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Volcanic Eruption Expected to Help Economy in Iceland

By Prof. James Mori

Shallow landslide at the border between the municipalities of Recife and Jaboatão dos Guararape, Brazil, in May 2022 (Source: Alves, 2022)

Dear Members,

We hope you are doing well and do hope that you took some time off for summer holidays.

This year, it has been unusually hot. We have seen an increased number of disasters from extreme heat waves to wild fires to draughts to heavy rains and flash floods and others, all related to climate change.

This newsletter covers various reports of value related to the volcanic eruption in Iceland, climate change related events and other reports shared by GADRI members.

We hope they are educational and useful. If you would like to get in touch with the authors, do not hesitate to contact the GADRI Secretariat at: secretariat-gadri@dpri.kyoto-u.ac.jp and we will help you to be in touch with them.

Should you have any articles to share with us too, please do not hesitate to send them to us.

Preparations are proceeding well to organise the 6th Global Summit of GADRI under the theme of “Towards GADRI Objectives of Achieving a Sustainable Disaster-Resilient World” to be held on-site at DPRI, Kyoto University, Uji Campus, Kyoto, Japan from 15 to 17 March 2023.

The Global Summit of GADRI will take place soon after the 3rd World Bosai Forum which will be held from 10 to 13 March 2023 at the Sendai International Center, Tohoku University, Kawauchi Hagi Hall, Sendai, Japan.

Do save the dates of the GADRI Summit and other activities. We count on your active participation in the summit. We hope you and your institute will engage in the Summit programme and contribute to achieving its stated goals.

We will be sharing further information and developments of the summit through e-mails and the GADRI website. Do keep an eye for them.

COVID-19 is still rampant. Do take care of yourselves and stay safe.

Hirokazu Tatano and the Secretariat of GADRI

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Volcanic Eruption Expected to Help Economy in Iceland

By Prof. James Mori

(Professor Emeritus, Disaster Prevention Research Institute (DPRI), Kyoto University, Japan

A short report on the volcanic eruption in Iceland by Prof. James Mori after his visit to the volcano site in Iceland on 12 August 2022.

The Icelandic volcano Fagradalsfjall in the Meradalir valley began a strong lava eruption on 3 August 2022. The volcano is located in an unpopulated area so it is not causing any local damage. Also, the levels of ash emissions are relatively low, so it is not disrupting airline traffic, as Eyjafjallajökull did in 2010. On the contrary, there is the hope that the eruption will be good for the Iceland economy by attracting many tourists. The volcano is located about 1 hour drive from the largest city of Reykjavik and because of the type of effusive eruption, people can walk quite close to the volcano relatively safely. This is providing a rare opportunity for people to have a close encounter with an erupting volcano.

The volcano viewpoint is about a 2 hour hike from the parking lot.

This photo shows the first part of the trail which is easy to walk. The path is very good because it also leads to the site of the 2021 eruption last year. During that time, the condition of the trail was greatly improved.

The 2nd half of the hike to the 2022 eruption is more difficult with lots of rocks and no clear path. It is not recommended for small children or people not in good physical condition. However, to encourage visitors, they are currently working to improve the path and every day the portion of the trail that is in good condition is being extended.

The hike passes the large lava flow (dark gray rocks) from the 2021 eruption.

The activity in March to September 2021 was similar to the current eruption, but in a slightly different location. The volcano attracted several hundred thousand Icelandic and foreign observers. However, because of the travel restrictions due to the Covid pandemic, there were relatively few foreign visitors. This year with the improved health conditions, Iceland is hoping that the presently erupting volcano will attract more foreign tourists.

This is the current main vent which opened on 3 August 2022 as part of a 360 meter long fissure eruption. The eruption is presently no longer a fissure eruption, but concentrated from this one main vent and a spatter cone is being built up. The black rocks are new lava which flowed out during the past 9 days.

Since the eruptive style is mainly an effusive lava eruption with relatively low explosive activity, it seems fairly safe to observe at close distances of less than 1 km. Of course, volcanoes are always dangerous and a sudden large explosion or a sudden change in the location of the vent is possible.

The physical and volcanic conditions here are unique and enable people to approach close to an erupting volcano.

At the close distance where the people are sitting in the photo, you can feel the heat and hear the sounds of the lava fountaining. The temperature of the erupting lava is over 1000 °C.

This is another photo of the current lava fountaining.

The eruption last year in 2021 lasted for 6 months from March to September. The Iceland tourist industry is hoping that the 2022 eruption will also last for a similar or longer duration and attract many foreign visitors.

