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Challenges and opportunities for Sendai framework disaster loss reporting in the United States

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ABSTRACT

The Sendai Framework for Disaster Risk Reduction provides quantitative indicators for nations to measure progress in the reduction of disaster losses. The collection and analysis of disaster loss data under the Sendai Framework improves our understanding of the effectiveness of national disaster risk reduction strategies and interventions. The Sendai Framework has enhanced cooperation among Federal agencies to collect and track disaster loss data in the U.S., yet challenges remain for reporting disaster losses. Based on our experiences collecting and reporting U.S. data to the Sendai Monitor, we identify opportunities to improve disaster loss reporting in the U.S.

1. Introduction

From 2015 to 2019, the United States (hereafter the U.S.) sustained 69 weather and climate disaster events in which economic losses exceeded $1 billion. These disasters claimed nearly four thousand lives and caused over half a trillion dollars in economic damage [44,56]. As the frequency and cost of disasters continues to rise [7,39], efforts to understand the impacts of these events, and how to mitigate those impacts effectively becomes ever more critical. The collection and analysis of long-term disaster loss data is a key part of any approach to addressing these urgent needs. Without these data, it is impossible to establish a baseline against which to measure the effects of interventions. Further, as a nation we must fully understand the true geographic and sectoral extent of disaster losses to best know how and where to intervene with future mitigation efforts, and whether past mitigation efforts were effective (Pew Charitable [10,41,48,58]).

The *Sendai Framework for Disaster Reduction 2015–2030* (hereafter referred to as the Sendai Framework) is a non-binding United Nations (UN) agreement that promotes disaster risk reduction and includes 38 quantitative indicators to measure progress and determine global trends in the reduction of risk and losses due to disasters [61]. The adoption of the Sendai Framework has given UN member nations a consistent structure to report these important disaster loss data and better understand disaster loss trends at a national level. Robust national-level disaster loss data is important for global risk assessments, risk management programs, emergency response, planning and preparedness, and identification of research gaps [27]. Therefore, it is critical that the U.S. contributes accurate and globally aligned data to best support domestic and international efforts towards reducing the impact of disasters [27]. After passing the five-year mark since the adoption of the Sendai Framework that occurred in March 2020, international scholars are calling for 1) improved and continued reporting and 2) the United Nations Office for Disaster Risk Reduction (UNDRR) to guide the comprehensive transformation of international disaster loss reporting [66]. In addition, global attention is expanding beyond the collection of indicator data towards the implementation of policy priorities based on these data [31,34].

The task of collecting and reporting disaster loss data for the U.S. is not straightforward. The U.S. Government has neither a common format for collecting and reporting impact data across all hazards nor a single agency or office that is responsible for collecting that data. Additionally, most disaster response and recovery in the U.S. occurs at the state and local levels rather than the Federal level, making nationally consistent data collection a challenge. As a result, much of the U.S. data reported in regard to the Sendai Framework is limited to large-scale disasters and/or certain hazard types. Logistical, administrative, political, technical, and operational challenges can also act as barriers to gaining a complete picture of disaster losses across the U.S. Thus, those examining U.S. data should understand that, while they likely represent general trends in disaster losses across the country, the dataset is incomplete. The U.S. is not alone in facing these challenges. Many other UN member countries have spent the past five years working to improve reporting and to develop new systems of intergovernmental collaboration to drive that improvement [26,38].

During the first five years of reporting to the Sendai Framework, the U.S. saw a growing interagency effort to collect both loss and preparedness data from a breadth of Federal sources. The Federal interagency coordination

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group, Science for Disaster Reduction (SDR), is the U.S. National Disaster Risk Reduction (DRR) focal point responsible for collecting information on Sendai Framework indicators on behalf of the U.S. Department of State and reporting those data to the UN as part of U.S. commitments under the Sendai Framework. The authors of this paper are SDR participants and include representatives from the U.S. Geological Survey (USGS), National Oceanic and Atmospheric Administration (NOAA), U.S. Agency for International Development (USAID), and the Federal Emergency Management Agency (FEMA).

In this paper, we begin by identifying the Sendai Framework indicators on which the U.S. Government has reported thus far and address some of the limitations of collating these data at a national level. Drawing upon our experiences collecting these data and assessing disaster loss reporting, we then explore opportunities for improved disaster loss reporting in the U.S., and potential challenges to realizing those opportunities.

2. Sendai reporting in the U.S.: methods and data sources

The Sendai Framework outlines seven global targets to be achieved by 2030. First, to substantially reduce:

A) Global disaster mortality,
B) The number of affected people,
C) Economic loss in relation to gross domestic product, and
D) Damage to critical infrastructure and services disruption.

And second, to substantially increase:

E) The number of countries with national and local disaster risk reduction strategies,
F) International cooperation to developing countries, and
G) Availability of, and access to, early warning systems and disaster risk reduction information.

The Sendai Framework identifies a total of 38 data indicators to measure each participating nation's progress towards success for these seven global targets [61]. Our methodology consists of identifying which U.S. data relates to these 38 data indicators and collecting these data from Federal agencies involved in disaster management and recovery activities. Federal agencies that were identified as already having collected information relevant to Sendai indicators include: the U.S. Department of Commerce's Bureau of Economic Analysis (BEA), Census Bureau, the U.S. Department of Education (ED), FEMA, NOAA, the Small Business Administration (SBA), and the U.S. Department of Agriculture (USDA).

Data collected from these agencies were then aggregated and reported to the UNDRR's online tool for reporting, management, and analysis of Sendai Framework data (hereafter referred to as the Sendai Monitor) [59] by the SDR after State Department clearance. In 2020, the U.S. voluntarily reported on 24 of 38 possible indicators (Figure 1). The number of indicators for which the U.S. reports data increased from 22 in 2017 to 24 in 2020 as new data sources were identified. The SDR continues to work with participating Federal agencies to increase its reporting capabilities.

The SDR has limited itself to reporting disaster loss data that can be consistently retrieved and aggregated each year, for the entire nation, for the whole 15-year lifespan of the Sendai Framework (2015–2030). These data are often associated with disasters declared by the President of the United States under the Robert T. Stafford Disaster Relief and Emergency Assistance Act [51]. A presidential declaration under the Stafford Act is made when the President of the United States determines that a given disaster requires Federal assistance or is beyond the ability of affected state and local governments, or tribal governments, subject to the requirements of the Stafford Act [13].

Most disasters in the U.S., however, are not presidentially declared [53]. Instead, most disasters in the U.S. are managed, and their losses recorded, at the state and local levels. The losses associated with these disasters are often not aggregated at the Federal level (see Section 3). In some cases, state and local-level data are collected by universities, research organizations and others, but not in a geographically or methodologically consistent or complete manner.

