy for encouraging collaboration of disaster loss data collection in Scotland. International perspectives were formed from a literature review. The Scottish perspective of data collection was formed from semi-structured interviews with Scottish Government and two focus groups conducted at a National Centre for Resilience workshop.

ES2 MAIN OUTCOMES

International organisations have made significant progress into developing frameworks for collecting and using disaster loss data. These have been used to categorise hazard events using a hierarchical system and identify priority impact metrics for national and international measurement. These efforts focus on human and economic impacts. The Joint Research Council (JRC) has combined this learning to develop a conceptual framework for disaster loss data collection at a European scale.

From these frameworks, several international databases have been created in developing countries where there is a lack of recorded data and no formal processes to undertake such a task. These databases provide a global standard for disaster loss data collection and have been designed for simplicity to encourage uptake. However, the national scale of data collection means that smaller disasters are not included, less critical impacts are not recorded and methodologies for each database differ.

For Scotland, the perspectives of neighbouring European countries are more relevant. In these developed countries, there are often established frameworks for disaster loss data collection in place. However across Europe, these differ in terms of underlying legislative support, levels of funding and its sources, IT infrastructures, data collection techniques, quality, coverage and ownership and public access rights. Consequently, this has produced a fragmented and disjointed data landscape. The challenge in these countries is subsequently how to make best use of the wealth of available data. To achieve this, it must be possible to identify the full spectrum of data available, identify gaps and data quality concerns and engage responsible organisations in data sharing.

In Scotland, key stakeholders in disaster risk management include the Scottish Environment Protection Agency (SEPA), the Met Office, the British Geological Survey (BGS) and local government.

These bodies hold a high regard for disaster loss data although data are collected for a variety of purposes. These include:

- Calculation of disaster loss compensation based on economic impacts, conducted by insurance companies.
- Disaster loss accounting for national reporting of statistics. While some bodies report disaster statistics at national level, Scotland and the wider UK does not yet have comprehensive processes in place to facilitate this. Improving this situation would assist the UK in its commitment to the international Sendai Agreement.
- Disaster forensics to learn lessons from past events for future response actions. This is the most common activity using disaster loss data in Scotland. Data collection is collaborative and compiled into post-event reports for evaluation by multi-agency Resilience Partnerships.
- Risk modelling to calibrate and validate prediction and forecasting models. This is also common across Scotland and relies on highly detailed disaster loss data, although sample sizes presenting case studies can be smaller than full national coverage. Risk modelling is undertaken by organisations such as SEPA and the Met Office and used to inform and generate warnings.

The prominence of flooding the Scottish national resilience agenda has therefore led to the identification of SEPA as having robust and well-considered systems of data collection and use.

ES3 RECOMMENDATIONS

There are two recommended options for developing the framework of Scotland's disaster loss data collection and improving collaboration between key stakeholders:

1. A unified database of *Hazard Impact Loss Data* (HILDA). This approach envisions the collation of all collected disaster loss datasets across Scotland. The unified database would represent a single source of data for all interested parties and would incorporate a standardised system of data collection, input and quality control. However, this approach is considered idealistic and currently impractical and expensive to implement.
2. An alternative is to generate a *Register of Hazard Impacts: Numbers and Observations* (RHINO). Instead of collating different data, as above, this option creates a list of database names and an overview of summary metadata to allow users to understand what data is available, where it is located, in what format and in what quality. This approach requires much less commitment from active stakeholders, but would provide the entire community with a comprehensive overview of all available disaster loss data.

In addition, there may be potential to extract useful impact information from post-event impact reports used by Resilience Partnerships. This could provide a new source of highly detailed local impact information for a catalogue of historic events, which would be useful across all applications listed above, but particularly for disaster forensics and risk modelling.

CONTENTS

LIST OF KEY ABBREVIATIONS

IRDR	Integrated Research on Disaster Risk
JRC	Joint Research Council
OECD	Organisation for Economic Co-operation and Development
UNDP	United Nations Development Programme
UNISDR	United Nations International Strategy for Disaster Reduction
SEPA	Scottish Environment Protection Agency
BGS	British Geological Survey

1 INTRODUCTION

Understanding what is currently lost or affected by disasters is a complex but essential process (Fakhruddin et al. 2017). The collection and management of information on observed impacts and loss resulting from disasters (hereafter termed *disaster loss data*) can help with this understanding, and contributes to the achievement of short-term and long-term development goals and help address disaster risks.

This is a core component of Priority 1 of the Sendai Framework for Disaster Risk Reduction: Understanding disaster risk (UNISDR, 2015), which specifically encourages countries "to systematically evaluate, record, share and publically account for disaster losses" (UNISDR, 2015 p15). This is emphasised in the UNISDR's Global Assessment Report on Disaster Risk Reduction 2015 (UNISDR, 2017a), which states that the systematic collection of data for disaster mitigation and prevention is an increasing concern of both development and response agencies.

Collecting and managing disaster loss data allows stakeholders to evaluate disaster policies, identify driving factors in loss trends and enable the generation of early warning systems (Bouwer et al. 2007). However, current practices in collection and storage of these data vary between countries, regions and organisations (Gall et al. 2009; Corbane et al. 2015a). Consequently, the regional, national and global pictures of historical disaster loss are incomplete and often based on inconsistent or poor quality data.