Video of the erupting lava taken on 12 August 2022. https://youtu.be/IWPjhpn63uM

In May-June 2022, 130 people died in landslides and floods caused by heavy rain in the Metropolitan Region of Recife, northeastern Brazil – Short report

By Prof. Masato Kobiyama

(Hydraulic Research Institute, Federal University of Rio Grande do Sul, Brazil)

1. General description

Recife (8° 04' 03'' S and 34° 55' 00'' W) is the capital of the state of Pernambuco, located in the Northeast Region of Brazil. This city is located on an alluvial plain along the Atlantic Ocean coast, with many islands, peninsulas and mangroves, and its mean altitude above sea level is 4 m. According to Leão et al. (2021), having four rivers and more than 70 artificial drainage channels, this city is known as "Brazilian Venice". Hence, the geomorphic features of the city are generally favorable to floods. During the early Portuguese colonization of Brazil, Recife was founded in 1537 and its population is 1,661,017 in 2021, which makes this city the sixth oldest city and the ninth largest city in the country. The city's Carnival is very famous both nationally and internationally. Thus, this capital of Pernambuco state plays a central role historically, culturally and economically in Brazil, especially in the northeast region. Furthermore, it should be emphasized that in Brazil Recife is one of the most vulnerable cities, precisely because of the whole geographical concerns: a very low altitude, a very high population density, and socio-economic inequality.

Nearly three weeks of heavy rainfall since the end of May 2022 caused landslide and flood disasters that left 130 dead, 9134 homeless, and 119,523 temporarily-displaced people in the Metropolitan Region of Recife. The most significant damage occurred on May 28th. This metropolitan region consists of 14 municipalities whose geographical characteristics are shown in Table 1.

Table 1 – Characteristics of 14 municipalities of the Metropolitan Region of Recife.

Municipality	Area (km^2)	Population (2021)	GDP per capita (2017)
Abreu e Lima	126.193	100,698	20164
Araçoiaba	96.381	20,936	4986
Cabo de Santo Agostinho	448.735	210,796	48689
Camaragibe	51.257	159,945	11238
Igarassu	305.56	119,690	21483
Ilha de Itamaracá	66.684	27,076	9283
Ipojuca	527.107	99,101	115089
Itapissuma	74.235	27,144	53089
Jaboatão dos Guararapes	258.694	711,330	19463
Moreno	196.072	63,792	10989
Olinda	41.681	393,734	13918
Paulista	97.312	336,919	12240
Recife	218.435	1,661,017	31743
São Lourenço da Mata	262.106	114,910	9878
Total	**2,770.452**	**4,047,088**	

Obs.: Municipalities marked in red are those that have lost human lives in this disaster.

Table 2 shows the number of human deaths and monthly rainfall in May and June of the municipalities that lost human lives. The municipality of Jaboatão dos Guararapes had the highest number of human deaths followed by Recife. Therefore, it is clearly noted that the border between these two municipalities, which is characterized by hills and cliffs, was more severely affected. Figure 1 shows the locality of the Metropolitan Region of Recife and its 14 municipalities.

Table 2 – Numbers of human deaths and monthly rainfall of May and June for each municipality.

Municipality	No. death	Monthly rain in May (mm)		Monthly rain in June (mm)	
		2022	Average	2022	Average
Camaragibe	7	684.5	294.6	393.5	339.1
Jaboatão dos Guararapes	64	675.0	310.1	436.0	352.5
Olinda	6	496.1	325.8	508.9	384.7
Paulita	1	653.5	310.1	447.7	363.0
Recife	50	686.4	328.9	449.2	389.6
Bom Conselho*	1	114.0	86.0	240.8	95.6
Limoeiro*	1	316.7	135.6	190.7	186.5

* The municipalities of Bom Consello and Limoeiro are not part of the Metropolitan Region of Recife and are 233.41 km and 64.75 km respectively from Recife.

