GADRI
Global Alliance of
Disaster Research Institutes

Landslides induced by typhoon Hagibis in Tomioka, Gunma

GADRI ACTIONS

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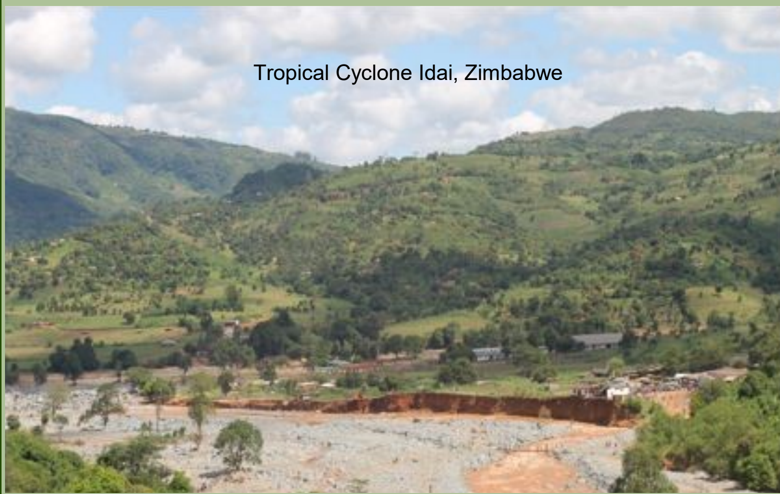
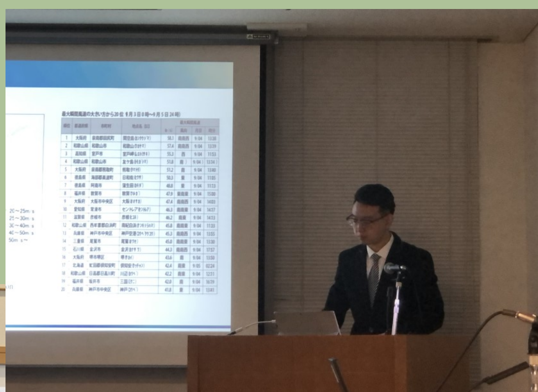

Tropical Cyclone Idai, Zimbabwe


Ridgecrest, CA, Earthquakes

GADRI Booth and Session at the World Bosai Forum 2019



Dear Member of GADRI,

In this issue, we bring various reconnaissance and disaster reports shared by our members covering hurricane Dorian in the US, typhoons in Japan, Ridgecrest earthquake, tropical cyclone Idai, and other information on GADRI activities.

During 2019, GADRI were quite active. To start with,

- the 4th Global Summit of Research Institutes for Disaster Risk Reduction: Increasing the Effectiveness and Relevance of our Institutes was held at the Disaster Prevention Research Institute (DPRI), Kyoto University, Kyoto, Japan from 13th to 15th March 2019. The summit specifically focussed on the contributions to the contextualization of the Science and Technology Roadmap.
- The 2nd GADRI General Assembly was held on 15 March 2019 at the Granvia Hotel Kyoto, Kyoto, Japan.
- GADRI Board of Directors and Advisory Board continued to meet face-to-face in Kyoto In March 2019 and during various online sessions throughout the year.
- GADRI actively participate at the Scientific and Technical Advisory Group (STAG) and the Global Risk Assessment Framework (GRAF) of UNDRR with GADRI Secretariat and many members involved in various working groups.
- Under Disaster and Risk Research: GADRI Book Series, the books on Disaster Resilience and the Proceedings of the 3rd Global Summit in March 2017 are sent to Springer Japan for publication..
- Quarterly newsletter, GADRI Actions continued to be published with contributions from the GADRI community.
- GADRI Annual Report 2018 was published. We started to gather information for GADRI Annual Report 2019.
- GADRI held a session on Contributions to the Science and Technology Roadmap at the World Bosai Forum 2019 held at Tohoku University, Sendai, Japan from 9 to 12 November 2019.
- GADRI also site visited European Commission, Joint Research Centre (EC-JRC), in Ispra, Italy in November 2019 to initiate the discussions and preparations for the 5th Global Summit of GADRI to be hosted at EC-JRC from 15 to 17 March 2021. Do save-the-dates of the GADRI 5th Global Summit to be held in Ispra, Italy from 15 to 19 March 2021.
- Our congratulations to Prof. Andrew Collins, Chair of the GADRI Board of Directors for being selected as the recipient of the 2019 DPRI Award.

Without your support we cannot continue on this mission to prevent new disasters and to work on reducing existing disaster risks at all levels. It takes collective efforts to work on strengthening resilience to disasters and build back better.

We take this opportunity to thank all of you for being part of GADRI, and wish you all the very best during the holiday season and the New Year.

Hirokazu Tatano and GADRI Secretariat

Contents

Photos were taken from the disaster reports shared by members of GADRI. Credit to the photos can be found in the respective articles.

GADRI Actions is designed, formatted and edited by Hirokazu Tatano and Wilma James.

Excerpts from the StEER PRELIMINARY VIRTUAL RECONNAISSANCE REPORT (PVRR)

Report shared by Prof. Khalid Mosalam, Director, PEER, University of California, Berkeley, highlights only the Executive Summary and the Introduction.

For the full report, please visit the following link: https://www.steer.network/

Photo from the main report—**Figure 4.7.** Aerial photo of the damage from Dorian at Marsh Harbour on Great Abaco Island, Bahamas. Note the surviving commercial and industrial buildings with minor roof damage. [The large building in the center is located at 26.532695 / -77.062676]. The photo was taken facing SW. (Source: CNN)

HURRICANE DORIAN

September 1, 2019

Released: September, 10, 2019

NHERI DesignSafe Project ID: PRJ-2549

PRELIMINARY VIRTUAL RECONNAISSANCE REPORT (PVRR)