Some domestic disaster loss databases do exist for the U.S., including Spatial Hazard Events and Losses Database for the United States (SHELDUS). These databases, however, draw primarily from the same Federal sources that are already included in our reporting, (such as the National Centers for Environmental Information) rather than aggregating different, more detailed county-level information [1]. Although the SDR is confident that the data reported to the Sendai Monitor are a best representation of nationally consistent data available in the U.S., we acknowledge that the data for some indicators are an underestimation.

2.1. Target A: reducing mortality

Tables 1–7 identify the 38 Sendai indicators, showing indicators for which it was possible for the U.S. Government to report data (indicated by a circle symbol), indicators for which the U.S. Government does not report data due to policy limitations that are further explained in Section 2.6 (diamond symbol), and indicators for which data have not been reported,

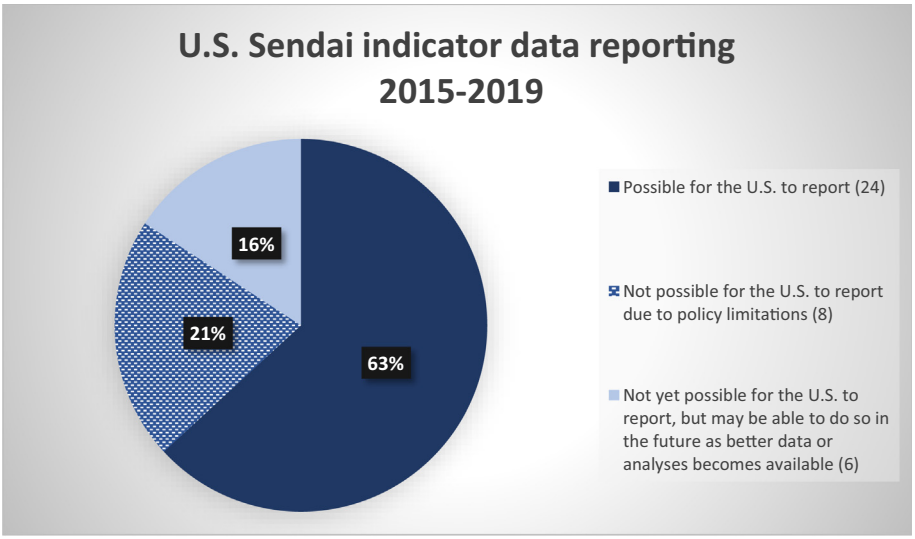

Fig. 1. Proportion of Sendai indicators for which the U.S. Government can and cannot report data, 2015–2019.

Table 1
U.S. reporting on indicators related to disaster mortality.

U.S. reporting	Indicator	Hazards addressed	Data sources
Substantially reduce global disaster mortality by 2030, aiming to lower average per 100,000 global mortality between 2020 and 2030 compared with 2005–2015.			
●	Number of deaths attributed to disasters	• Weather-related hazards (e.g., severe storms, flooding, freezes, winter storms, and tropical cyclones) • Climate-related Hazards (e.g., wildfire, excessive heat/heatwaves, debris flows)	NOAA Storm Data [45]
▲	Number of missing persons attributed to disasters		

Table 2
U.S. reporting on indicators related to the number of people affected by disasters.

U.S. reporting	Indicator	Hazards addressed	Data sources
Substantially reduce the number of affected people globally by 2030, aiming to lower the average global figure per 100,000 between 2020 and 2030 compared with 2005–2015.			
●	Number of injured or ill people attributed to disasters	• Weather • Hazards related to climate change	• NOAA Storm Data [45]
●	Number of people whose *damaged* dwellings were attributed to disasters	• Presidentially declared disasters (PDDs) (All Hazards) • SBA Administrative disaster declarations (All Hazards) • PDDs (All Hazards)	• FEMA Individuals and Households Program • SBA Office of Disaster Assistance Home Loans
●	Number of people whose *destroyed* dwellings were attributed to disasters	• PDDs (All Hazards) • SBA Administrative disaster declarations (All Hazards) • PDDs (All Hazards)	• FEMA Individuals and Households Program • SBA Office of Disaster Assistance Home Loans
▲	Number of people whose livelihoods were disrupted or destroyed, attributed to disasters		

but the SDR has determined there is potential for future reporting as better data or analysis become available (triangle symbol).

Target A (Table 1) measures disaster mortality, including deaths and missing persons. U.S. mortality data reported to the Sendai Monitor are limited to weather and climate-related hazards. This dataset remains incomplete, as it lacks information on deaths attributed to geophysical, biological, and technological disasters. Even data related to weather-related mortality may be limited due to the many challenges that the U.S. faces regarding reporting and recording disaster-related mortality and morbidity. These challenges stem from a lack of standardization across county, state, and Federal systems for hazard-related mortality reporting [40].

Currently, the Federal government does not report on missing persons attributed to U.S. disaster events. Although the Federal Bureau of Investigation (FBI) collects information on missing persons related to "catastrophes" that include airplane crashes, terrorist attacks, and natural disasters, along with other potential scenarios [5], these data are not disaggregated in a way that can be used for Sendai reporting. As a result, the U.S. is unable to report on the number of people declared missing as a result of natural disaster events. If the FBI were able to disaggregate these data, reporting on this indicator may be possible in the future.

2.2. Target B: Reducing people affected

Target B (Table 2) measures the number of directly affected people attributed to disasters, including injuries and illnesses and damaged or destroyed dwellings. For the number of injured or ill people, the U.S. has been able to report the number of people suffering direct injuries only from weather and disasters likely to be related to climate change [45]. As noted in Section 2.1, this excludes injuries and illness from a number of other disaster types, rendering the data the U.S. is able to report incomplete.

The number of damaged and destroyed dwellings reported is limited to those impacted by PDDs or SBA Administrative disaster declarations. FEMA's Individual Assistance (IA) grant program's Individuals and Households Program is used to provide assistance to uninsured or under-insured disaster loss survivors following catastrophic disaster events [15]. Similarly, the SBA Disaster Loan Program provides assistance to uninsured or underinsured households and businesses [55].

The SDR recognizes that reporting disaster loss statistics based on these programs paints an incomplete picture of damage and loss to homes due to disasters. Many hazards are covered by homeowner's insurance, but damage caused by floods, storm surge, and earthquakes typically are not [23]. For these hazards, homeowners need to take out additional private earthquake insurance, and/or flood insurance through the National Flood Insurance Program. Thus, certain hazard losses may only be recorded by the insurance industry and may not be reported at the Federal level [57]. Further, some research has shown that socially vulnerable populations may be less likely than others to receive short-term emergency assistance, leaving some critical statistics out of our accounting [11,18,33,50].