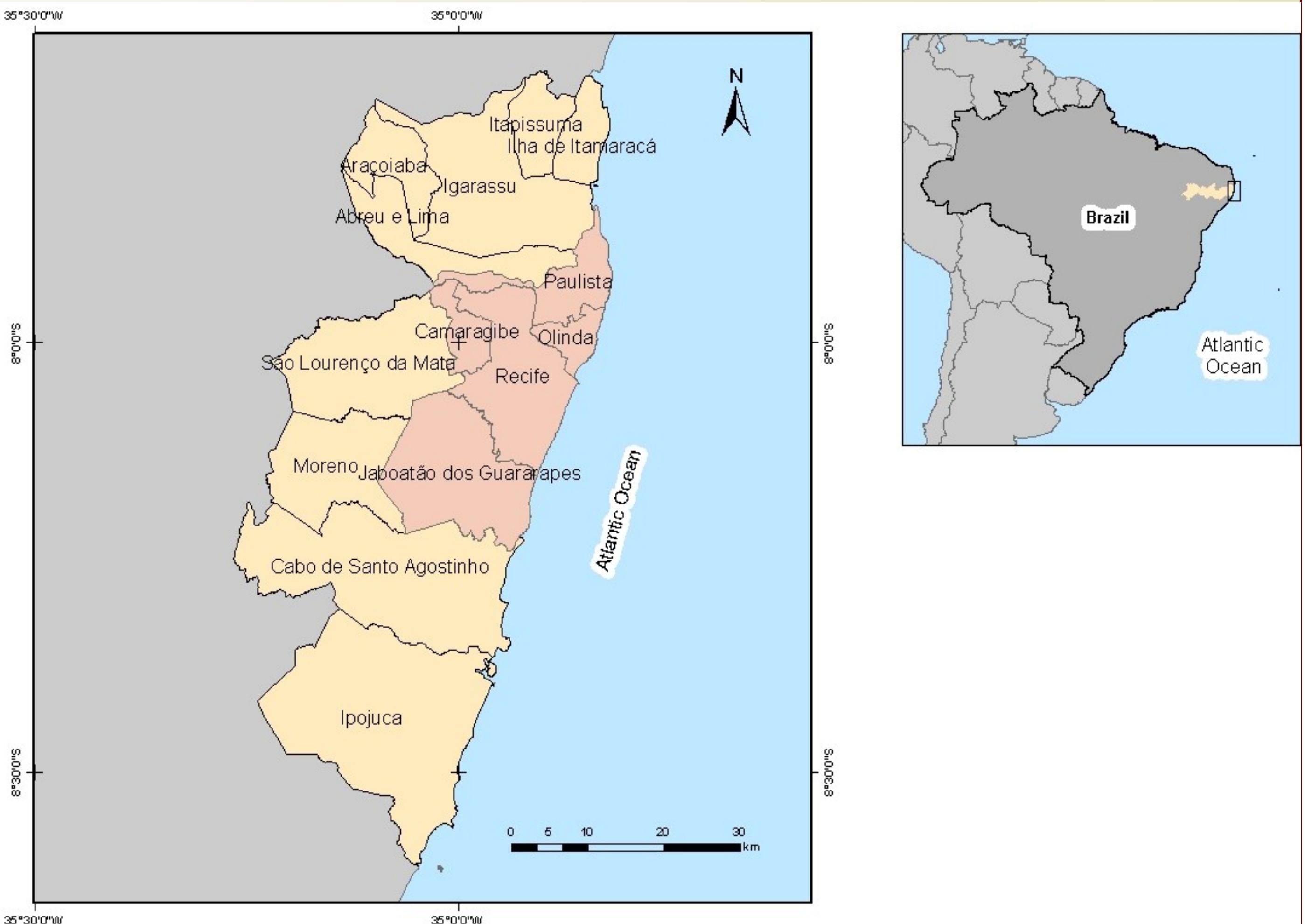

Figure 1 – Locality of the Metropolitan Region of Recife and its 14 municipalities. Five municipalities marked in pink color are those that have lost human lives in the disaster.

Based on information presented by Aguiar (2022) that examined public data from various public agencies, the breakdown of fatalities data by category is briefly demonstrated in Table 3. It is clearly observed that this disaster in Recife in 2022 was predominantly characterized with shallow landslides which caused 121 deaths. Figure 2 shows the typical scene of shallow landslide (hillslope failure) which occurred at the border between the municipalities of Recife and Jaboatão dos Guararapes and many people were buried alive.

Table 3 – Categorical characteristics of fatalities caused by the disaster.

Category	Description
Sex	• Male 58 • Female 72
Hazard type	• Shallow landslide 121 • Flood 9
Age	• 0-12 years old 25 • 13-17 years old 8 • 18-30 years old 24 • 31-65 years old 63 • > 65 years old 10

Figure 2 – Shallow landslide at the border between the municipalities of Recife and Jaboatão dos Guararape, Brazil, in May 2022 (Source: Alves, 2022)

2. Rainfall characteristics

The rainy season of the Metropolitan Region of Recife usually runs from April to July, with June and July being the rainiest months in the region. Accumulation of heavy rain during this period is natural. In other words, the rainy season had already started in this reagion at the moment the disaster struck. In addition to the onset of the rainy season, there were three other factors contributing to the intensification of the storm.

i) The La Niña phenomenon: The anomalous cooling of the waters of the equatorial Pacific causes the intensification of the trade winds and, consequently, intensifies the rains in the Northeast region in 2022.

ii) Easterly Waves (EWs): They form on the African coast, reach the Brazilian Northeast coast and meet warm waters. This meeting serves as if it were fuel to intensify these rain waves which are even more charged. It is considered as one of the most important weather systems to the total rainfall over many tropical regions. They can be defined as synoptic disturbances associated with troughs and warm sea surface temperature (Machado et al., 2012; Cheng et al., 2019; Silva et al., 2020; Enyew and Mekonnen, 2022). The EWs generate Eastern Wave Disturbances that advance through the tropical region of the African continent towards the Americas, often giving rise to tropical storms and hurricanes in the North Atlantic. According to Sias (2022), however, in the case of Northeast Brazil, the EWs do not bring hurricanes, but a lot of rain. These waves form in the area of influence of the trade winds, close to the equator, especially in the autumn and winter months of the Southern Hemisphere.

iii) The warming of the Atlantic Ocean in front of the Brazilian Northeast coast: In 2022, this warming is up to 1°C above average.