The NHP has been commissioned by the Scottish Government to develop a strategy for encouraging collaboration of disaster loss data collection in Scotland. This document aims to establish a common understanding of Scottish disaster loss data collection from the context of broader International and European progress. Scenarios and recommendations are then drawn out to help improve Scottish disaster loss data management. The document is separated into 5 subsequent Chapters:

- Chapter 2. An overview of contributions made by key organisations to create relevant standardised processes for disaster loss data collection.
- Chapter 3. An overview of selected global disaster loss data collection initiatives. Development of these initiatives has been driven by demand from the international community and they are the basis for much of the work described in chapter 2. Much of the focus of these initiatives is on developing countries but the approaches are still relevant.
- Chapter 4. An overview of disaster loss data collection in the European context based on a Joint Research Council (JRC) review.
- Chapter 5. A summary of the current state of disaster loss data collection in Scotland. This is based on discussion with stakeholders in the Scottish government, local government, forecasting and warning services and Category 1 and 2 responders.
- Chapter 6. Scenarios and recommendations for disaster loss data collection. These offer potential solutions for a more unified approach to Scottish disaster loss data management.

2 DEVELOPING STANDARDS FOR DATA LOSS COLLECTION

International organisations have started to develop frameworks to unify the collection and classification of disaster loss data. These frameworks outline minimum recommended criteria for recording disaster impacts as well as approaches to classifying hazards and hazardous events. Impacts are primarily focussed on the physical costs to humans and the economic costs to individuals and nations.

This chapter focuses on two organisations central to the development of current disaster loss data frameworks: The Integrated Research on Disaster Risk (IRDR), a decade-long research programme co-sponsored by the International Council for Science, the International Social Science Council, and UNISDR; and The Joint Research Council (JRC), who conduct research in the European arena, relevant for Scotland and the UK.

In 2014, the IRDR produced a classification for peril and hazard (IRDR, 2014), reproduced in Figure 1. They outlined a hierarchical structure starting with broad categorical Hazard Families. Hazard Families can be split into a number of different events (Main Events) and from these Main Events, a number of different specific Perils can be realised. The IRDR state that the association of Perils to Main Events is not always cleanly defined as suggested in Figure 1 and that some Perils can arise from a number of different Main Events types. They further highlight that the classification can be applied at different levels dependent on what is most appropriate.

The IRDR also proposed a conceptual framework for human and economic impact measurement that distinguishes three levels of indicators in a disaster loss database (Figure 2) (IRDR, 2015). The highest level of reporting is Primary and this should be reported in most disaster loss databases. Subsequent levels (Secondary and Tertiary) provide more detail, differentiating between direct and indirect and human and economic losses (OECD, 2016). Figure 2 details the four human impacts and one economic impact at the primary level of reporting. This places a clear focus on understanding and distinguishing the full picture of human impacts, even at the highest reporting level. The different dimensions of human impact includes: deaths, injuries, missing and exposed. This allows decision makers to understand the more complex contingency and resilience situations required from national care systems, and national shelter and rehousing policies.

Figure 1. Peril Classification at Family, Main Event and Peril levels. (Adapted from IRDR, 2014).