The final indicator in Target B quantifies the number of people whose livelihoods were disrupted or destroyed due to disasters at a national scale. This includes the number of workers affected by the damage or loss of crops, livestock, or productive asset facilities due to disasters. The U.S. has not yet been able to report on this indicator, as there is no accepted means of estimating the relevant number of workers per productive asset (land area, production facility, etc.) that could be potentially matched with Federal disaster data concerning those assets. As better data and methods of analysis emerge over time, however, this indicator may be possible to report on in the future.

2.3. Target C: reducing economic loss

Target C (Table 3) measures the direct economic loss attributed to disasters, which is presented in relation to gross domestic product. Direct economic losses include agricultural losses, losses to productive assets, direct economic losses in the housing sector, direct economic losses from damaged or destroyed critical infrastructure and cultural heritage.

The U.S. Department of Agriculture (USDA) notes that the estimated agricultural losses data that they are able to provide are an underestimate

Table 3
U.S. reporting on indicators related to economic loss due to disasters.

U.S. reporting	Indicator	Hazards addressed	Data sources
Reduce direct disaster economic loss in relation to global gross domestic product (GDP) by 2030.			
●	Direct agricultural loss attributed to disasters	• Eligible adverse weather events, disease, and attacks	• USDA Federal Crop Insurance Program • USDA Livestock Indemnity Program (LIP) • USDA Emergency Livestock Assistance Program (ELAP)
		• Disasters declared by NOAA's National Marine Fisheries Service (NMFS)	• NOAA NMFS
●	Direct economic loss to all other damaged or destroyed productive assets attributed to disasters	• SBA Administrative disaster declarations (All Hazards) • SBA economic injury disaster declarations • PDDs • Secretary of Agriculture disaster declarations (All natural hazards)	• SBA Office of Disaster Assistance Home Loans
●	Direct economic loss in the housing sector attributed to disasters	• Weather-related disasters	• Property Claim Services (PCS) annual aggregate data shared by NOAA [32]
		• SBA Administrative disaster declarations (All Hazards) • SBA economic injury disaster declarations • PDDs • Secretary of Agriculture disaster declarations (All natural hazards)	• SBA Office of Disaster Assistance Home Loans
		• PDDs • Floods	• FEMA Individuals and Households Program • FEMA National Flood Insurance Program
●	Direct economic loss resulting from damaged or destroyed critical infrastructure attributed to disasters	• PDDs	• FEMA Public Assistance (PA) Program
▲	Direct economic loss to cultural heritage damage or destroyed attributed to disasters		

because: a) not all disasters are eligible for USDA Livestock Indemnity Program (LIP) or USDA Emergency Livestock Assistance Program (ELAP) payments, b) some producers' losses may not meet eligibility requirements, and c) many producers choose not to claim losses under LIP or ELAP [63,64]. NOAA National Marine Fisheries Service (NMFS) data may also be an underestimate because not all fishery disasters may meet necessary criteria for a disaster determination.

U.S. economic losses in the housing sector due to disasters are derived from a number of sources, listed in Table 3. For example, NOAA provides annual Property Claim Services (PCS) insured residential paid losses for all combined weather disasters, reflecting events with >$25 million in insured losses that have affected a significant number of policyholders and insurers [57]. PCS aggregates private sector insurance data and is recognized internationally as an authoritative source [32].

It is challenging to quantify the degree to which U.S. economic loss data may be underestimated. The economic losses reported to the Sendai Monitor by these Federal sources are actually greater than those recorded in the International Disaster Database (EM-DAT) [8]. In the future, SDR would benefit from comparing its findings with those of the reinsurance industry for a more complete understanding of reporting gaps.

The U.S. has not yet been able to report on economic losses related to the loss of education facilities health facilities, or on direct economic loss from damaged or destroyed cultural heritage due to disasters. The SDR continues to work with the Department of Education and with the Department of Health and Human Services Office of the Assistant Secretary for Preparedness and Response to be able to report on the dollar value of these losses. Although the U.S. can report on the number of damaged or destroyed educational facilities (see Section 2.4), it is currently impossible to attribute a specific dollar amount to these losses. It is not possible to report health facility data because most health facilities are private and/or privately insured and have little incentive to report damage or loss to the Federal government (see Section 5.4). The SDR continues to explore how to report on cultural resource damages with the National Park Service, National Endowment for the Arts, FEMA, and the Smithsonian Institution. While many institutions collect data related to this topic, there is no standardized disaster loss reporting mechanism for cultural resource damages due to disasters.

2.4. Target D: reducing damage and disruption to critical infrastructure and services

Progress on Target D (Table 4) is measured by reporting disaster damage to critical infrastructure and disruption of basic services, including health and educational facilities. The U.S. has not been able to report on

Table 4
U.S. reporting on indicators related to damage and disruption to critical infrastructure and services.

U.S. reporting	Indicator	Hazards addressed	Data sources
Substantially reduce disaster damage to critical infrastructure and disruption of basic services, among them health and educational facilities, including through developing their resilience by 2030			
●	Number of destroyed or damaged educational facilities attributed to disasters.	• All Hazards	• Department of Education Federal Student Aid Office
●	Number of disruptions to educational services attributed to disasters	• PDDs	• FEMA Public Assistance Program
▲	Number of disruptions to health services attributed to disasters		
▲	Number of destroyed or damaged health facilities attributed to disasters.		
●	Number of other destroyed or damaged critical infrastructure units and facilities attributed to disasters	• PDDs	• FEMA Public Assistance Program
●	Number of disruptions to basic services attributed to disasters	• PDDs	• FEMA Public Assistance Program

Table 5
U.S. reporting on indicators related to the adoption of DRR strategies.

U.S. reporting	Indicator	Hazards addressed	Data sources
Substantially increase the number of countries with national and local disaster risk reduction strategies by 2020.			
●	Detailed rating to score adoption and implementation of national disaster risk reduction strategies in line with the Sendai Framework for Disaster Risk Reduction 2015–2030		• FEMA Strategic Plans for 2014–2018 and 2018–2022
●	Number of local governments with DRR strategy in line with national strategies		• Stafford Act; FEMA Hazard Mitigation Plan Status [12]

Table 6
U.S. reporting on indicators related to international cooperation.