Each of these three phenomena can be said to occur naturally. However, when they occur simultaneously, they cause anomalous energy input in the physical spatial system and sometimes exceptional rainfall events.

Based on daily rainfall monitoring data as Rainfall Bulletin (*Boletim Pluviométrico*), available at the Pernambuco Water and Climate State Agency (*Agência Pernambucana de Águas e Clima* – APAC) (https://www.apac.pe.gov.br/boletins), daily rainfall values obtained in Recife during the period May 17th to June 14th, 2022, were summarized in Table 4. In case of Recife, most of May's monthly rainfall began on May 22nd. In addition, it should be emphasized that the event lasted for 22 days (May 22nd to June 12th), with a total amount of 926.4 mm and an average daily precipitation of 42.1 mm during this period. The highest amount of rainfall occurred on May 28th. For comparison, the average annual rainfall for Recife is about 2155 mm.

According to Madeiro (2022), the Brazilian Center for Monitoring and Early Warnings of Natural Disasters (*Centro Nacional de Monitoramento e Alertas de Desastres Naturais* – CEMADEN) issued a geo-hydrological bulletin on May 25th, warning of the "high risk" of heavy rains and landslides in the Metropolitan Region of Recife. Even with this alert, just on May 27th (Friday) when the APAC issued another statement informing the heavy rain forecast for the weekend, the Recife City Hall finally activated the contingency plan. After the APAC alert was issued, the Civil Defense Agency of Recife acted immediately in the late morning of May 27th, summoning more than 3,000 municipal civil servants to work on duty from the same day. In addition, this Agency sent the alert to over 32,000 families living in at-risk areas via Short Message Service (SMS). On the other hand, Madeiro (2022) reported the comments of community leaders: Local residents were not informed that they would need to leave the area, nor were they receiving assistance, such as vehicles, to move them to safer shelters. Therefore, it will be necessary to find out what kind of communication actually occurred (or whether it did not occur) between the Civil Defense Agency and local residents.

Table 4 – Daily rainfall in Recife during the period May 17th to June 14th, 2022.

May date	Daily rainfall (mm)	June date	Daily rainfall (mm)
17th	0.0	1st	15.2
18th	0.0	2nd	18.0
19th	0.0	3rd	9.2
20th	0.0	4th	81.5
21st	0.0	5th	38.0
22nd	10.2	6th	0.3
23rd	1.8	7th	101.4
24th	69.0	8th	12.0
25th	137.4	9th	5.2
26th	33.2	10th	4.0
27th	13.2	11th	26.2
28th	190.0	12th	21.0
29th	85.2	13th	0.0
30th	19.2	14th	0.0
31st	35.2	15th	0.0

3. Historical views of disasters in Recife.

The population of Recife, one of the major cities in northeastern Brazil, has been growing rapidly (Figure 3). The current situation of the city, which plays an important role culturally and economically, encourages an influx of people to Recife from within the state, from outside the state, and even from outside the country.