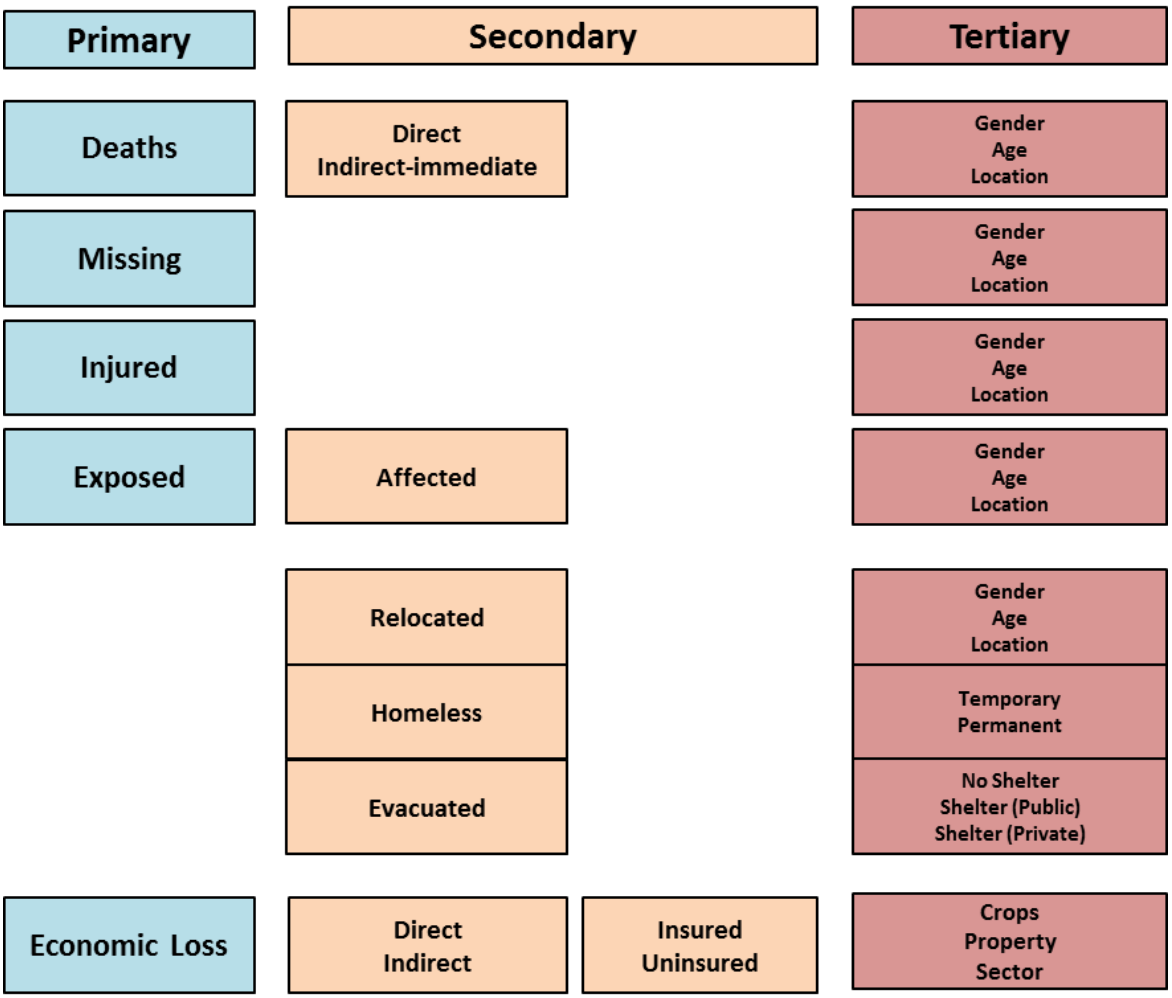

Figure 2. Conceptual framework for Human indicators in disaster loss (adapted from IRDR, 2015).

In 2015, the JRC applied the learning taken from their 2014 review to propose a model of disaster loss data collection (Figure 3). The JRC approach aims to improve the coherence and completeness of national disaster damage and loss data in European Union (EU) member states via an event-based disaster loss database. The database is based on encapsulating disaster events, which are given a unique Event ID. Each event can then be populated with a number of Hazard IDs to allow attribution of losses to specific perils (as defined by the IRDR). For example, an event may be represented by a large storm or season of high impact weather, but individual hazards may be the specific cause of impacts (flooding, landslides, high wind episodes etc.). The JRC suggest the use of INSPIRE (European Commission, 2017) natural hazard categories as of relevance to Europe. For each hazard, increasingly detailed information on impacts can be logically and systematically added as appropriate.

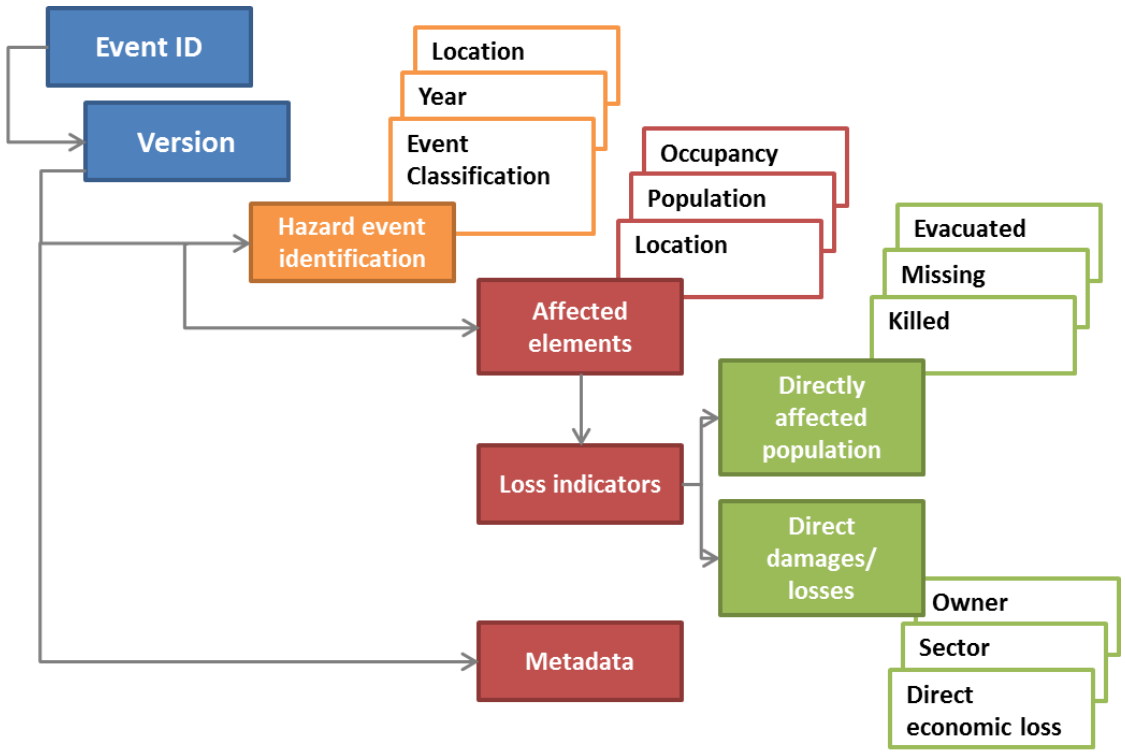

Figure 3. JRC's conceptual data model for loss data (Adapted from Corbane *et al.*, 2015b).

Table 1 outlines the JRC's recommended minimum criteria for primary impact data collection. The table presents a summary of minimum collection requirements for damage and loss per hazard event by NUTS2/NUTS3 region (e.g. County/Local Authority area) or Units of Management (UoM) if different. The table below encapsulates the three key components for loss recording: Hazard event identification, location and the loss indicators measured. The pedigree score in the final column represents a measure of uncertainty relating to the type, quality and coverage of impact data used (De Groeve *et al.*, 2014).

Table 1. Minimum criteria for primary national impact data collection as recommended by JRC, (adapted from Corbane *et al.*, 2015b).