U.S. reporting	Indicator	Hazards addressed	Data sources
Substantially enhance international cooperation to developing countries through adequate and sustainable support to complement their national actions for implementation of this framework by 2030.			
◆	Total official international support, (official development assistance (ODA) plus other official flows), for national disaster risk reduction actions		
◆	Total official international support (ODA plus other official flows) for national disaster risk reduction actions provided by multilateral agencies		
◆	Total official international support (ODA plus other official flows) for national disaster risk reduction actions provided bilaterally		
◆	Total official international support (ODA plus other official flows) for the transfer and exchange of disaster risk reduction-related technology		
◆	Number of international, regional and bilateral programs and initiatives for the transfer and exchange of science, technology and innovation in disaster risk reduction for developing countries		
◆	Total official international support (ODA plus other official flows) for disaster risk reduction capacity-building		
◆	Number of international, regional and bilateral programs and initiatives for disaster risk reduction-related capacity-building in developing countries		
◆	Number of developing countries supported by international, regional and bilateral initiatives to strengthen their disaster risk reduction-related statistical capacity		

the number of destroyed or damaged health facilities attributed to disasters (see section 2.3). Conversely, the U.S. does report on this number for educational facilities.

The U.S. Department of Education manually collects data on the number of Higher Education facilities that experienced flood, water, or structural damage or destruction due to disasters. The Department of Education collects these data when tracking the operating status of Title IV eligible school locations – institutions that process U.S. Federal student aid – that are impacted by natural disasters (Ingrid Valentine, Department of Education Federal Student Aid Office, written communication, 30 July 2020). The U.S. also reports on disasters that disrupt educational services.

Currently, disaster loss reporting for primary and secondary schools faces two main challenges. First, states and school districts are not required to report as to the closure or damage/destruction of a building due to a disaster at a Federal level. Second, reporting may be further complicated by schools with numerous buildings where some, but not all may be damaged. Schools damaged or destroyed by disasters sometimes fall into specific statutory relief programs or as a part of competitive or disaster assistance grant program requests. Grant funds, however, are often not tied to specific schools or structures but rather to districts or regions (Douglas Geverdt, Department of Education National Center for Education Statistics, written communication, 28 May 2020).

Due to the security concerns of some agencies that manage critical infrastructure in the U.S., data reported on other destroyed or damaged critical infrastructure units and facilities are an underestimate (see section 3.5). It is difficult for the SDR to determine the scale of this underestimate without the disclosure of information on the nature of these sensitive data sources.

2.5. Target E: increasing countries with DRR strategies

UNDRR instructs countries to rate the adoption and implementation of national Disaster Risk Reduction (DRR) strategies in line with the Sendai Framework (Table 5) based on the following 10 key elements covering whether the strategies:

1. Have different timescales, with targets, indicators and timeframes
2. Have objectives and measures aimed at preventing the creation of risk
3. Have objectives and measures aimed at reducing existing risk
4. Have objectives and measures aimed at strengthening economic, social, health and environmental resilience
5. Are based on risk knowledge and assessments to identify risks at the local and national levels of the technical, financial and administrative disaster risk management capacity
6. Mainstream and integrate DRR within and across all sectors with defining roles and responsibilities
7. Guide the allocation of the necessary resources at all levels of administration for the development and the implementation of DRR strategies in all relevant sectors
8. Strengthen disaster preparedness for response and integrate DRR response preparedness and development measures to make nations and communities resilient to disasters
9. Promote policy coherence and compliance, notably with the SDGs and the Paris Agreement
10. Have mechanisms to follow-up, periodically assess and publicly report on progress

The U.S. score is based on the degree to which the FEMA Strategic Plans for 2014–2018 and 2018–2022 align with these 10 key elements for the respective calendar years [14,16]. The second indicator measures the number of local governments that have local DRR strategies in line with national strategies. For the U.S., "local governments" are treated as "U.S. state governments," and all U.S. states, the District of Columbia, and five U.S. territories have state mitigation plans approved by FEMA [12]. In contrast to potential underestimates in U.S. reporting for other indicators, the SDR is highly confident that there is little to no underestimation in U.S. reporting for Target E indicators.

2.6. Target F: increasing international cooperation

The U.S. reports whole-of-government official foreign assistance data and information to the Development Assistance Committee of the Organization for Economic Co-operation and Development (OECD) on an annual basis [62]. However, data for Sendai Target F indicators (Table 6) are not part of OECD data requirements and were not collected. Therefore, the U.S. does not report data on Target F of the Sendai Framework.

Table 7
U.S. reporting on indicators related to early warning and risk information.

U.S. reporting	Indicator	Hazards addressed	Data sources
Substantially increase the availability of and access to multi-hazard early warning systems and disaster risk information and assessments to the people by 2030			
●	Number of countries that have multi-hazard and forecasting systems		FEMA Integrated Public Alert and Warning Systems Division
●	Number of people covered by multi-hazard early warning systems		FEMA Integrated Public Alert and Warning Systems Division
●	Number of local governments having a plan to act on early warnings		FEMA Integrated Public Alert and Warning Systems Division
●	Number of countries that have accessible, understandable, usable, and relevant disaster risk information and assessment available to the people at national and local levels		Pew Research Center
▲	Population exposed to or at risk from disasters protected through pre-emptive evacuation following early warning		

2.7. Target G: increasing availability of early warning and risk information

Target G (Table 7) measures the availability of, and access to, multi-hazard early warning systems and disaster risk information and assessments. The U.S. has numerous early warning systems for extreme, sudden-onset hazards including meteorological events, as well as localized early warning systems for geophysical events like earthquakes and tsunamis [46,65]. Instead of reporting on the coverage of multi-hazard early warning systems themselves, the SDR reports on the coverage of alert notification systems that deliver hazard information to the population. Alert and notification systems enable people to take protective actions based on early warnings; thus, the SDR determined that this metric better meets the intent of this indicator.

NOAA and FEMA-supported mechanisms cover 100% of the U.S. population via one or more hazard alerting pathways, including the Emergency Alert System (radio, television broadcasters, and cable media networks) and cellular broadcast Wireless Emergency Alerts. All U.S. states and territories have developed comprehensive emergency management plans speaking to the distribution of a state or local emergency warning. Most of the U.S. population lives in a local jurisdiction that has access to the Integrated Public Alert and Warning System to send Emergency Alert System messages and Wireless Emergency Alerts.

U.S. disaster risk information is readily available on official government websites (e.g., FEMA's National Risk Index) [43]. For such online information, United Nations guidance recommends using a country's national internet penetration rate as a proxy for the accessibility and availability of disaster risk information [60]. Therefore, the percentage of U.S. adults who use the internet, tracked by the Pew Research Center [49], is reported as a proxy for the accessibility of understandable, usable, and relevant disaster information. The internet penetration rate is an imperfect proxy, given that not every person with internet access may be aware of, or motivated to seek out, authoritative disaster risk information.

A sub-indicator for Target G concerns the percentage of the population exposed to or at risk from hazards that is protected through pre-emptive evacuation following early warning. The SDR has not yet determined if it can report on this indicator. Given that the majority of evacuation orders in the U.S. are issued by local governments, it is unlikely that the Federal government would be able to report these data.