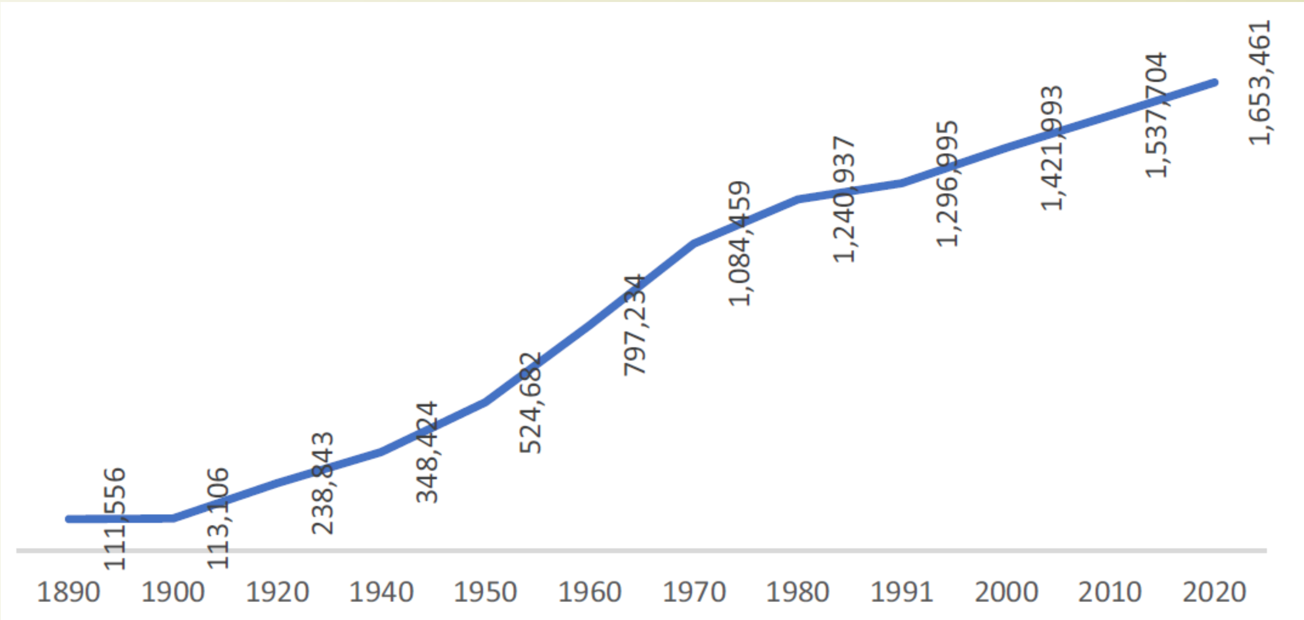

Figure 3 - Population trends in Recife during the period 1890-2020 (Source: Leão et al. 2021)

At first, poorer people generally began to live in vulnerable areas, especially in coastal, wetlands and mangrove areas. These areas are naturally susceptible to (coastal) flood. Through such a population settlement history, inhabitants in Recife frequently suffered from large and strong floods. Two largest flood disasters occurred in 1966 and 1975 (Table 5). Alves (2022) reported that, in the past, poor people lived in wetlands or floodplains and many of them were evacuated and transported to hillslopes and cliffs. Carrying out interviews with various experts in Recife, this author emphasized the housing deficit and urgent establishment of adequate housing policies. In summary, it can be said that the greater population density towards the hillslopes and cliffs of the city contributed to the social problems, i.e., sediment-related disasters.

Table 5 – Three main disasters occurred in (Metropolitan Region of) Recife

Year	Locality	Date	No. deaths	Characteristics
1966	Recife	May 30h	175	Predominantly flood. River Capibaride overflowed. In many places the water was more than 2-m deep. There was no problem with cliffs.
1975	Recife	July 17-18	107	Predominantly flood. River Capibaride overflowed. 80% of the city was flooded. 350,000 people became temporarily homeless. At one moment, more than 50% of the houses in the city lost power. There was no problem with cliffs.
2022	Metropolitan region of Recife	May 22 - June 12 (May 28)	130	Predominantly shallow landslide. More than 100 people were buried alive in slope failures and died.

Furthermore, with interviews and available data analysis, Lins et al. (2022) mentioned that 600 thousand people (about 36% of Recife's population) are living at hillslopes and cliffs which are considered as high hazard area, and concluded that the social inequality can be the principal factor for disasters in Recife.

Thus, it is easily thought that there is a growing tendency of landslide disasters in Recife. Lins et al. (2022) investigated citizens' calls for landslides, registered by the Civil Defense Agency of Recife during the period 2014 to May 2022, and reported the total of 7340 calls. Table 6 shows this data.

Table 6 – Number of calls for landslides in Recife during the period 2014 to May 2022.

Year	2014	2015	2016	2017	2018	2019	2020	2021	2022
Calls	486	1043	1124	710	639	1064	253	1145	876

Obs.: The number of calls in 2022 is just until May 2022.

Figure 4 shows that many unstable houses were built on the top and bottom of cliffs and on steep hillslopes which are all dangerous places. This situation certainly caused the landslide disasters in May-June 2022.

Figure 4 **–** above photos—Several landslide-related disasters in the Metropolitan Region of Recife, Brazil (Sources: Diego Nigro/AFP/METSUL-Meteorologia in Sias (2022))

4. Final remarks

An evolution of hydrological disasters in a city, from flood disaster (water-related disaster) to mass movement disaster (sediment-related disaster) through the city's development history can be observed in various cases over the world (Figure 5). Kobiyama et al. (2010) explained that a city settlement normally starts with flood-plain occupation. Then after occupying this area, hillslope areas will be occupied. Therefore, the numbers of occurrences of flood and mass movement as natural phenomena can be constant through the city's history meanwhile those numbers as natural disasters will be probably changed, especially with a drastic increase of sediment-related disasters. Thus, people just feel that they have suffered formerly from flood and now from mass movements (landslides, debris flow, etc.). This is the hydrological disasters' evolution associated to land-occupation history in a city. Recife is not an exception and has been certainly performing such an evolution.

Investigating the inequality in Brazilian metropolis, Salata and Ribeiro (2022) concluded that the Metropolitan Region of Recife is in the worst situation in Brazil. The authors also reported that 13% of the population of the region live in extreme poverty (with an income of less than US$32/month) and that 39.7% live in poverty (US$91/month). This means that, in case of the Metropolitan Region of Recife, more than half of the people (52.7%) live in poverty. These poor people used to live in coastal areas or swamps at altitudes near sea level. As a result of suffering from frequent flood disasters, they were relocated by public policy to cliffs or hillslopes which have another type of natural hazard.