Click on the link to view the full report: https://www.steer.network/

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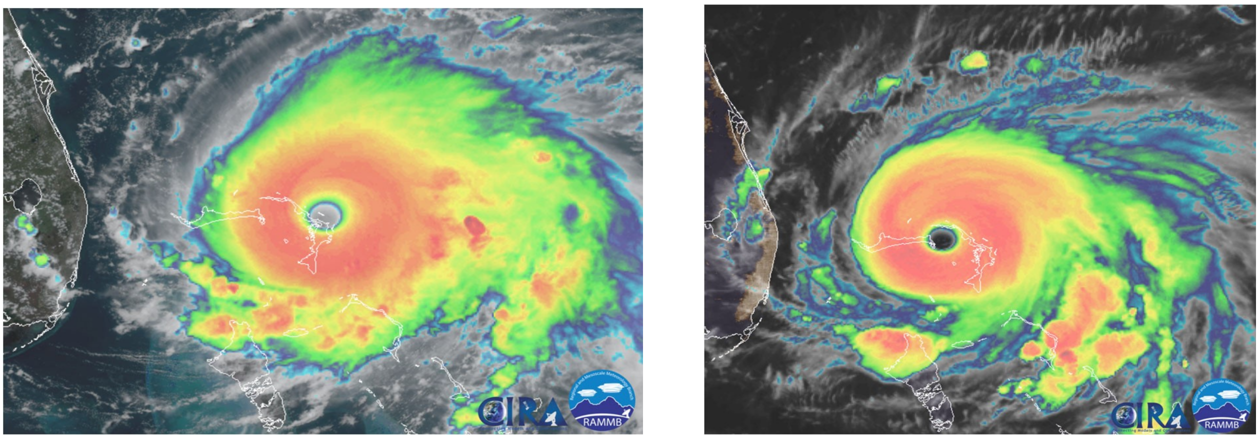


Photo from the main report—**Figure 2.2.** Band 13 Infrared from GOES-16 as Dorian makes landfall near (left) Great Abaco, Bahamas at 1800 UTC and (right) Grand Bahamas at 0300 UTC (imagery captured via CIRA/RAMMB).

Executive Summary

On September 1, 2019, Hurricane Dorian made landfall on Elbow Cay in the Bahamas at 16:40 UTC with sustained winds of 185 mph (295 km/h), wind gusts up to 225 mph (360 km/h), and a central pressure of 910 mb, tying Dorian with the 1935 Labor Day hurricane for the strongest sustained winds observed in a landfall in the Atlantic Basin. Shortly thereafter, Dorian made a second landfall in the Bahamas at Marsh Harbour on Great Abaco Island before continuing westward across Grand Bahama Island. After nearly two days pummeling Grand Bahama Island, setting records for the longest duration over land at a Category 5 intensity, Dorian approached the US in a weakened state with its most notable impacts confined to flooding and tornadoes in the Carolinas. The devastation to the Bahamas is staggering and driven in large part by storm surge, in excess of an estimated 20 feet above mean sea level in some locations. While dozens have been confirmed dead at the time of this report's release, the storm made landfall in informal settlements on Great Abaco Island that were home to a large number of undocumented migrants. Considering this along with the large number of yet accounted for documented citizens suggests the death toll is likely to substantially rise and may never be confirmed. Meanwhile, the survivors face a wide-spread humanitarian crisis with significant food and water deficits affecting more than 60,000 residents of Abaco and Grand Bahama Islands.

Preliminary losses (insured and uninsured) are estimated at $7B, not yet accounting for infrastructure losses. Rapid assessments suggest that more than 13,000 houses, or about 45% of the homes in Grand Bahama and Abaco, were likely severely damaged or destroyed. Significant impacts to healthcare facilities, airports, roadways and power infrastructure in Grand Bahama and Abaco islands have also been extensively documented. The full extent of damage to infrastructure in this event is likely obscured by the massive debris field instigated by Dorian's storm surge as well as the limited access to some of the most heavily affected areas. Specifically, the damage to major harbors and airstrips has posed significant logistical challenges for rescue, evacuation, recovery and humanitarian efforts currently unfolding across the two major affected islands, as well as a number of smaller islands and cays.

Hurricane Dorian thus offers the opportunity to investigate a powerful storm's impact over multiple geographies. The storm's slow evolution and sustained intensity presented numerous challenges in forecasting and preparation and imposed incredible stresses upon the built and natural environments as well as its victims. While in no way diminishing Dorian's impact on the Carolinas, the careful examination of properties in the Bahamas with little to no damage in this record breaking event can serve as an important validation of design and construction practices. This **Preliminary Virtual Reconnaissance Report (PVRR)** represents StEER's first step in the process of learning from this disaster by (1) providing an overview of Hurricane Dorian's impact on the built environment, including the effects of its hurricane-force winds, coastal storm surge and cyclone-induced tornadoes, (2) overviewing the regulatory environment and construction practices in the Bahamas, (3) summarizing the preliminary reports of damage to a range of building and infrastructure classes, (4) establishing current conditions in the Bahamas with respect to access and services, and (5) providing recommendations to inform the continued study of this event.

1.0 Introduction

On September 1, 2019, Hurricane Dorian made landfall on Elbow Cay in the Bahamas at 16:40 UTC with sustained winds of 185 mph (295 km/h), wind gusts up to 225 mph (360 km/h), and a central pressure of 910 mb, tying Dorian with the 1935 Labor Day hurricane for the strongest sustained winds observed in a landfall in the Atlantic Basin (Fedschun, 2019). Shortly thereafter, Dorian made a second landfall in the Bahamas at Marsh Harbour on Great Abaco Island before continuing westward across Grand Bahama Island, where the storm's pace slowed to 1 mph. After nearly two days pummeling Grand Bahama Island, setting records for the longest duration over land at a Category 5 intensity, Dorian approached the US in a weakened state, hovering between Category 2-3 intensity as it continued its slow trek parallel to the Atlantic coast of Florida the week of September 2.

By September 5, the effects of the storm were evident in the Carolinas, as Dorian continued to weaken to a Category 1, just brushing the coast of North Carolina, about 35 miles southeast of Wilmington. While not directly landfalling in the US, Dorian spawned tornadoes, triggered flash flooding, and delivered hurricane-force winds and life-threatening storm surge as it continued its slow trek along the North American Atlantic Coast toward Canada. Hurricane Dorian is part of a larger trend of tropical cyclones with reduced forward speeds caused by disruptions in the atmospheric circulation patterns that steer these weather systems, attributed to the warming of the atmosphere (Hall and Kossin, 2019). Devastating effects of stalled hurricanes like the remnants of Harvey and now Dorian are speculated to become increasingly common. While states from Florida all the way to Virginia have had some effect from Dorian, the sections that follow will focus on the hurricane's impact in the Bahamas, as well as the storm's implications for South and North Carolina.

To read the full report, click on the link : https://www.steer.network/

Photo from the main report—**Figure 1.2.** Preliminary loss estimates: total (insured and uninsured) losses to residential, commercial and industrial properties. Infrastructure and auto losses not included (KCC, 2019).

Excerpts from the StEER Event Briefing on Typhoon Hagibis, 12 Oct. 2019

Report shared by Prof. Khalid Mosalam, Director, PEER, University of California, Berkeley, highlights only the Executive Summary and the Introduction.