Hazard type	Indicator fields	Value	Pedigree score
< Natural Hazard Classification >	**Year**	< 20XX >	n/a
	Geographical location	< NUTS2/NUTS3 or UoM >	n/a
	Houses destroyed	< total number >	< value between 1-5 >
	Houses damaged	< total number >	< value between 1-5 >
	Education centres	< total number >	< value between 1-5 >
	Health facilities	< total number >	< value between 1-5 >
	Directly affected	< number of persons >	< value between 1-5 >
	Deaths	< number of persons >	< value between 1-5 >
	Missing	< number of persons >	< value between 1-5 >
	Direct loss for all sectors	< total in monetary value >	< value between 1-5 >

3 INTERNATIONAL DISASTER LOSS DATABASES

Initiatives at the global scale support national governments by collating disaster loss data and reporting national disasters. Existing databases are either in public or private ownership and all those listed here are at least partly accessible to the general public. Examples of international databases are listed below:

- *DesInventar* was created by the Network of Social Studies on Disaster Prevention in Latin America (LA Red) for South America and Asia in 1994. *DesInventar* is hosted, maintained and sponsored by the United Nations International Strategy for Disaster Reduction (UNISDR).
- *The Emergency Disasters Data Base (EM-DAT)* was launched in 1988 is managed by the Centre for Research on the Epidemiology of Disasters, based in Belgium.
- The *NatCat* service is provided by Munich Re, a reinsurance company based in Germany.
- The *Sigma series* is provided by Swiss Re, a reinsurance company based in Switzerland.

These global databases report national-level statistics. They draw information from governments, charities, research institutions and the press. Population of the databases is usually based on standardised methodologies specific to each, which may not be compatible with other databases (Gall *et al.* 2009). For example, *DesInventar* uses a method provided by UNISDR and UNDP (UN Development Programme), while *EM-DAT* uses the GLobal IDEntifier number (GLIDE) initially proposed by the Asian Disaster Reduction Centre to standardise the identification and assessment of disaster information.

The global-scale of these databases means that smaller disasters are sometimes not included. Further, some databases apply minimum thresholds for inclusion (See table 2, which demonstrates different data collection approaches), making them appropriate for international assessment, but more difficult to use at national or municipal scale. For example, *EM-DAT* applies thresholds to ensure that only larger disasters are recorded. Conversely, *DesInventar* has more lenient thresholds to encourage national governments to contribute data on smaller national disasters too (OECD, 2016).

Input data sources for *NatCat* and *Sigma* are not disclosed because these are owned by private enterprise (Munich RE and Swiss RE are the two largest re-insurers in the world). Further, while *EM-DAT* and *DesInventar* are fully accessible to the general public, *NatCat* and *Sigma* are only publically available at summary level, albeit via user-friendly online tools. The loss indicators listed in Table 2 further demonstrate the difficulties in developing a globally standardised approach. For example, the nuanced differences between terminologies such as people who are *homeless, displaced*, *relocated*, *evacuated* or *affected* make differentiating populations challenging.

Table 2. Minimum recording thresholds and recorded impacts for selected international disaster loss datasets (adapted from Integrated Research on Disaster Risk, 2014).

	EM-DAT	**NatCat**	**Sigma**	**DesInventar**
Owner	Centre for Research on the Epidemiology of Disasters, Belgium	Munich Re, Germany	Swiss Re, Switzerland	Varies by country
Recording thresholds	≥10 fatalities ≥100 affected Declaration of state of emergency Call for international assistance	Unclear	Unclear	≥1 fatalities ≥$1 in economic loss
Loss indicators				
Killed	X		X	X
Injured	X	X	X	X
Missing		X	X	X
Homeless	X		X	X
Affected	X	X	X	
Evacuated		X		X
Relocated				X
Displaced		X		
Property loss	X			
Crop loss	X			
Environmental loss	X			
Insured loss		X	X	
Aggregate Economic loss	X	X	X	X
Infrastructure damage	X	X		X
Economic sector damage	X	X		X

4 EUROPEAN PROGRESS IN DISASTER LOSS DATA COLLECTION

The international databases outlined above represent efforts by the international community to raise the baseline of disaster loss data collection in countries where little information has previously been formally recorded. However, with respect to available resources and historical data collection, European examples may be more relevant to Scotland.

Developed countries do not share the challenge of having no recorded disaster loss data. Instead, they often hold multiple fragmented sources of collected data. Typical challenges are more associated with data management including identifying available data, assessing data quality, adhering to data protection policies, determining access permissions, and evaluating suitable approaches for unifying available resources via national agencies, research institutes and commercial enterprises. This final challenge is exacerbated by the barriers of communication between the mature organisational structures of key stakeholders.

The JRC, in collaboration with the European Commission, reviewed the state of national disaster loss data collection in Europe in 2014 (De Groeve *et al.* 2014). They found significant differences in data collection processes and a general lack of guidelines or standards, in particular for human and economic losses. They also found that supporting IT infrastructure varied significantly. Of the 15 EU member states that participated, only 12 countries have established and maintained some form of national loss database (Austria, Belgium, Bulgaria, France, Germany, Greece, Italy, Portugal, Romania, Slovenia, Spain, and Sweden). Of these, only Austria, Belgium, Bulgaria, Romania, Slovenia, Spain and Sweden had binding legislation regarding data loss collection, and only France, Germany, Italy and Sweden have made their databases available in some way to the public. Croatia, the UK and the Netherlands did not have a national loss database at the time of the review.