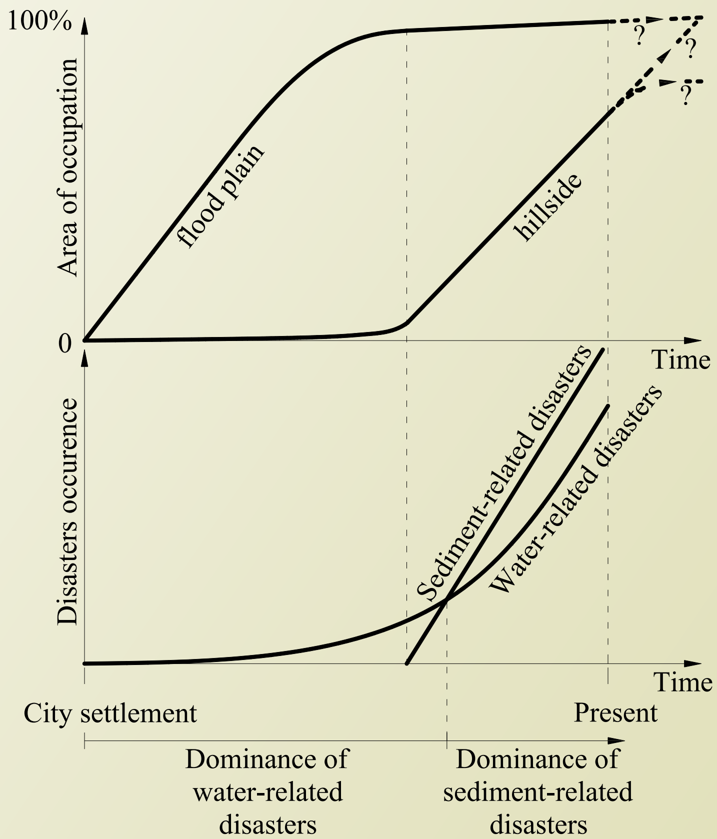

Figure 5 – Hydrological disasters evolution due to the land occupation change. (Source: Kobiyama et al., 2010).

Indeed, Recife has been playing an important role in climate change and greenhouse gas emission issues, and showing its leadership nationally and internationally (Leão et al., 2021). Though these actions are certainly useful in improving the lives of local residents and should be highly evaluated, the reality is that the results have not reached the poor people adequately.

UN (2015) presented 17 Sustainable Development Goals and 169 targets, among which the Goal 10 is "Reduce inequality within and among countries". Landslide-dominated disasters in the Metropolitan Region of Recife in 2022 gave many lessons to people and public agencies. The fact is that the achievement of the Goal 10 should be considered the best action for disaster risk reduction in this region as well as the other places in Brazil.

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Unusual rainfall intensity and total amount causing more than 200 deaths in Petrópolis City, Rio de Janeiro State, Brazil, in February 2022.

By Prof. Masato Kobiyama

(Hydraulic Research Institute, Federal University of Rio Grande do Sul, Brazil)

Figure 1 – Shallow landslide in Petrópolis City in February 2022 (Source: METSUL, 2022).

On the afternoon of February 15th, 2022, heavy rainfall triggered shallow landslides, debris flows and flash floods in Petrópolis City (22° 30' 17" S and 43° 10' 56" W) which is located in mountain region of Rio de Janeiro State, Brazil. The incident resulted in 234 deaths, 3 missing persons, 994 homeless people and an economic loss of about US$ 133 million (considering only the direct damage to companies). The population, area and mean elevation of this city are 306,678 in 2020, 795.798 km^2, and 838 m, respectively. According to METSUL (2022), the Civil Defense of Petrópolis City Hall reported that there were 325 incidents in 24 hours, including 269 landslides. Figure 1 shows one of shallow landslides occurrences in the city.

The intensity of the rain that fell in a very small region of the city was 230 mm in just three hours and the maximum intensity was recorded of 199.2 mm/h at the Alto da Serra rain gauge in the city. These values are extremely rare in the region. The total amount of rainfall in 24 hours was 259 mm which is the highest record in Petrópolis since the beginning of measurements in 1932. In fact, this amount occurred in 6 hours. This extremely-heavy rainfall was caused by the combination of heat and humidity, which favored the development of nuclei in atmospheric instability areas in Petrópolis. In this city, the previous rainfall record in 24 hours was 168.2 mm that occurred in 1952, and the average monthly rainfall in February is 240 mm.