Authors:	Selim Günay, Pacific Earthquake Engineering Research Center, University of California, Berkeley David O. Prevatt, Engineering School of Sustainable Infrastructure & Environment Ian N. Robertson, University of Hawaii at Manoa Khalid M. Mosalam, Pacific Earthquake Engineering Research Center, University of California, Berkeley		
Editors:	Tracy Kijewski-Correa, University of Notre Dame David Roueche, Auburn University		
DesignSafe Project #	PRJ-2577	Release Date:	October 17, 2019

Figure 3: Wave Striking breakwater in Kiho, Japan

(Source: Toru Hanai/Associated Press, New York Times, 2019)

For the full report, please visit the following link: https://www.steer.network/

and http://gadri.net/resources/2019/10/event-briefing-on-typhoon-hagibis-and-earthquake-on-12-october-2019.html

Key Lessons

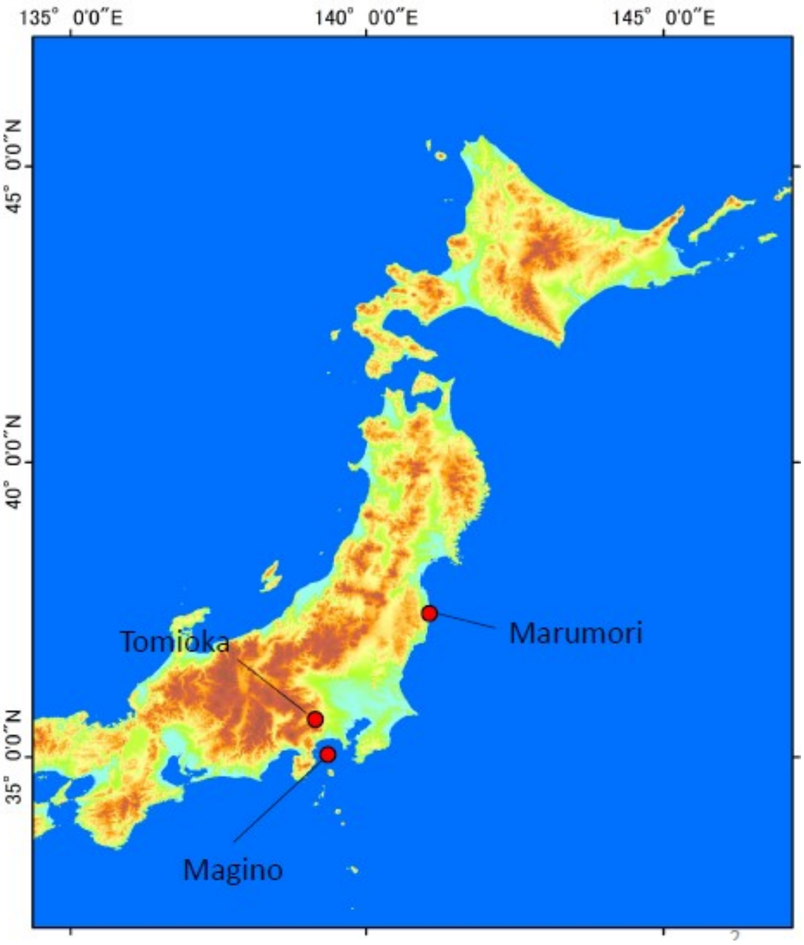
- The occurrence of an earthquake during landfall of Typhoon Hagibis is a rare opportunity to observe the impact of simultaneous multi-hazards on structures.
- Current US building codes do not include load combinations of wind and earthquake forces occurring simultaneously; however, this event might warrant revisiting the current load combinations to consider combining a design level wind event with a lesser earthquake or vice versa.
- These simultaneous events also highlight the importance of instrumentation in buildings to capture valuable data that can be used for identifying structural characteristics, understanding the structural response, and updating analytical models.
- The combination of extreme rainfall-induced runoff, along with storm surge and wave action at river estuaries warrants consideration in modeling of effects of major tropical cyclones.
- The number of households without power were 34,000 as of the morning of 10/16/2019, down from a peak of 520,000, indicating a fast response time and quick recovery for an event of this size. These and other indicators of community resilience are critical to improve future performance. A coordinated effort from the extreme events community is needed to develop tools and methods for systematic documentation and quantification measures related to resilience and recovery time.

Excerpts from the Report

Landslides Induced by Typhoon Hagibis, 2019

By Chigira et al. (Disaster Prevention Research Institute, Kyoto University)

To view the full report visit: http://gadri.net/resources/2019/11/landslides-induced-by-typhoon-hagibis-2019.html



Locations of fatal landslides induced by typhoon Hagibis

Tomioka: 4:32 pm 12 Oct

- Pyroclastic fall
- 3 fatalities

Marumori: about 10:30 pm 12 Oct

- Weathered granite
- 4 fatalities

Magino: 9:45 pm 12 Oct

- Andesite lava and volcanic
- soil
- 2 fatalities

- Typhoon Hagibis crossed the Japanese Islands from 12 to 13, October 2019, and brought record-breaking rainfall and strong wind.
- This typhoon induced river floods and landslides in eastern Japan and caused tremendous damage with 93 fatalities and 3 missing.
- This paper reports the characteristics of 3 fatal landslide areas, referring to the possibility of their prediction.

Landslides induced by typhoon Hagibis in Tomioka, Gunma

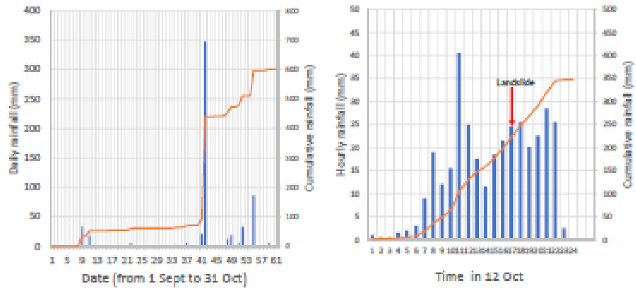
19 October, 2019

By Masahiro Chigira, Division of Geohazards, DPRI, Kyoto University

Location: Takumi, Tomioka, Gunma Prefecture

- Occurrence: 4:30 pm, 12 October, 2019
- 3 fatalities

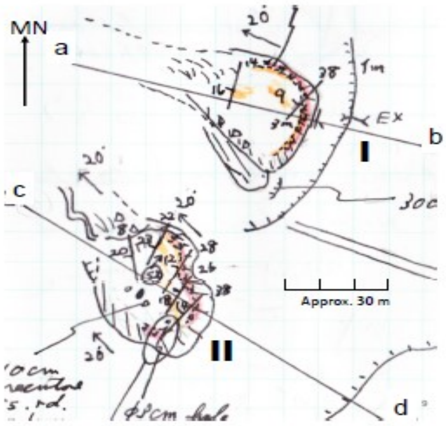
Rainfall at Fujioka (AMEDAS) 15 km east of Tomioka



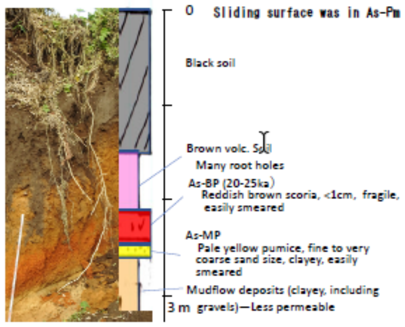
350 mm at 12 Oct. Before that almost no rain in one month.