3. Challenges and opportunities

Below we focus on challenges that the Federal government's SDR interagency coordination group encountered as we reported disaster losses to the Sendai Monitor. Given that this effort is still relatively new, much of this reporting work has involved individual consultation with disaster risk reduction experts across Federal agencies to better understand what data those agencies collect and how (or whether) disaster loss data can be aggregated and reported. This process has allowed us to better understand and capture challenges to consistent, national-scale disaster loss reporting.

There is a wealth of literature on challenges to disaster loss reporting [2,10,23,37,40–42]. This literature touches on a wide variety of reasons that disaster losses are not well reported, spanning from an inability to report due to disability, lack of education, or fear of reprisal [18,52], to issues with the definition of what makes a "disaster" [23]. It has also been pointed out that with 'slow-onset disasters' (e.g. drought) or disasters that have a 'long tail' (e.g. toxic chemical spill) a true accounting of disaster losses cannot be made until long after the initial event has occurred [19,20,36,47,54]. Comprehensive disaster loss reporting also suffers from other important temporal, geographic, threshold, hazard, and accounting biases to disaster loss reporting [22,23]. While each of these topics are of concern, in this paper we focus on the administrative and policy-driven challenges that the SDR encountered in the reporting of U.S. disaster losses to the Sendai Monitor.

Sendai reporting efforts in the U.S. have faced four main challenges: 1) the lack of a national focal point and Federal mandates for disaster loss reporting, 2) the lack of consistent and systematic data collection and reporting across Federal agencies, 3) the lack of strong incentives for local, county, and state entities to report disaster loss statistics to the Federal government, and 4) the lack of reporting on particular disaster losses due to security concerns. Some of these challenges may never be overcome and others would require massive efforts and resources to resolve. In other cases, opportunities for improvement have already been identified and are being acted upon by government agencies.

3.1. Challenge: lack of central focal point for disaster loss reporting

As noted in Section 2 above, if a disaster is not presidentially declared, losses are often recorded only at the county or state level and not aggregated at the Federal level [4,23,40]. Such disaster loss data have been collected and archived in different ways, for different purposes, and at different temporal and geographic scales [9,23]. Effectively collecting and standardizing these data on an annual basis would require a team of dedicated staff. Currently, that resource is lacking in the U.S. There is no single agency or office within the U.S. government with a mandate to collect and analyze all disaster loss information. Instead, reporting to the Sendai Monitor is led by the SDR, a small coordinating body within the Federal government that has no administrative or regulatory authority.

As a result, U.S. reporting to the Sendai Monitor is limited to the collection of easily accessible data, such as those derived from presidentially declared disasters, and may continue to exclude losses from smaller-scale incidents [6,53]. As Gall, et al. [23] point out, "the insurance industry has a better understanding of economic losses suffered from natural hazards than the U.S. government despite the multitude of Federal agencies that focus on natural hazards."

Opportunity: A critical first step towards reporting Sendai Framework data is to standardize national disaster preparedness and loss data reporting. The 2012 National Academies of Sciences, Engineering, and Medicine report, *Disaster Resilience: A National Imperative*, specifically recommends developing a national database for U.S. disaster losses to develop more quantitative models and understand vulnerability [41]. The creation of such a database may encourage an interagency effort to consolidate information across disaster response agencies.

Creating a funded mandate for a particular office, agency, or group to act as the Federal focal point to collect and standardize disaster loss data across the U.S. may also enable dedicated staff to work with other Federal agencies, as well as state, local, and tribal governments to improve disaster loss reporting over time. This mandate would assign responsibility for creating and maintaining a disaster loss database, while also expanding the types and the number of hazards for which U.S. disaster loss data is aggregated.

3.2. Challenge: lack of federal mandate or funding for standardized disaster loss reporting across all agencies

In the U.S., only certain Federal agencies are mandated and funded by the U.S. Congress to collect disaster loss data pertaining to their mission. For example, NOAA's National Centers for Environmental Information collects and updates quarterly information on climate and weather-related disasters whose losses amount to more than one billion-dollars [44]. NOAA also documents death and injury data for all reported and observed weather events as a standard operating procedure of the 122 National Weather Service offices throughout the country [45]. FEMA's collection of disaster loss data is tied largely to disasters declared by the president under the Stafford Act.

Although the USGS is responsible for the study of geophysical and biological hazards, the USGS does not systematically collect information on the mortality, morbidity, or economic losses associated with these hazards because it is not mandated to do so by Congress. Thus, while some U.S. government agencies may engage in mission-specific disaster loss reporting, mandates for national disaster loss reporting at the Federal level are uneven and incomplete. Beyond these mandates, funding is critical to carrying out these tasks appropriately. Disaster loss reporting in individual sectors of the Federal government requires manpower, appropriate information technology (IT) structures, and the funding to create and maintain them over the long term (Pew Charitable [48]).

Opportunity: Increase the types of hazards for which the U.S. can report disaster losses by 1) examining the types of disaster loss data each Federal agency could provide and 2) mandating the standardized reporting of those data. Such mandates for standardized disaster loss data reporting may also increase the ability for the U.S. government to report on losses occurring at more localized scales by including standardized data that is collected at the field or regional office level. Finally, mandates for standardized data reporting could provide opportunities for data sharing and data interoperability across and between agencies that have not yet been realized.

3.3. Challenge: federal government agencies do not always collect internal disaster loss data in formats compatible with Sendai reporting

Federal agencies also face gaps in reporting on disaster losses for the considerable number of Federal government-owned assets. The Federal government owns around 640 million acres of land in the U.S., totaling around 28% of the country's total land area [3]. The Federal government also owns or leases over 9000 civilian-use buildings across the country [28]. Moreover, this footprint does not include the U.S. Department of Defense, which has its own extensive real property portfolio [24]. The Federal government manages and maintains thousands of highways, tunnels, and bridges, as well as hundreds of dams and other critical infrastructure across the nation. The U.S. government self-insures most of its property against damage or loss [25,29].

In most Federal agencies, disaster losses related to the agency's property, assets, and mission *are* recorded for internal use. Following a disaster event, most Federal agencies are required to report on damaged or destroyed infrastructure, facilities, or equipment owned by the U.S. government and injured or ill employees for situational awareness and/or internal accounting purposes. These data, however, are often not collated or archived in a manner that could be used for Sendai disaster loss reporting. For example, the Department of the Interior issues daily email reports on impacts to Department assets following a disaster event. Yet, the data from these reports are never combined into a central database that could permit easy collation and analysis. A dedicated staff (see Section 3.1) might be able to parse these reports into a useable format for Sendai reporting, but given the small number of Federal employees currently dedicated to U.S. disaster loss reporting, such an effort is impractical.