In order to collect information for supporting decision making, the Geological Survey of Brazil (*Serviço Geológico do Brasil* – CPRM) sent a specialized technical team during the period February 17th to March 2nd. By carrying out the field survey and also using other available data such as airplane and DRONE

Figure 2 – Several localities of hydrological disasters in Petrópolis, Rio de Janeiro, Brazil (Sources: Modesto et al., 2022)

Figure 2 – Several localities of hydrological disasters in Petrópolis, Rio de Janeiro, Brazil (Sources: Modesto et al., 2022)

The social element associated to residents' vulnerability and exposure further intensified this tragedy. At the moment of a certain survey performed in 2012, Petrópolis City had 500 hazard areas. The evolution of the number of hazard areas and exposed people has been greatly intensified due to the large population growth as well as the lack of territorial control in the city. Therefore, in 2022, the numbers of hazard areas and highly-vulnerable population could be much higher. Such population growth results from the fact that Petrópolis belongs to the Metropolitan region of Rio de Janeiro and has many tourist spots.

Most of all places where disasters occurred are located at the foot of the steep hillslopes (Figure 1) and characterized with precarious land-occupations. There is no good infrastructure in these places, where, without projects approved by the city hall, residents have been carrying out self-constructions. This actual situation makes the areas even more fragile. Such a land-occupation's style can be considered typical both in Brazil and in Petropolis and is becoming common more and more. In other words, these areas have turned into shantytowns (or slums), i.e., ‘favelaizations’ (Müller, 2017). Thus, hazard areas have been occupied by a poor population with no other choice.

Furthermore, as a part of the metropolitan region, Petrópolis has been exercising typical (or conventional) urbanization without adequate land-planning. In this city, there is a strong tendency to reduce river channel width for construction of roads and buildings, which certainly reduce river’s transport capacity. Vegetation areas have been also decreasing. Urbanized areas without planning should seek for ecosystem services and/or ruralization proposed by Kobiyama et al. (2021).

According to Xavier (2022), the administrative movement for regularization of residences demonstrated the seriousness’ lack in the housing policies of the city hall. In 2017, the Municipal Risk Reduction Plan had already indicated that more than 28,000 houses were in high or very high hazard areas which represented one third of the total area of the city at that time.

Thus, inappropriate (and sometimes illegal) land-occupation of vulnerable population and inefficient land-management of public institutions have been increasing social vulnerability and population exposure, consequently increasing risk of residents. In this sense, Daré (2022) presented common opinions of several experts of Geosciences Institute of State University of Campinas (*Universidade Estadual de Campinas* – UNICAMP). Their opinions are that excessive rainfall should not be considered the sole cause of the tragedy in Petrópolis and that the tragedy in Petrópolis was not a natural disaster. Social factor should be always considered a key in disaster risk management.

Figure 2 – Several localities of hydrological disasters in Petrópolis, Rio de Janeiro, Brazil (Sources: Modesto et al., 2022)

The society itself which may be the principal social factor consists of local habitants and public institution such as city hall as well as scientists and so on. Hence, it is worth discussing actions of scientists especially meteorologists. The Brazilian Center for Monitoring and Early Warnings of Natural Disasters (*Centro Nacional de Monitoramento e Alertas de Desastres Naturais* – CEMADEN) warned about rain in Petrópolis by sending a “very intense weather event” alert to Petrópolis City two days before the tragedy, but without informing the probable rainfall intensity. Responding to an interview, the director of CEMADEN said that people need to fully understand that the CEMADEN informed the weather scenario and that it was impossible to predict how much it would rain. He emphasized that the natural disaster alert had been issued two days in advance by CEMADEN. According to him, Brazil has improved weather monitoring system very well; however, there has been no progress in prevention work (forecasting system).

One meteorologist of the CEMADEN explained that there had been practically no displacement of the clouds. In this case, the rain appeared on top of Petrópolis and remained there practically until it dissipated. In case of this phenomenon, the monitoring equipment and system were very inefficient. Besides, in the world there is no meteorological model capable to predict this type of natural phenomenon even now. In summary, he commented that there were no models, methodologies and tools that could predict this very large amount of rain in a very small space in a very short time, and concluded that it was not a failure of Brazilian meteorology.

Even though his comment “it was not a failure of Brazilian meteorology” can be true, I surely think that Brazilian science and technology related to hydrometeorology could have reduced the magnitude of this tragedy. In my opinion, weather monitoring system is not satisfactory in Brazil even now, especially in mountain regions. Based on the fact that water-related and sediment-related disasters have been intensified in mountain regions in Brazil (Kobiyama et al., 2019), it is exactly the moment to improve more the weather monitoring system in this country.

In case that immense difficulty in predicting rainfall in mountain regions results from the poor investment for monitoring system, rainfall-induced disasters in Brazil might become social disasters indeed.

As Daré (2022) criticized the public policies in the city by mentioning frequent occurrences of tragedy, Petrópolis is well-known as a city frequently suffering from hydrological disasters. In the mountain region of Rio de Janeiro State, on January 11th, 2011, intense rainfall (281.6 mm in eight hours in Nova Friburgo) caused a historic tragedy, where 947 deaths, nearly 300 disappearances, more than 50 thousand homeless, affecting nearly 1 million people were reported (Dourado et al., 2012). Petrópolis was one of three most damaged cities in this tragedy. Table 1 shows the history of hydrological disasters with the number of victims recorded by the Civil Defense of Petrópolis during the period 1966 to February 2022.