Made from the data of Japan Meteorological Agency (http://www.data.jma.go.jp/obd/stats/etrn/index.php5)

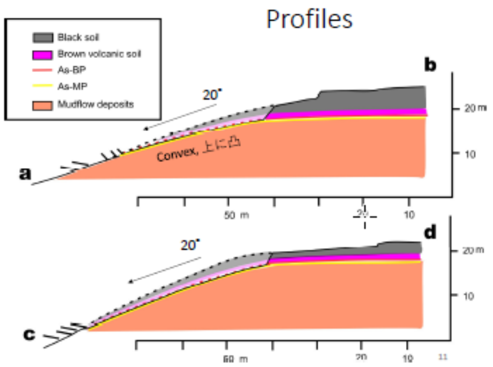
Plan view

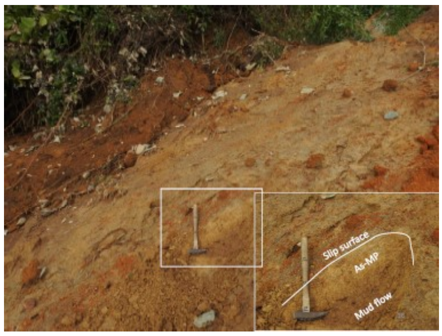


Materials that slid were from the Asama volcano



As-BP, As-MP: Tajikara et al. (2011) Quaternary Research, 50, 21-34.





Summary

- Landslide occurred on gentle slopes with 20°angle on a margin of a terrace.
- Slid materials were pyroclastic fall deposits up to 3 m thick on less permeable mudflow deposits.
- Sliding surface was made in the lower part of As-MP (pumice), which was weathered to be clayey materials.
- As-MP layer was eroded underground at the rim of the terrace, where bedding dip becomes steeper toward downslope.
- This underground erosion formed piping holes, where water pressure could have been build-up to trigger the landslides.

Points to be noted

- Slid materials and sliding horizons were of pyroclastic materials from the Asama volcano, which must be distributed around the landslide slopes.
- The reason why only these slopes slid is assumed to be:
    - Beds warped convex upward, steepening downslope.
    - So, the groundwater velocity must have been faster downslope, which facilitated underground erosion.
    - The vegetations on the landslide slopes seem to be less than the surrounding.
- The underground erosion we observed suggests that water springs must have been at the foot of the slopes. Behaviour of the spring might have been a key for the landslide prediction.

To view the full report visit: http://gadri.net/resources/2019/11/landslides-induced-by-typhoon-hagibis-2019.html

Disaster Report

2019 Typhoon Hagibis (No.1)

By Shiomi Yumi and Koji Suzuki, Asian Disaster Research Center (ADRC), Kobe, Japan

1. Overview

On 12 October 2019, a large and powerful typhoon, Hagibis, locally named as Typhoon No.19 made a landfall in Shizuoka Prefecture, about 100 km southwest of Tokyo, passing through eastern and north-eastern regions until early morning of 13 October. Central and northern parts of the country were severely affected by strong winds and heavy rainfall and subsequent floods and geohazards.

From 24 to 25 October 2019, low pressure passed through western, eastern and northern regions along the Pacific coast, bringing another heavy rainfall in the Pacific coast of Kanto and Tohoku regions, especially Chiba and Fukushima Prefectures. The rainfall resulted in floods and geohazards again, causing human and physical damages to the typhoon-hit areas.

According to the report of the Cabinet Office, as of 20 November 2019, 101 persons were killed or went missing while 481 persons were injured. About 2,400 houses were totally collapsed and over 33,000 houses were damaged. Furthermore, some 50,000 houses were inundated *.

* The figures include data of the impact of heavy rain on 24 to 26 October 2019

2. Outline of Typhoon Hagibis

Typhoon Hagibis was formed on 6 October in the south of Minamitori Island, developing into large and strong typhoon, with its central pressure at 915hPa and maximum sustained winds at 55m/s. When it landed on Izu Peninsula, Shizuoka Prefecture on 12 October with the strength of 955hPa, maximum 40m/s, categorized as strong in the country, the area within its 600km-radius from the typhoon center was forecast as strong wind.

The typhoon brought about heavy rainfalls in wide areas of Kanto (eastern) and Tohoku (north-eastern)

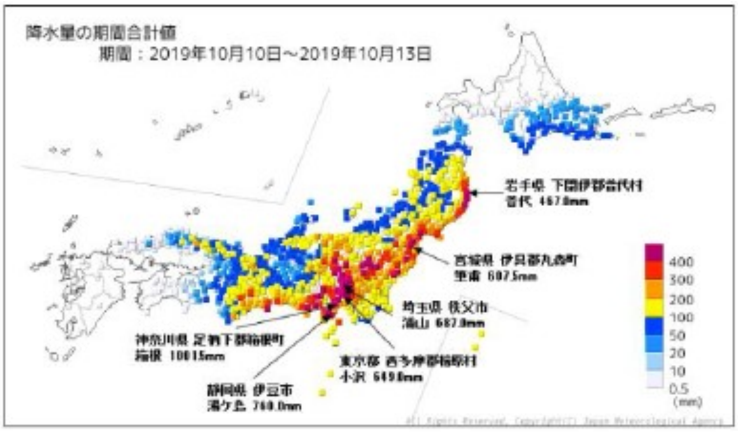


Figure 1. Total Precipitation from 10 – 13 October (Source: Japan Meteorological Agency)

regions of the country, where rainfalls exceeded past records in hourly, daily and total precipitation in more than 120 areas. For example, in Hakone, Kanagawa Prefecture, total precipitation reached 1001.5 mm.

Also, record high waves and storm surges were observed mainly in the Pacific coast.