Opportunities for systematically reporting the effects of disasters on Federal infrastructure and employees may be missed as well. For example, most Federal agencies collect information on damage to Federal infrastructure through a digital records system. The specific cause of damage, however, is often not recorded. Thus, water damage to a structure may be recorded, but it may be impossible to know whether the water damage was due to a leaky pipe suffering from regular wear-and-tear (not a reportable event under the Sendai Framework), or flooding following a hurricane (a reportable event under Sendai). Performing data forensics to identify and provide missing information related to Federal agencies' internal disaster loss data is not feasible at a national scale, especially in the absence of staff dedicated to this task. As a result, information that could contribute to U.S. Sendai disaster loss statistics may be missing in the nation's annual reports.

Opportunity: The creation of a mandatory system of disaster loss reporting for Federal assets that is standardized across Federal agencies could greatly assist with the collection of information pertinent to U.S. Sendai reporting. Establishing such a system could demonstrate the U.S. government's commitment to ongoing collaboration with the global disaster risk reduction community. Through the SDR's efforts and communication with a variety of agencies across the Federal government, some agency officials are already considering how to alter their reporting mechanisms to collect disaster loss information more systematically in the future.

3.4. Challenge: lack of incentives for standardized reporting

As mentioned previously, the Federal government is not directly involved in managing most disasters in the U.S. In practice, this means that state, local, tribal and territorial (SLTT) governments, the private sector, or nonprofit organizations have few incentives to report disaster loss data to the Federal government unless Federal grant dollars are involved. FEMA Hazard Mitigation Assistance grants offer incentives for communities to document historical damage as part of conducting a benefit-cost analysis for their grant applications [17]. Applying to these grants, however, is voluntary and any historical damage data reported is unlikely to be in a format conducive to consistent reporting under the Sendai Framework. Therefore, most disaster loss information is provided by SLTT governments to the Federal government only after a presidential disaster declaration under the Stafford Act, where FEMA documents disaster-related damage in order to provide recovery grant funding. Without a presidential disaster declaration or a Federal mandate for standardized disaster loss reporting at a state-level, states may see little incentive to report disaster losses to FEMA. Disaster loss data related to smaller-scale storm events collected by NWS are often based on local news coverage or voluntary, self-initiated reports [45], not due to any Federal mandate for disaster loss reporting.

Disaster loss data is also collected by insurance companies and private industry. In some cases, particularly in the private sector, there may be a disincentive to report detailed proprietary disaster loss data, as they may reveal vulnerabilities, or lead to a loss of reputation among business competitors or clients [30]. Nevertheless, businesses in certain industries are legally required to report on direct and indirect losses regarding occupational health and safety and accidental chemical releases [35].

Even when states or other entities do share disaster loss statistics with the Federal government, these data are sometimes recorded in differing formats or databases that make national-level reporting difficult (Pew Charitable [21,48]). State reporting on injuries and illness related to disaster events provides a good example of the limitations the U.S. faces. States do collect emergency department visit and hospital discharge data from community hospitals. These medical data can be used to understand how many people have been made ill or have been injured by a disaster by

comparing baseline data for a given geographic area with data collected during and immediately following a disaster event. Even so, states have very different formats for medical data, and sharing these data with the Federal government is not required, but rather at each state government's discretion. Those who choose to share this information have different data use agreements, which can make further sharing between or across Federal agencies more difficult. So, while these important data are collected nationwide, it is very difficult to share, aggregate, and analyze these data on a national scale. Due to these hurdles, U.S. reporting of disaster-related illness and injury data to the Sendai Monitor has been incomplete. The above-described challenges are not unique to disaster morbidity data; other sectors present similar issues, hindering detailed and systematic reporting at a national level.

Opportunity: It may be possible to insert Sendai principles into how reporting structures are improved following disasters. For example, the COVID-19 pandemic has led many hospitals to begin daily reporting on bed capacity, available staff, and illness burden to the Department of Health and Human Services. This pivotal moment in public health reporting may present an opportunity to design and implement a nationwide system of illness burden reporting that can be shaped by the Sendai Framework and inform its implementation in the U.S. Not only would this reporting aid the U.S. in reporting to the Sendai Monitor annually, it would also help the nation create a clearer picture of the health impacts of disasters in different parts of the country.

More broadly, guiding states to develop reporting systems that are standardized across the U.S. may facilitate the seamless roll-up of disaster loss information to the Federal level. Recognizing that collecting disaster loss information can improve community resilience, states like Ohio have already invested in data collection to build out robust mitigation dashboards to help policymakers identify best practices. This approach, however, has not been adopted across all states [58].

3.5. Challenge: security concerns

Certain industries and government agencies cannot or will not report on disaster losses in their sectors because such reporting might lead to security concerns for the U.S. For example, reporting the impact of disasters on critical infrastructure such as power grids, ports, and dams may expose vulnerabilities that could be exploited by potential adversaries. As a result, U.S. agencies often do not consistently provide external disaster loss reports in a variety of sensitive sectors.

Opportunity: The U.S. may be able to use the Sendai reporting process as a means of learning from other nations as to how they have effectively reported on losses to potentially sensitive sectors. One of the major benefits of this international effort is that it provides a platform for the exchange of ideas and experiences across nations.

4. Conclusion

In this paper, we have shown what Sendai Framework indicators the U.S. government reports on, which metrics are included in that reporting, and limitations on U.S. reporting capabilities. We have considered gaps, challenges, and potential opportunities for consistent, comprehensive disaster loss reporting in the U.S.

Implementing the Sendai Framework in the U.S. involves improving the collection of disaster loss information, collaborating across institutional boundaries, and integrating disaster risk reduction into national and global efforts. The Sendai Framework encourages systematic data collection and reporting and provides a nexus for that reporting across different U.S. government agencies. Better collection and synthesis of U.S. disaster data may lead to important advances in disaster mitigation efforts. Ultimately, the more comprehensively we are able to synthesize U.S. disaster loss data, the better we can apply these data to reduce disaster risk and build national resilience. As U.S. participation in the Sendai Framework endures, opportunities may emerge to make lasting improvements in both the strength of our data and our communities.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