The JRC found that most databases were supported by public funding, with the potential for public-partnerships to facilitate such work and help to ensure engagement of all stakeholders. Further, there is EU civil protection legislation which establishes procedures for co-ordination between national civil protection agencies (Corbane *et al.* 2015b). Examples include the EU Solidarity Fund Regulation, which established rules relating to public compensation in a disaster, and the INSPIRE legislation, which provides a basis for interoperability and comparability of individual member state databases. The variety of approaches presented in this report demonstrates that there is no 'one-size-fits-all' answer. The list below highlights some of those that were considered good practice by the JRC:

- Slovenia's model is developed by the government and reinforced by national legislation. The approach includes detailed methodologies for multi-scale loss assessment and nationally standardised field survey forms to help ensure collection of high quality data, regardless of the active organisation or agency. The database is linked to external sources (e.g. building register, land classification), which allow for different levels of verification.
- Spain, Germany and Greece have incorporated interpretation of remote sensing imagery into their data collection processes, which have improved large-scale damage estimation

and highly detailed inventories. The results can then be integrated into a GIS platform, which enables spatial analysis of loss data.

- In Italy, there has been a focus on regional collection of data into a national repository. This has a strong focus on participation from academia and local government, allowing all stakeholders to gain ownership of the process. This also allows a region-specific approach to data collection, allowing more detailed data to be collected.
- France demonstrates a high quality database supported by public and private funding in partnership – including members of the national insurance market. The JRC report considered this to be good practice as the data collection is based on more solid funding and by improving the process of data collection, it can reinforce the insurance industry's strategic role in collecting and sharing data loss recording.

5 SCOTTISH DISASTER LOSS DATA COLLECTION

Scotland has a history of extreme weather events. These include flooding, landslides, extreme temperatures, snow and ice, and high winds (Met Office, 2017; Ready Scotland, 2017a; Transport Scotland, 2017; Kay, 2016; Met Office, 2015). During the recent winter of 2015, Storm Frank claimed two lives in Scotland during extensive flooding (The Guardian, 2016), and approximately 100 flood warnings were put in place with the risk of severe flooding in Dumfries & Galloway (Scottish Government, 2016). Floods and landslides also led to widespread disruption of road and rail networks across the country and left approximately 35,000 homes experiencing power disruption (BBC, 2016). Ready Scotland state that 1 in 22 homes and 1 in 13 non-residential premises in Scotland are at risk of flooding (Ready Scotland, 2017b).

This chapter details the current state of disaster loss recording in Scotland. The information was collected by the authors through semi-structured interviews with the Scottish Government and two focus groups containing key stakeholders in Scottish disaster loss recording.

5.1 METHODS

This section provides details on data collection methods.

5.1.1 Semi-structured interview.

A telephone interview was conducted on 20 July 2017 by HSE with three members of the Scottish Government and the Scottish Environment Protection Agency (SEPA). The aim of the interview was to determine the current state of disaster loss data collection and use in Scotland. HSE had a list of topics to cover, but the interview was semi-structured to allow key themes to develop through the discussion. Questions from HSE were grouped into two categories:

- Which organisations collect disaster loss data?, and
- Which organisations use disaster loss data?

Within these categories, HSE were interested in how data was collected, whether this activity was co-ordinated beyond individual organisations and identification of any barriers or challenges.

5.1.2 Focus Groups

The focus groups were conducted during the Daily Hazard Assessment Workshop in Edinburgh on 29 September 2017 (Freeborough *et al.* 2018). Two 30 minute focus groups were conducted during the workshop, containing 12 and 13 participants respectively. Participant organisations are listed below:

- National Centre for Resilience
- Scottish Government
- Prestwick Airport
- Civil Contingency Service
- Scottish Fire and Rescue Service
- Centre for Ecology and Hydrology
- Council representatives
- East of Scotland Regional Resilience Partnership
- SEPA

- University of Dundee
- Met Office
- British Red Cross

Participants were highlighted the importance of impacts and observed impact data during the opening presentations of the workshop. These set the scene for the day and helped to ensure that participants gained a common understanding in preparation for the focus groups. The two groups were asked the same four broad questions designed to gather insights and information:

1. How do you use observed impact data?
2. How do you collect observed impact data?
3. Do you make data available outside your organisation?
4. What are the issues?

The questions were designed to gather information on the current state of Scottish disaster loss data collection across the community. Many of the underlying challenges are relatively well known in this field, so questions 3 and 4 which address these issues, were placed towards the end of the list. Experience from the telephone interview suggested that these issues and potential solutions were likely to be raised throughout the conversation from the outset. The group facilitator used the list of questions to provide direction for the conversation within the group. Two colleagues took notes of the conversation to allow the group facilitator to engage with the group and develop conversation.

5.2 USE OF IMPACT DATA

A number of organisations have responsibility for resilience in Scotland and have a use for disaster loss data. These include local government, Regional Resilience Partnerships and Local Resilience Partnerships and public bodies such as SEPA, the Met Office and The British Geological Survey (BGS). Scottish risk management stakeholders currently hold observed impact data in high regard and many are active in collecting and using disaster loss data for a range of purposes. De Groeve *et al.* (2014) identified four applications for disaster loss data. These are outlined below in relation to current applications in Scotland. Relevant data collection approaches are also highlighted.

5.2.1 Calculation of disaster loss compensation (primarily related to insurance activities)

The ability of those affected by natural hazards to recover relies on effective post-event service provision including compensation. The importance of this application could increase across the public sector in Scotland if partnerships between the public sector and private enterprise are encouraged.

This is a key driver for data collection in the insurance industry. The data required for compensation applications must be at the asset level of loss, which is of most relevance to insurance companies. However, human loss data are less important, due to a stronger focus on economic losses. While these data are collected by insurance companies in Scotland, the data are not easily shared at the asset level because of data sensitivity, commercial value and complications surrounding co-operation between the public and private sectors.