3. Early Warning:

With the typhoon approaching, Japan Meteorological Agency (JMA) started to issue Tropical Cyclone Information, forecast and warning and advisory, as well as information on landslide, inundation, flood etc. Heavy Rain Emergency Warning, its highest alert level was issued to Shizuoka, Kanagawa, Tokyo, Saitama, Gunma, Yamanashi, Nagano, Ibaraki, Tochigi, Niigata, Fukushima, Miyagi and Iwate prefectures on 12 and 13 October.

4. Evacuation

Followed by JMA's information, municipalities issued Evacuation Order to over 2.1 million people in 11 prefectures and Evacuation Advisory to over 4.3 million people in 16 prefectures.

It is reported that some 219,000 people actually evacuated to evacuation shelters.

Table 1. Issued Evacuation Order and Evacuees

Prefecture	Evacuation Order (Urgent)	Evacuated
Iwate	185,918	9,930
Miyagi	983,136	10,104
Fukushima	302,853	3,590
Ibaraki	204,910	19,595
Tochigi	TBC	19,822
Gunma	11,750	5,213
Saitama	TBC	30,147
Chiba		25,195
Tokyo	196,545	76,235
Kanagawa	0	6,648
Niigata	39,087	3,878
Nagano	134,260	7,435
Shizuoka	47,494	85
Others[2]		1,006
TOTAL	**2,105,953**	**218,883**

(Source: CAO, as at 13:00, 13 October 2019)

Others include Aomori (91), Akita (77), Yamagata (300), Ishikawa (4), Yamanashi (343), Gifu (29), Aichi (75), Mie (83), Osaka (2) and Yamaguchi (2)

5. Impacts

Flooding:

River overflows and damages to embankments and river facilities occurred, causing floods in many areas causing human and physical damages. According to Ministry of Land, Infrastructure, Transport and Tourism (MLIT), river embankments collapsed at 140 areas in 71 rivers. Total inundation area reached 25,000 ha.

Sediment disaster:

Many sediment disasters occurred triggered by heavy rainfall. According to MLIT, 954 cases were reported including 423 debris flows, 44 landslides and 487 slope failures in Iwate, Miyagi, Fukushima, Tochigi, Gunma, Saitama, Chiba, Ibaraki, Tokyo, Kanagawa, Yamanashi, Nagano, Niigata, Shizuoka, Ishikawa, Akita, Aomori, Mie and Wakayama prefectures.

6. Damages

Typhoon Hagibis and subsequent low pressure caused tremendous damages to human and properties.

- Damages to Human Lives and Houses: Due to the typhoon 98 persons lost lives and 3 went missing. 40 persons were seriously injured and 441 persons were slightly injured. As for houses, 2,419 houses were totally collapsed and 16,331 sustained 50% damages while another 17,414 were partially damaged.

- Damages to Properties: Due to the typhoon, many critical infrastructures and lifelines suffered serious damages, causing suspension of services such as loss of electricity in maximum 521,540 houses and suspension of water supply to maximum 167,986 houses.

Figure 2. Estimated inundation area of the Chikuma River (Source: Geospatial Information Authority of Japan)

7. Government Response

At the onset of the disaster, Emergency Disaster Management Headquarters was established on 13 October 2019. Due to the severity of the disaster, Disaster Relief Act was applied to 390 municipalities in 14 prefectures. Also it was designated as disaster of extreme severity under the Act on Special Financial Support to Deal with Designated Disaster of Extreme Severity on 29 October 2019.

References

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- Japan Meteorological Agency—The Heavy Rain Event by Typhoon Hagibis in October 2019 - Portal—http://www.jma.go.jp/jma/en/201910_Heavyrain/2019_Heavyrain.html
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- **Asian Disaster Reduction Center—**https://www.adrc.asia/
- Disaster Information - https://www.adrc.asia/view_disaster_en.php?NationCode=392&Lang=en&Key=2357

Excerpts from the StEER Ridgecrest, CA Earthquake VAST Report

This report, shared by Prof. Khalid Mosalam, Director, PEER, University of California, Berkeley, highlights only the Executive Summary and the Introduction.

Click on the link to view the full report: https://www.steer.network/

StEER
STRUCTURAL
EXTREME EVENTS
RECONNAISSANCE

M 6.4 and M 7.1 Ridgecrest, CA Earthquakes

VIRTUAL ASSESSMENT STRUCTURAL TEAM (VAST) REPORT

Damaged mobile home in Ridgecrest, CA during the M 6.4 earthquake. Photo by Darla A. Baker / The Californian.

(a) (b)

Photo from the main report—Figure 17. Two houses caught fire in Ridgecrest after the M 6.4 event (San

Executive Summary

A magnitude 6.4 earthquake with a depth of 10.7 km occurred in San Bernardino County, CA on July 4, 2019. The epicenter was located 12 km south west of Searles Valley. On July 5, 2019, a 7.1 magnitude earthquake occurred near the same location and at a depth of 17 km. It is noted that the earthquakes occurred in a fairly remote area in the Mojave Desert region of eastern California. The earthquakes were felt strongly in the China Lake-Ridgecrest area, and more broadly from Los Angeles to Las Vegas. The 6.4 magnitude earthquake was preceded by several foreshocks and followed by hundreds of aftershocks. The maximum Peak Ground Accelerations (PGA) of the 6.4 and 7.1 magnitude earthquakes were 0.38g and 0.48g, respectively. In this report, the PGA residuals are estimated using the ASK14 GMPE in terms of the number of standard deviations with respect to the median model, which correlates to structural response due to earthquake ground motions.

The impact of the two earthquakes on the city of Ridgecrest demonstrated its resiliency as it recovered rapidly where many restaurants and gas stations are back up and running. There was very little structural damage, even from the second stronger earthquake of M 7.1, except for the typically vulnerable buildings (e.g. unreinforced masonry structures and mobile homes). However, there were substantial non-structural and content losses. Fortunately, both earthquakes occurred during a holiday weekend, which meant that schools were not in session and most offices were not operational during the events. If it had not been a holiday and these schools and office spaces would have been fully occupied or the earthquake occurred in a more urban area, fatalities/injuries due to these non-structural damages could have been larger. As a community, we have to be prepared for those scenarios as well. Once again, these two earthquakes have proven the need to improve our regulations when it comes to the design of non-structural components.

Moreover, some utilities for electricity and water distribution suffered from distress. On the other hand, transportation systems and bridges suffered none to minor damage with effective and rapid repair actions.