References

[1] ASU. FAQ: Center for Emergency Management and Homeland Security. What are the data sources for SHELDUS?; 2020https://cemhs.asu.edu/sheldus/faq#data-sources-for-sheldus. (accessed December 8, 2020).
[2] Clarke L, Blanchard K, Maini R, Radu A, Eltinay N, Zaidi Z, et al. Knowing what we know – reflections on the development of technical guidance for loss data for the sendai framework for disaster risk reduction. PLOS Currents Disasters Ed. 2018:1. https://doi.org/10.1371/currents.dis.537bd80d1037a2ffde67d66c604d2a78.
[3] Congressional Research Service (CRS). Federal land ownership: overview and data (February 21, 2020). https://fas.org/sgp/crs/misc/R42346.pdf; 2020. (accessed November 19, 2020).
[4] Congressional Research Service (CRS). Congressional primer on responding to and recovering from major disasters and emergencies (3 June 2020). https://fas.org/sgp/crs/homesec/R41981.pdf; 2020. (accessed November 3, 2020).
[5] Congressional Research Service (CRS). Missing adults: background, federal programs, and issues for congress. (August 23, 2019). https://fas.org/sgp/crs/misc/RL34616.pdf; 2019. (accessed November 19, 2020).
[6] Congressional Research Service (CRS). Stafford act declarations 1953–2016: trends, analyses, and implications for congress (28 August 2017). https://fas.org/sgp/crs/homesec/R42702.pdf; 2017.
[7] Coronese M, Lamperti F, Keller K, Chiaromonte F, Roventini A. Evidence for sharp increase in the economic damages of extreme natural disasters. Proc of the Natl Academy Sci. 2019;116(43):21450–5. https://doi.org/10.1073/pnas.1907826116.
[8] CRED (Centre for Research on the Epidemiology of Disasters). EM-DAT: The international disaster database explanatory notes. Brussels: CRED; 2020http://www.emdat.be/explanatory-notes (accessed December 8, 2020).
[9] Cutter S. Building disaster resilience: steps toward sustainability. Chall Sustain. 2013;1:72–9. https://doi.org/10.12924/cis2013.01020072.
[10] Cutter SL, editor. American hazardscapes: the regionalization of hazards and disasters. Washington, DC: Joseph Henry Press; 2001. https://doi.org/10.17226/10132.
[11] Emrich CT, Tate E, Larson SE, Zhou Y. Measuring social equity in flood recovery funding. Environ Hazards. 2020;19(3):228–50. https://doi.org/10.1080/17477891.2019.1675578.
[12] FEMA. Hazard mitigation plan status. https://www.fema.gov/emergency-managers/risk-management/hazard-mitigation-planning/status; 2020. (accessed November 3, 2020).
[13] FEMA. How a disaster gets declared. https://www.fema.gov/disasters/how-declared; 2020. (accessed November 3, 2020).
[14] FEMA. Strategic plan 2018–2022. https://www.fema.gov/sites/default/files/2020-03/fema-strategic-plan_2018-2022.pdf; 2018.
[15] FEMA. Individuals and households program unified guidance. FP 104-009-3. https://www.fema.gov/sites/default/files/2020-05/IHP_Unified_Guidance_FINAL_09272016_0.pdf; 2016.
[16] FEMA. Strategic plan 2014–2018. https://www.fema.gov/media-library-data/1405716454795-3abe60aec989ecce518c4cdba67722b8/July18FEMAStratPlanDigital508HiResFINALh.pdf; 2014.
[17] FEMA. BCA reference guide. https://www.fema.gov/sites/default/files/2020-04/fema_bca_reference-guide.pdf; 2009. (accessed December 17, 2020).
[18] Fothergill A, Peek LA. Poverty and disasters in the United States: a review of recent sociological findings. Nat Hazards. 2004;32:89–110. https://doi.org/10.1023/B:NHAZ.0000026792.76181.d9.
[19] Researching disaster from an STS perspective. In: Fortun K, Knowles SG, Choi V, Jobin P, Matsumoto M, de la Torre P, et al, editors. 2016 The handbook of science and technology studies. Boston: MIT Press; 2016.
[20] Fortun K. Advocacy after Bhopal: Environmentalism, disaster, new global orders. Chicago: Univ. of Chicago Press; 2001.
[21] Gall M. The suitability of disaster loss databases to measure loss and damage from climate change. Int J of Global Warming. 2015;8(2):170–90.
[22] Gall M, Kreft S. Measuring what matters? A suitability analysis of loss and damage databases for the climate change convention process. Loss and Damage Working Paper; 2013.
[23] Gall M, Borden Kevin A, Cutter Susan L. When do losses count? Six fallacies of natural hazards loss data. Bull Am Meteorol Soc. 2009;90(6):799–810. https://doi.org/10.1175/2008BAMS2721.1.
[24] GAO. Defense real property: DOD-wide strategy needed to address control issues and improve reliability of records. https://www.gao.gov/assets/710/709224.pdf; 2020. (accessed December 17, 2020).
[25] GAO. U.S. GAO - Survey of the application of the government's policy on self-insurance. https://www.gao.gov/products/096532; 1972. (accessed December 17, 2020).
[26] Glasser R. The climate change imperative to transform disaster risk management. Int J Disaster Risk Sci. 2020;11:152–4. https://doi.org/10.1007/s13753-020-00248-z.
[27] Green HK, Lysaght O, Saulnier DD, Blanchard K, Humphrey A, Fakhruddin B, et al. Challenges with disaster mortality data and measuring progress towards the implementation of the Sendai framework. Int J Disaster Risk Sci. 2019;10:449–61. https://doi.org/10.1007/s13753-019-00237-x.
[28] GSA. GSA properties. https://www.gsa.gov/real-estate/gsa-properties; 2020. (accessed January 17, 2020).