5.2.2 Disaster loss accounting

Disaster loss accounting is typically nationally focused and relates to the performance of strategic disaster risk reduction policies. Accounting aims to document loss trends to better understand the general exposure of society to disasters via nationally aggregated statistics.

Disaster accounting represents the broadest requirements for disaster losses and falls under the Sendai Framework requirements for national reporting. Many of the examples featured in Chapters 3 and 4 are examples of disaster loss accounting. There is little evidence of data used for national-scale disaster loss accounting in Scotland, but the unique nature of devolved administrations in the United Kingdom means that the responsibility may lie with the Cabinet Office, who act as the UK's National Platform for Disaster Risk Reduction (UNISDR, 2017b). However, the Business Emergency Resilience Group (BERG) which is part of Business In The Community (BITC) report global figures, SEPA run the *Report-a-flood* service (SEPA, 2012), and BGS update and maintain the *National Landslide Database* (BGS, 2017), which acts as a register of data on historical landslides covering key observations of key geological processes, meteorological conditions and classified impacts. The Met Office has similar initiatives and also makes use of data collected by the public through its *Weather Observation Website (WOW)* (Met Office, 2018), which encourages people to add photos and classify personal observations of weather impacts to a map. Some of these services are publically accessible and make use of public data, but access for more advanced analyses is less easy to acquire.

Disaster loss accounting requires high quality loss data at broad temporal and spatial resolutions. This is commonly coupled with disaster risk economics data or demographic data to report the overall resilience of a nation with respect to disaster losses. The national-scale context of disaster loss accounting requires a well-coordinated national system of data collection. Data content does not need to be detailed, but it does require full coverage across the country and across all major hazard events. Currently in Scotland data are not collected specifically for national-level disaster loss accounting, although recent international agreements like the Sendai Framework are placing this as a global priority. There is a drive across Scotland to collate national-scale data for easier internal access.

5.2.3 Disaster forensics

Disaster forensics relies on disaster loss data from a specific event to determine drivers via analysis of exposure, vulnerabilities, coping capacities, mitigation, and response activities. Compared to disaster loss accounting, disaster forensics has a more focussed aim to improve disaster management through specific lessons learned.

Across Scotland, data for disaster forensics are used to inform future response activities of the three multi-agency Regional Resilience Partnerships covering North, East and West Scotland and their constituent Local Resilience Partnerships. Much of this activity is based on observed impact data, which requires either immediate or future action. For example, displaced residents may require a rest centre to be opened in the local area. Evidence of prolonged or extended displacement may require additional longer term actions. As part of Scotland's Integrated Emergency Management approach (Scottish Government, 2012), Resilience Partnerships conduct a robust debriefing process based on detailed reports after every event. These reports contain local-level loss data in free-text format. Evaluation of the evidence in these reports and the preparation and response actions taken provides valuable learning that can be applied in future events. Lessons learned are shared across

the resilience community and fed into business continuity plans. However, the observed impact data used in these response activities are not formally structured and there may be potential to improve and widen the use of this valuable information.

Data collection at event level is acceptable for disaster forensics as the analysis compares overall losses against the prevention or response measures implemented. Multiple organisations across Scotland have well-organised data collection processes in place for event-specific emergencies, with evidence of multiple agencies successfully co-operating to help save lives and reduce impacts. However, there is recognition that while the details of larger events and particularly huge catastrophic events are likely to be captured, this is less likely to be the case for the more commonly occurring minor impacts. The views from the workshop groups were that this is because the impacts of smaller events are planned for in business continuity management. However, there was some concern that continual and repeated minor impacts can have consequences on insurance compensation and psychological health. Thus failure to collect data on these minor hazards could present an incomplete picture of disaster risk. The group also recognised that local response communities hold a wealth of impact information that is not currently being shared for regional or national strategies.

A key challenge for event-level data collection can be demonstrated by the variability of geography and climate across Scotland. These two features in concert produce marked differences in regional weather patterns, and define regional disaster risk priorities. Where one region may be frequented by fierce coastal flooding, another may prioritise the impact of local landslides. This means that the relative resilience of local communities may be different depending on how frequently the consequences of a given hazard affect their daily lives. Consequently, national-scale interpretation of local impact data is challenging and can only be meaningfully undertaken in relation to local conditions and priorities.

Regional relative resilience is further compounded by the fact that Scotland's national transport infrastructure is not as widespread and comprehensive as the rest of the UK. This means that proportionally more rural communities are significantly separated from national emergency services (compared to England in particular). It is not uncommon for local residents in these communities to hold disaster response roles on top of their normal day jobs. These people are therefore not just active in local disaster management, but also hold a local understanding of the relevant risks. This means that they may be more aware of required response actions when given an appropriate warning. However, this may also mean that nationally-produced warnings may not match local perceptions.

5.2.4 Risk Modelling

Disaster loss data are a key component for estimating the losses of future disasters through development of risk models. These data are used as part of the evidence base for model development (e.g. identifying flooding susceptibility, or formulating loss exceedance or damage curves), and also used for calibration and validation. The Met Office and SEPA also have teams involved in estimating secondary economic and social impacts from these models to gather more holistic assessments. This application typically requires the most detailed, asset-based disaster loss data. However, de Groeve et al. (2014) suggested that total spatial coverage is not required as these data are most often used in the form of observed case studies.