The other city that was impacted the most is Trona, which did not perform as resilient as Ridgecrest where the city remained dysfunctional up to the time of writing this report. There were more damaged structures, mostly from the effects of ground failure and possibly strong site response related to soft sediments. The town suffered from significant loss of water where its main water pipes fractured due to fault rupture and lateral spreads.

This report overviews the hazard characteristics of the July 4 and 5, 2019 Ridgecrest, California M 6.4 and M 7.1 earthquakes, the regulatory context and emergency response, the impacts of these earthquakes, and current conditions by collocating publicly-reported information. This Preliminary Virtual Reconnaissance Report (P-VRR) represents the first product of StEER's larger coordinated response to this event, informing and supporting other research teams seeking to learn from this disaster.

Introduction

On July 4, 2019 at approximately 10:33 am PDT, a magnitude 6.4 earthquake with a depth of 10.7 km occurred in a remote area of San Bernardino County, CA. The epicenter was located 12 km south west of Searles Valley at coordinates of 35.71°N and 117.51°W. On July 5, 2019 at 8:19 pm, approximately 34 hours after the first earthquake, a 7.1 magnitude earthquake occurred near the same location, with coordinates of 35.77°N 117.61°W. The 7.1 magnitude earthquake had a depth of 17 km. Since the events were not close to urban areas, the damage experienced by buildings and other infrastructure was not extensive. However, this earthquake sequence is quite important as it includes the two largest earthquakes that occurred in Southern California in the past two decades. It provides many opportunities to learn about the following, among several other useful lessons: a) the earthquake sequence characterized by two large magnitude earthquakes one day apart, and relevantly the large magnitude foreshock scenario, b) the performance and impact of the Earthquake Early Warning and ShakeAlertLA systems, c) the expected performance in future earthquakes of pre-1980 non-ductile reinforced concrete buildings, the pre-1980 soft-first story buildings, the water system infrastructure, and the telecommunications infrastructure, which were identified as four areas of seismic vulnerability by the LA Mayoral Seismic Task Force, d) the efficacy of the adopted retrofit techniques in improving structural response, e) the performance of various structures, including school buildings, hospitals, large industrial facilities, regional airports, and mobile homes, f) the significance of non-structural damage, g) the ground motion characteristics, and h) the community resilience in terms of the duration of power outages, mobile phone network access, infrastructure repairs, etc.

StEER further hopes to use this event to exercise protocols, procedures, policies and workflows that StEER will be developing over the next year in collaboration with the wider hazards community including the Natural Hazards Engineering Research Infrastructure (NHERI) and other members of the Extreme Events Reconnaissance Consortium.

The first product of the StEER response to the 2019 Ridgecrest, California Earthquakes is this **Preliminary Virtual Reconnaissance Report (PVRR)**, which is intended to:

1. provide an overview of the hazard characteristics

2. introduce the regulatory and disaster response context for these events

3. summarize the preliminary reports of damage to wide-ranging infrastructure

4. review StEER's event strategy in response to these earthquakes

5. enhance situational awareness to guide subsequent missions conducted by StEER and the engineering reconnaissance community.

Please visit the following link for the fill report: https://www.steer.network/

It should be emphasized that all results herein are preliminary and based on the rapid assessment of publicly available online data within 3-4 days of these events. Damage assessments discussed herein are based largely on the judgement of the authors without access or with very preliminary and limited access to additional aerial imagery and ground-truthing.

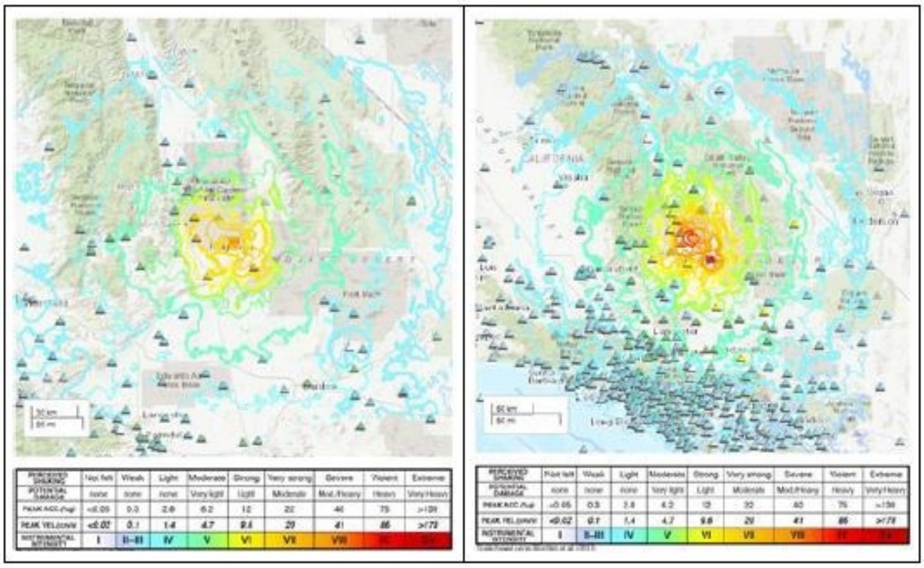

Photo from the main report—Figure 1. Epicenters of the two Ridgecrest earthquakes and Shakemaps [Left: M 6.4 event and right: M 7.1 event] (USGS, 2019a; USGS, 2019b)

Tropical Cyclone Idai

Lessons learned and the way forward for Africa Alliance for Disaster Research Institutions (AADRI)

By Prof. Desmond Manatsa

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The once thriving Kopa Business Centre that was completely destroyed by Cyclone Idai

Several months have passed since Tropical Cyclone Idai hit Zimbabwe and leaving behind a trail of destruction and casualties unprecedented of any natural disaster in Zimbabwe or even in southern Africa's modern history. The number of those dead and the devastation it inflicted on property and the environment was far more than what the cyclone caused in Mozambique where it made landfall when it still retained much higher destructive power from the Indian Ocean. Then what could be the reason that exposed our nation to such a precarious state to this cyclone? Media and various platforms proposed many theories, stories have been told both of natural and supernatural nature to try to explain the possible causes which led to this catastrophe. The human's most sharpened talent of apportioning blame whilst proffering little or no solution was also not spared. However, what is important to the people of Chimanimani and Zimbabwe at large is to remove the fear that this calamity might happen again in future. The most essential undertaking at this juncture is to systematically extract lessons from the cyclone's impacts that can catapult us to a state where we can live in harmony with this natural hazard while harnessing the 'positives' and reducing the associated risks. Though not exhaustive, here we examine the lessons which could be derived from Cyclone Idai's extraordinary impact before examining the way forward from a national action research perspective under the banner of the Africa Alliance for Disaster Research Institutions (AADRI).