[29] GSA. Guide to your fleet vehicle. https://www.gsa.gov/cdnstatic/gsa_fleet_vehicle_guide_2014.pdf; 2014. (accessed December 17, 2020).
[30] Hiete M, Mirjam M. An indicator framework to assess the vulnerability of industrial sectors against indirect disaster losses. Proc. of the 6th Int. ISCRAM Conf.—Gothenburg, Sweden; 2009.
[31] International Institute for Sustainable Development (IISD) Reporting Services. Resilience dividend: Towards sustainable and inclusive societies. 6th session of the glob. platf. for disaster risk reduct; 2019https://enb.iisd.org/undrr/globalplatform/2019/. (accessed November 3, 2020).
[32] Insurance Services Office, Inc. Property Claims Services. https://pcs.iso.com/pcs/app/start.do; 2020. (accessed November 3, 2020).
[33] Kamel N. Social marginalisation, federal assistance and repopulation patterns in the New Orleans metropolitan area following hurricane Katrina. Urb Stud. 2012;49(14):3211–31. https://doi.org/10.1177/0042098011433490.
[34] Kelman I. Introduction in: five years of the Sendai framework for disaster risk reduction. Int J Disaster Risk Sci. 2020;11:145–6. https://doi.org/10.1007/s13753-020-00271-0.
[35] Kleindorfer PR, Saad GH. Managing disruption risks in supply chains. Prod Op Manag. 2005;14(1):53–68. https://doi.org/10.1111/j.1937-5956.2005.tb00009.x.
[36] Little P. Toxic town: IBM, pollution, and industrial risks. New York: NYU Press; 2014.
[37] Mileti D. Disasters by Design: A Reassessment of Natural Hazards in the United States. Washington, DC: Joseph Henry Press; 1999. https://doi.org/10.17226/5782.
[38] Mizutori M. Reflections on the Sendai framework for disaster risk reduction: five years since its adoption. Int J Disaster Risk Sci. 2020;11:147–51. https://doi.org/10.1007/s13753-020-00261-2.
[39] Munich RE. TOPICS Geo Natural Catastrophes 2017: A stormy Year. https://www.munichre.com/en/risks/natural-disasters-losses-are-trending-upwards.html; 2018.
[40] National Academies of Sciences, Engineering, and Medicine. A framework for assessing mortality and morbidity after large-scale disasters. Washington, DC: The National Academies Press; 2020. https://doi.org/10.17226/25863.
[41] National Research Council. Disaster resilience: a national imperative. Washington, D.C.: National Academies Press; 2012. https://doi.org/10.17226/13457.
[42] National Research Council. Reducing disaster losses through better information. National Academies Press; 1999. https://doi.org/10.17226/6363.
[43] National Risk Index. https://hazards.geoplatform.gov/portal/apps/MapSeries/index.html?appid=ddf915a24fb24dc8863eed96bc3345f8; 2020. (accessed, December 17, 2020).
[44] NOAA National Centers for Environmental Information (NCEI). U.S. Billion-Dollar Weather and Climate Disasters NOAA; 2021. https://www.ncdc.noaa.gov/billions doi:10.25921/stkw-7w73.
[45] NOAA. NOAA storm data directive. National Oceanic and Atmospheric Administration (NOAA); 2018https://www.nws.noaa.gov/directives/sym/pd01016005curr.pdf. (accessed November 3, 2020).
[46] NOAA. U.S. tsunami early warning system. https://www.noaa.gov/explainers/us-tsunami-warning-system; 2017.
[47] Petryna A. Life exposed: Biological citizens after Chernobyl. Princeton: Princeton University Press; 2002.
[48] Pew Charitable Trusts. What we don't know about state spending on natural disasters could cost us: Data limitations, their implications for policymaking, and strategies for improvement. A Report https://www.pewtrusts.org/-/media/assets/2018/06/statespendingnaturaldisasters_v4.pdf; 2018.
[49] Pew Research Center. Internet/broadband fact sheet. Pew Research Center Internet and Technology. https://www.pewresearch.org/internet/fact-sheet/internet-broadband/; 2020.
[50] Rufat S, Tate E, Burton CG, Maroof AS. Social vulnerability to floods: review of case studies and implications for measurement. Int J Disaster Risk Reduction. 2015;14:470–86. https://doi.org/10.1016/j.ijdrr.2015.09.013.
[51] Robert T. Stafford Disaster Relief and Emergency Assistance Act; 2018 U.S. Code 42. § § 5121–5206.
[52] SAMHSA. Greater impact: how disasters affect people of low socioeconomic status. https://www.samhsa.gov/sites/default/files/dtac/srb-low-ses_2.pdf; 2017. (accessed December 17, 2020).
[53] Schmidtlein MC, Finch C, Cutter SL. Disaster declarations and major hazard occurrences in the United States. Prof Geogr. 2008;60(1):1–14. https://doi.org/10.1080/00330120701715143.
[54] Singer M. Down Cancer alley: the lived experience of health and environmental suffering in Louisiana's chemical corridor. Med Anthropol Q. 2011;25(2):141–63. https://doi.org/10.1111/j.1548-1387.2011.01154.x.
[55] Small Business Administration. Physical Damage Loans. "Home and Personal Property Loans". https://www.sba.gov/funding-programs/disaster-assistance/physical-damage-loans#section-header-0; 2020. (accessed December 11, 2020).
[56] Smith A. 2010-2019: a landmark decade of U.S. billion-dollar weather and climate disasters. https://www.climate.gov/news-features/blogs/beyond-data/2010-2019-landmark-decade-us-billion-dollar-weather-and-climate; 2020.
[57] Smith A, Katz R. U.S. billion-dollar weather and climate disasters: data sources, trends, accuracy and biases. Nat Hazards. 2013;67:387–410. https://doi.org/10.1007/s11069-013-0566-5.
[58] Stauffer A, Foard C. As disaster costs grow, understanding state spending is key. Pew Charitable Trusts; 2018https://www.pewtrusts.org/en/research-and-analysis/articles/2018/08/30/as-disaster-costs-grow-understanding-state-spending-is-key (accessed November 3, 2020).
[59] UNDRR. Sendai framework monitor homepage. https://sendaimonitor.undrr.org; 2020. (accessed November 2, 2020).
[60] UNISDR. Technical guidance for monitoring and reporting on progress in achieving the global targets of the sendai framework for disaster. https://www.unisdr.org/files/54970_techguidancefdigitalhr.pdf; 2017. (accessed November 3, 2020).
[61] UNISDR. Sendai framework for disaster risk reduction: 2015–2030. https://www.unisdr.org/files/43291_sendaiframeworkfordrren.pdf; 2015.
[62] U.S. Agency for International Development (USAID). U.S. overseas loans and grants: obligations and loan authorizations, July 1, 1945–September 30, 2018. https://pdf.usaid.gov/pdf_docs/PBAAJ820.pdf; 2018. (accessed November 3, 2020).
[63] USDA. Disaster assistance: ELAP - emergency assistance for livestock, honeybees and farm-raised fish program. U.S. Department of Agriculture (USDA) Farm Service Agency fact sheet, April 2020. https://www.fsa.usda.gov/Assets/USDA-FSA-Public/usdafiles/FactSheets/elap-general-2020-fact-sheet-1.pdf; 2020.
[64] USDA. Disaster assistance: livestock indemnity program. U.S. Department of Agrigulture (USDA) Farm Service Agency fact sheet, May 2020. https://www.fsa.usda.gov/Assets/USDA-FSA-Public/usdafiles/FactSheets/livestock_indemnity_program_lip-fact_sheet.pdf; 2020.
[65] USGS. Earthquake hazards: early warning. https://www.usgs.gov/natural-hazards/earthquake-hazards/early-warning; 2020. (accessed December 17, 2020).
[66] Wisner B. Five years beyond Sendai—can we get beyond frameworks? Int J Disaster Risk Sci. 2020;11:239–49. https://doi.org/10.1007/s13753-020-00263-0.