Flooding is a primary concern in Scotland. Consequently, the Met Office and SEPA are core organisations in Scottish flood risk management. Both organisations collect and use disaster loss data to verify weather forecasts and validate flood risk models to improve forecasting and warning duties. Landslides can also have a major impact on Scotland's infrastructure network consequently BGS play a core role in geological monitoring and collection of landslide impact data. These data are being used by the NHP to develop a landslide hazard impact model.

As the specifications for the data required for risk modelling are the most detailed across all applications, this represents the largest challenge for adequate data collection, and requires significant co-operation with other stakeholder organisations. Further, as risk models become more complex, the validation data must also include more detail, as they need to cover or act as proxy for more parameters and more impact metrics.

5.3 SEPA DISASTER LOSS DATA COLLECTION

The prevalence of flood events throughout Scotland means that SEPA have developed among the most well-considered and well-managed systems of disaster loss recording in Scotland. Consequently, this section presents a case study of SEPA's activities in disaster loss data collection. SEPA work with a range of organisations across the public and private sectors to ensure that data collection is as comprehensive as possible. SEPA is mainly interested in immediate physical impacts as these are related to its primary legislative role of saving lives. Consequently, much of the data are focused on extent of flooding, infrastructure affected and properties affected. Financial measurements are not considered a priority.

SEPA are currently in the process of formalising procedures for post-event data collection. This includes information on when and how data collection should be carried out, by whom and where. SEPA recognise a number of uses for the observed flood event data that they collect. This includes:

- *Operation flood risk,* which considers impacts at catchment level for mitigation and planning purposes.
- *Strategic flood risk*, which considers the longer term risk of flooding to Scotland.
- *Forecasting and Warning*, which uses data to calibrate and validate existing models.
- *Flood advisors,* who are interested in documenting impacts in catchments within flood warnings in place or proposed.
- *Hydrometry*, which is concerned with estimating flood level/flow at gauging stations. Survey data are used to revise estimates at gauging stations and identify high water marks.
- *Flood Risk Management Policy*, which requires data to provide an immediate snapshot of flood impacts to verify information in flood risk management strategies and to provide a strategic oversight role.

SEPA and their contractors collect data in a variety of formats throughout the flood event to support these activities. During the post-flood period, these data are collated into a more centralised Observed Flood Events database, which also includes historical records based on anecdotal accounts. Methods of data capture employed by SEPA and their contractors include:

- Collection of aerial photography

- Site visits
- River surveys
- Household surveys (Private contractors, Scottish and local government)
- Photography
- Social media
- Print/online media

6 RECOMMENDATIONS

This review has demonstrated that across the world, there is no one-size-fits-all approach to disaster loss data collection. The most appropriate approach depends on many factors including available resources, the type, volume and quality of data already collected, established data collection processes, co-operation levels across regional and local stakeholders, and underlying legislative requirements.

In Scotland, disaster loss data are collected for a range of applications by a number of stakeholder organisations. There is acknowledgement among these stakeholders that data are currently collected in a fragmented and sometimes sporadic fashion and that differing data requirements mean that developing a unified system of data collection would be challenging. Several initiatives have started to condense and formalise data collection processes, although these currently remain in-house. However, there is understanding of a need to improve how datasets are shared between parties and made more accessible to wider audiences.

This chapter considers the context presented by the previous chapters to provide a number of scenarios and recommendations that may assist collaborative data collection and promote data sharing. Some scenarios could be developed and implemented relatively quickly, while others may require more significant changes to governance structures and significant resources for successful implementation and upkeep.

6.1 OPTION 1. A SINGLE DATABASE OF HAZARD IMPACT LOSS DATA (HILDA).

This scenario envisions collation of collected datasets from across the Scottish resilience community into a unified database. Historically, this approach has typically been set up by international organisations for developing countries with fewer resources to spend on disaster loss recording (e.g. *DesInventar*). De Groeve *et al.* (2014) suggest that this would be the ideal model in a data-rich Europe, where loss data could be rapidly collected at the asset/municipality level, and then aggregated up as required. Chapter 2 lays out an established format for development of such a database, which would be compatible with other similar initiative, facilitating the requirement for international reporting. Table 3 presents an overview of benefits and challenges for developing HILDA.

Table 3. Benefits and Challenges for developing HILDA.

Benefits	Challenges
• Easy, single, managed access for users and contributors. • Cost effective in the long term as there is only one central database to support. • Strong alignment with SENDAI requirements for easier international comparisons. • Facilitation of data standardisation and quality assurance. • Relatively simple (although dedicated) long term maintenance. • Could be made flexible enough to interrogate for different purposes and at different scales.	• Large initial financial and technical costs for system design and creation. • System design challenges surrounding the potential diversity of data to be included and the different types of access required. • Questions around ownership of data, custodianship and data confidentiality requirements, which may differ by data providers. • Extending the system into England and Wales may pose challenges where there are different legal and operational structures. • Significant change to current working practice and additional training is an unwelcome proposal in systems that already have established frameworks. This may lead to poor engagement from local actors. • Potentially a lot of work for local authorities to keep the database update.

Developing a single national database requires significant effort, organisation and collaboration between international, national and regional organisations and governments. It presents the idealised long-term solution and a carefully designed system could enable real-time collection and integration of data from all members of society including the general public. However, based on workshop feedback, current thoughts amongst Scottish stakeholders are that development of a single storage place to hold the volume and diversity of data available would require significant effort and a major disruptive shift in current working practices.