Physical Vulnerabilities associated with Tropical Cyclone Idai

The tropical cyclone made landfall over the Mozambique coast, more than 200km away from the eastern border with Zimbabwe, on the 14th of March 2019, before slowly moving to hit Chimanimani at about 7:00 pm the following day on Friday. As expected with tropical cyclones when they make land fall, their potential destructive force in terms wind speed and amount of deposited rainfall is severely curtailed as it moves inland due to decrease in 'fuel input to the cyclone engine'. The enhanced smoothness and evaporation from the sea surface waters offer conducive environment for the cyclone to increase in strength while the land surface friction and reduced surface evaporation from the relatively dry land tend to suffocate the cyclone thereby killing it gradually. But despite more lead time to prepare for the cyclone and reduced force of potential damage we still see that Mozambique had far less casualties, environmental and infrastructure destruction than Zimbabwe. The possible factors which can be attributed to this rather unfortunate scenario is the level of disaster preparedness of Zimbabwe, the fragile environment that was offered by the predominant mountainous landscape and the relatively slow speed of the cyclone which enabled it to damp a lot of rainfall per unit time. This could have been compounded by the time when the disaster came, which was in the dark of the night hence reducing visibility to assess evacuation options for the victims and, severely limited the search and rescue processes.

The general Preparedness and the issuing of the Tropical Cyclone Warning

The number of people affected by a hazard are in direct proportion to the preparedness of the community to the impending disaster. If I may quote from one of the victims, *"No one knows where this water came from, it took us by surprise",* clearly testifies to the fact that most of the communities affected had not been fore warned about the impending floods. While the Meteorological Services can be applauded for having given the warning a least 2 days before the cyclone, can we learn something from how the forecast was issued. My few lessons on disaster warnings which I had some decades back tells me that when one is more confident of an impending disaster, the frequency of the warnings should not only be increased with time but also updated to suit the changing circumstances as the hazard characteristics unfold. We are told that that the Met Office stuck to their 8:00 pm News slot to disseminate the warning instead of soliciting for more slots both on the TV and radio to conscientize the people of the impending disaster. At the same time, the TV and radio could also have allowed unscheduled warnings to be flighted. Unless the Met Forecasters themselves were not sure of the magnitude of the expected cyclone impact, I am confident that the more they had exposed the people to the warnings by increasing the issuing frequency and updates, the more they were going to be taken more seriously by the related stakeholders responsible for evacuating the communities who were at risk.

Large boulders and mud that was carried downslope and destroying houses in their path during Cyclone Idai.

On the other hand, even if a warning is issued timeously and, with the required frequency and mode of dissemination which reaches down to the communities, these people also need to know what to do when a warning has been issued. Their prior coordinated response is key to ensure predictable community behavior when the hazard strikes. It is a welcome development that Chimanimani Rural District Council is one of the few districts in the country to have adopted the District Climate Change and Watershed Management Policy. But were the local communities trained on what to do when flood warnings are issued? At the same time, evacuation needs resources both to carry out the process and providing safe havens, endowed with food and other necessities. Were these readily available to execute the process? We understand that the contents of the tropical cyclone warning itself advised people to move to high ground. Was this the correct advice to give to Chimanimani in the face of rock and mudslides which made these high places riskier, especially that the disaster struck at night when most people were indoors and preparing to sleep? These are some of the preparedness questions we need to ask ourselves as we take introspect of the lessons derived from the Tropical Cyclone Idai preparedness and warning.

Fragility and Vulnerability of Settlements in the Mountainous Environment of Chimanimani.

Tropical Cyclone Idai brought to the fore the high degree of exposure of settlements and how fragile the mountainous environments are. The cyclone came after the region has been exposed to a prolonged drought which removed the capacity of the vegetation left to hold the soil intact. The accelerated land degradation and frequent fires which characterize periods of drought removed vegetation and hence limited root depths, thereby increasing the landslide hazard. It was then easy for the loose waterlogged soil to flow downslope and with it, imbedded rocks which then chocked the normal flow of the water thereby exacerbating the flooding spatial extent and intensity. As such, the blocked rivers reopened old paths which had for the past decades been converted to settlements. A case in point is the Kopa Business Center which was raised to the ground and leaving behind little or no shred of evidence that buildings, with thriving businesses, were once predominant in the area as the river repossessed its former route. This means that old river paths remain unsafe for settlements as at some point in time the river may still rejuvenate its former paths.

Therefore, careful planning for resettlement sites needs to take into consideration the possibility of changing river course characteristics. On the other hand, the prevailing superstitions surrounding the presence of the large rock boulders which were left in the river channels by the flowing mud from the mountain slopes owes a scientific explanation. It was the large and uneven multi-tone rocks which were hitting against the slope surfaces as they were rolling downslope which were wrongly interpreted as an earthquake that accompanied the tropical cyclone. This was corroborated by the Meteorological Services which confirmed not recording any seismic activity in the area during the cyclone. Explaining this phenomenon to the affected communities assists in focusing on the real causes whilst getting rid of superstitious beliefs which usually lead to wrong attribution to the causes of the disaster. Dwelling on superstitious beliefs has the danger of diverting the community's attention to immaterial answers rather than providing implementable scientifically backed solutions.

The way Forward under AADRI

With the advent of climate change, tropical cyclones are not going 'anywhere', rather they are poised to become more frequent and accompanied by increased intensity. In this regard, it is invertible that we find ways to live with them whilst preventing the metamorphosis process from being just a mere meteorological hazard to becoming an unmanageable national disaster. This is 'doable' as Islands like Mauritius that lie in the path of more intense tropical cyclones and are hit directly more than once in every cyclone season, are now nearing the zero target casualty. At the same time, it is more than welcome that the general shock from the devastating impacts of Tropical Cyclone Idai have once again united the nation through unprecedented donations towards the victims' recovery. It has also spontaneously given birth to a strong desire from national disaster research institutions, to learn from this disaster in the bid to understand why this phenomenon happened with such dire consequences.