Corbane *et al.* (2015b) pose a number of options to reduce complexity in a unified database, based on simplifying the scale or detail of the database. These options would be easier to implement, but would not present a complete picture:

- Include only the impacts of major disasters (as *EM-DAT*). Specialised centres are set up to perform this data collection and assessment. This approach allows the reporting at national and global levels, but creates uncertainty regarding frequent, low impact events.
- Hazard specific impacts are recorded by responsible national authorities. This is representative of the current system in Scotland with regards to flooding. An alternative is for sectorial authorities to be mandated to collect data (e.g. agriculture, transport, energy etc.).
- Collection of impact data to the minimum requirement of impact categories detailed in Chapter 2 (Table 1).

6.2 OPTION 2. A REGISTER OF HAZARD IMPACTS: NUMBERS AND OBSERVATIONS (RHINO)

Chapter 5 demonstrates that impact loss data are being collected by a range of different stakeholders often for specific purposes. These data vary in format, structure and maturity. Large organisations such as SEPA, the Met Office and BGS have made significant inroads into collating their datasets, while others are further away from this. While this environment may not encourage creation of a unified database, creation of a register of data held by stakeholders could be a valuable and achievable goal. Table 4 presents an overview of benefits and challenges for developing RHINO.

Table 4. Benefits and Challenges for developing RHINO.

Benefits	**Challenges**
• Easy to maintain on a day-to-day basis. • Would not require significant time, energy or expertise from individuals. • Low start-up costs. • Open access. • Tackles issues of data sensitivity by not disclosing any actual data. • Data access is by key contacts, which promotes sharing of data across the community. • Easy to identify gaps in collected data.	• Requires a low level of continual support from all partner organisations. The register would need to be updated if a contact or data content changes or if a new dataset is collected. • May be difficult to get engagement from all members of the community. • Data acquisition may still be challenging – data sharing/confidentiality is not addressed. • Additional metrics in the register such as data coverage and quality may be difficult to define without accompanying guidelines.

Of the two headline options outlined, the second has the potential to provide a satisfactory level of utility, with relatively minor costs in terms of data maintenance and contribution from stakeholders. It would provide a single list of all of the impact loss data collected in Scotland including descriptions of the data, formats, most recent updates, ownership, sensitivity, licensing and contact details. This Option is recommended as an initial step towards Option 1 to help Scotland build up a complete picture of the impact loss data that its resilience community holds.

6.3 FURTHER CONSIDERATIONS

6.3.1 Sendai Framework

Evaluating, recording, sharing and publically accounting for disaster losses forms a core component of the Sendai Framework (UNISDR, 2015). The recommendations detailed in this chapter could assist Scotland in addressing some of the challenges set out by Sendai. Specifically, the recommendations could help Scotland identify and catalogue the data that are currently being collected. This would provide a platform for developing a logical and comprehensive reporting and accounting strategy. From this perspective, the recent launch of the Sendai Monitoring process in December 2017 (UNISDR, 2017c) provides a useful global context and a relevant practical framework within which to define appropriate measurements, definitions and data standards that are compatible at local,

regional, national and global scales. Alignment to the Sendai Monitor framework would also allow Scotland (and the UK) to directly and transparently contribute towards the Sendai Monitor's progress indicators.

6.3.2 Handling sensitive data

It is likely that some impact datasets will hold sensitive information that could be used to identify individual people or businesses. It is therefore critical that these data are stored and handled appropriately within any of the recommendations above.

In Scotland, the general public have statutory rights to access recorded information held by public authorities, which are also required to proactively publish information under the Freedom of Information (Scotland) Act (2002). The authority may refuse the request if they can prove that there would be real and significant damage to the authority or other people. This includes commercially sensitive data or data that might endanger the health and safety of someone (Scottish Information Commissioner, 2017). In these circumstances, the authority's decision to share data depends on whether the benefit to the public is greater that the harm to the authority or other people.

While public authorities are encouraged to share data, there are circumstances where the authority may consider that even revealing the very existence of information may be contrary to public interest. In the event of a Freedom of Information Enquiry in this instance, the authority may issue a 'neither confirm nor deny' response (Freedom of Information (Scotland) Act 2002).

6.3.3 Encouraging public participation

SEPA currently manage the *report a flood* programme, which uses crowd-sourced data to assist with flood mapping as it happens. Similar programmes such as *WOW* (*Weather Observations Website*) at the Met Office could be refined to include data from resilience communities and other social media additions. This has the benefit of building on existing infrastructure, although development of the systems may be significant and data quality issues may be an issue. Further investigation into these systems would be beneficial.

6.3.4 Encouraging public-private partnerships

The JRC recommended the promotion of partnerships between public bodies and private enterprise in disaster loss data collection activities. Citing the French example in Chapter 4, the JRC point to the key role that insurance and re-insurance companies could play. These industries have expertise and a core business interest in disaster loss in terms of the disaster loss compensation calculations that guide their business. Public-private partnerships also have the potential to bring a stable source of funding, which would allow for a more sustainable and robust system. The private enterprises in the partnership would also benefit from the wide-ranging networks and extensive data held by the public sector as well as access to key contacts in the local, regional and national resilience arena.

6.3.5 Analysis of briefing report information

Local and regional resilience partners across Scotland complete debriefing sessions after a natural hazard to understand lessons learned and refine business continuity plans if necessary. The reports produced contain impact information, which has often informed response decisions. This information is not currently formally collected as impact loss data. The workshops highlighted that there is some support from local resilience partnerships to pursue the possibilities of this source of data. It is recommended that an initial pilot study is implemented, which focuses on text mining to

optimise the impact observation data that can be extracted from these valuable reports. The study would also include accompanying guidance on methodologies and interpretation.

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