In research terms, Chimanimani provides a conducive operational background and a well defined geographical area, which could provide for feasible action orientated research that could inform policy and action in other areas within Zimbabwe and beyond. The fact that the region has all the five Agroecological Regions of the country makes the results derived from the research to be relevantly replicated in any other part of the country. In this regard, Bindura University of Science Education under AADRI with its vast experience in disaster risk reduction research is coordinating a consortium of other state universities to properly document, in a scientifically informed way, the lessons learnt from tropical Cyclone Idai. This national action orientated research, which is yet to source for funding, is poised to pave way for a future situation that would allow the communities within Zimbabwe to be better prepared and become more resilient in the face of potentially recurring Climate Change related events such as Cyclone Idai. The strategy is to ride upon the shock that is currently vividly present within Zimbabwe and beyond to bring sustainable policy initiatives and practices in view of various interests that could provide for learning and dedicated action in Chimanimani and other nationally comparable situations. The objective of the research is to 'Build National Resilience to Tropical Cyclones through deriving lesson from Tropical Cyclone Idai'. Preliminary work to enable scouting for solid funding for this noble action research was conducted at a workshop in Harare that was facilitated by TSURO Trust, a community-based NGO in Chimanimani that was actively involved in Cyclone Idai relief and recovery.

Prof. Desmond Manatsa, Executive Dean of the Faculty of Science and Engineering; Bindura University of Science, Zimbabwe; and Advisory Board Member for Global Alliance for Disaster Research Institutes (GADRI)

GADRI Session at the World Bosai Forum 2019

The Global Alliance of Disaster Research Institutes (GADRI) and the Disaster Prevention Research Institute (DPRI), Kyoto University actively participated at the World Bosai Forum 2019 held at Tohoku University, Sendai, Japan from 9 to 12 November 2019.

GADRI Session on Contribution to the Science and Technology Roadmap for the Implementation of the Sendai Framework for Action for Disaster Risk Reduction 2015-2030 at the World Bosai Forum was held on 11 November 2019.

The session particularly drew attention to current status of research conducted by members of GADRI in line with the targets of the Science and Technology road to implement the Sendai Framework for Agenda for 2030.

Prof. Manabe Hashimoto, Director, Disaster Prevention Research Institute (DPRI), Kyoto University greeted the participants and shared information on DPRI, Kyoto University activities.

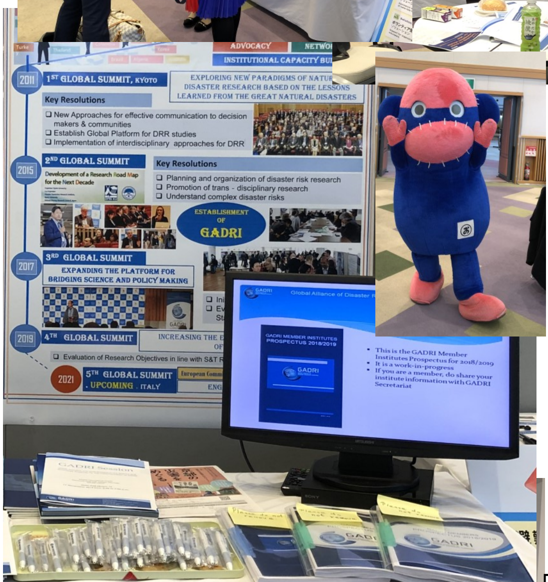
This was followed by Prof. Hirokazu Tatano, Secretary-General, GADRI; and Vice-Director and Professor, DPRI, Kyoto University who delivered an outline of GADRI and purpose of the GADRI Session at the World Bosai Forum 2019.

Prof. Yin-Nan Huang, Associate Professor, Dept. of Civil Engineering, National Taiwan University; and Division Head, Earthquake Disaster Simulation Division, National Center for Research on Earthquake Engineering (NCREE), Chinese Taipei presented an overview of his institute activities and the aligning research projects towards the S&T Roadmap.

Prof. Ana Maria Cruz, delivered a presentation on NATECH research and its contributions to the S&T Roadmap. Dr. Tetsuya Takemi and Dr. Subhajyoti Samaddar summary and way forward for GADRI Global Summit series.

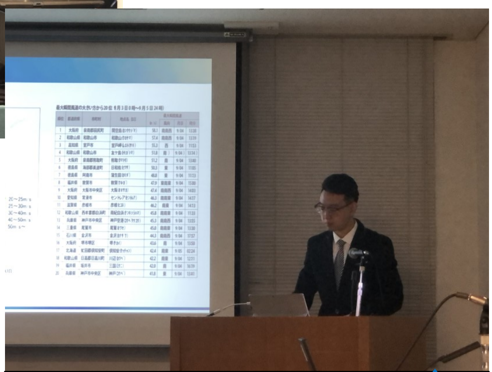
In addition, three students from DPRI-KU contributed to the Flash Talk sessions.

Prof. Manabu Hashimoto, Director, DPRI, Kyoto University



Alessandra Colocci presenting a paper on A social-ecological approach to disaster risk management applied to the case study of the Marche Region, Italy

Haris Rahadianto presenting a paper on Damage Distribution of Typhoon No. 21 in 2018 on Osaka and Wakayama Prefecture based on Questionnaire Surveys



Hasi presenting a paper on Fragility curves for economic losses in industrial sectors after strong wind disaster: A case of 2018 Typhoon Jebi

GADRI Members

The Global Alliance of Disaster Research Institutes (GADRI) was established in March 2015 to support the implementation of the Sendai Framework for Disaster Risk Reduction 2015-2030 (SFDRR) and the work of the Scientific and Technical Advisory Group of the United Nations Office for Disaster Risk Reduction (UNDER).

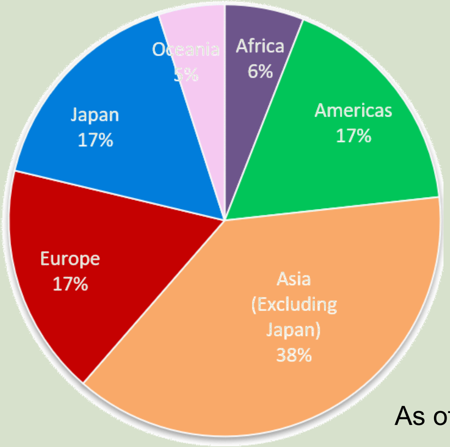
GADRI joined hands with science communities around the world to further realize these goals and targets of the Science and Technology Roadmap. Since March 2015, GADRI's membership has expanded to exceed 200 member institutions.

GADRI Secretariat is currently hosted by the Disaster Prevention Research Institute (DPRI), Kyoto University, Kyoto, Japan.

Membership is free; and completely voluntary and non-binding.

To join GADRI, please contact GADRI Secretariat:

secretariat-gadri@dpri.kyoto-u.ac.jp



As of December 2019

Area	Members	Economies
Africa	12	**7**
Americas	35	**8**
Asia (Excluding Japan)	77	**21**
Europe	35	**12**
Japan	33	**1**
Oceania	10	**2**
Total Institutes	**202**	**51**
	51 economies	

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