Table 1 – Number of human deaths of hydrological disasters in Petrópolis during the period from 1966 to 2022 February.

Year	Death	Year	Death	Year	Death
1966	80	2003	17	2013	34
1977	11	2007	3	2016	2
1979	87	2008	9	2017	1
1988	171	2009	6	2018	4
1997	6	2010	1	2021	1
2001	51	2011	73	2022	234

Pinto and Iory (2022) demonstrated that Petrópolis City Hall invested US$ 26,000 in Civil Defense in 2020. This amount is just 0.009% of the municipal revenue of US$ 298 million in 2020. In 2021, the City Hall cut spending on Civil Defense, investing only US$ 18,000, which is only 0.007% of the revenue of US$ 250 million in 2021. Though this investment reduction may be serious concern for Petrópolis City residents, various actions in disaster risk reduction (DRR) can be performed with low cost. In risk and disaster management, there is the principle where education is the key to DRR. In the case of a city with economic problems such as Petrópolis, it is necessary to return to this principle and enhance education for DRR.

According to Silva et al. (2021) which reported the “Civil Defense Program in School” executed by Santa Catarina State government, Brazil, it is not easy to carry out a insertion of civil defense activities to primary and secondary schools. However, since education is the principle and does not demand high-cost investment, Petrópolis city residents together with their city hall must implement several educational activities for DRR.

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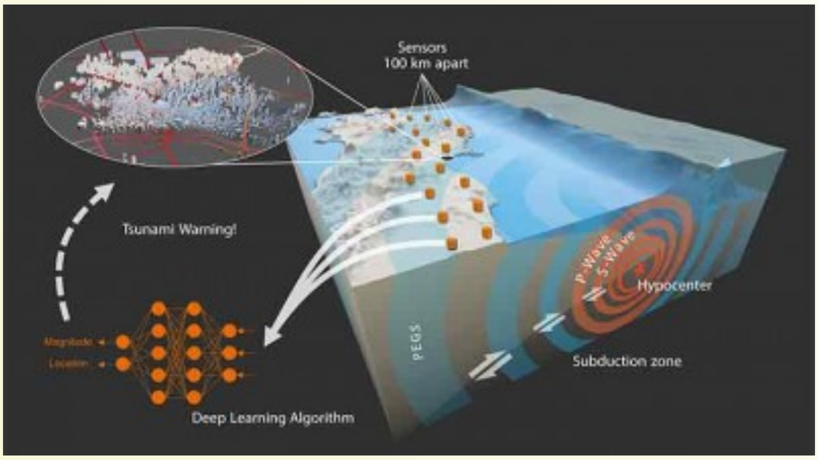
Article on Instantaneous tracking of earthquake growth with elastogravity signals

By Prof. Bertrand Rouet-Leduc et.al.

Published in Nature in May 2022



Prompt Elasto-Gravity Signals (PEGS) are gravitational changes carrying earthquake information much faster than seismic waves.

The research article on “Instantaneous tracing of earthquake growth with elastrogravity signals” by Prof. Bertrand Rouet-Leduc, Disaster Prevention Research Institute (DPRI), Kyoto Univers et.al. was published at Nature in May 2022.

Everyone wants to know the occurrence of a huge earthquake as soon as possible. Yet it is difficult to estimate the magnitude of large earthquakes. The recent breakthrough of “speed-of-light prompt elastogravity signals (PEGS)” raises hopes of an answer to this situation while remaining to be tested on early warning systems.

The team from Kyoto University and Géoazur has developed a new method based on deep learning AI for detecting "prompt elasto-gravity signals" (PEGS). PEGS is a gravitational change generated by the massive motion of mega earthquakes and can be recorded by a seismograph. PEGS also conveys information about ongoing earthquakes at the speed of light, arriving much faster than the fastest seismic waves.

“These signals allow us to track the extent of an earthquake in real time as soon as it reaches magnitude 8 and above,” says author Bertrand Rouet-Leduc.

In the past, however, the small amplitude of PEGS has hindered its application to earthquake and tsunami warning systems. Standard early warning systems based on seismic waves estimate magnitude directly from shaking but fail to detect rapidly the size of an earthquake. Magnitude 9 earthquakes have 30 times more energy than magnitude 8 earthquakes, which saturates the early warning system and tends to make it impossible to estimate the magnitude for larger earthquakes.

"When our research team developed a deep learning AI model using the information carried by PEGS, we were pleasantly surprised by the success of the first prototype to classify earthquakes according to magnitude," said Rouet-Leduc.

The research team was then able to demonstrate the power of their deep learning model to instantly track earthquakes in real time after they reach a certain size. Although the algorithm needs to be further tested on raw data, scientists believe the results could improve seismic and tsunami warning systems.

"Our new model may help people to know quickly about the tsunami that will occur after a major earthquake," the author concludes.

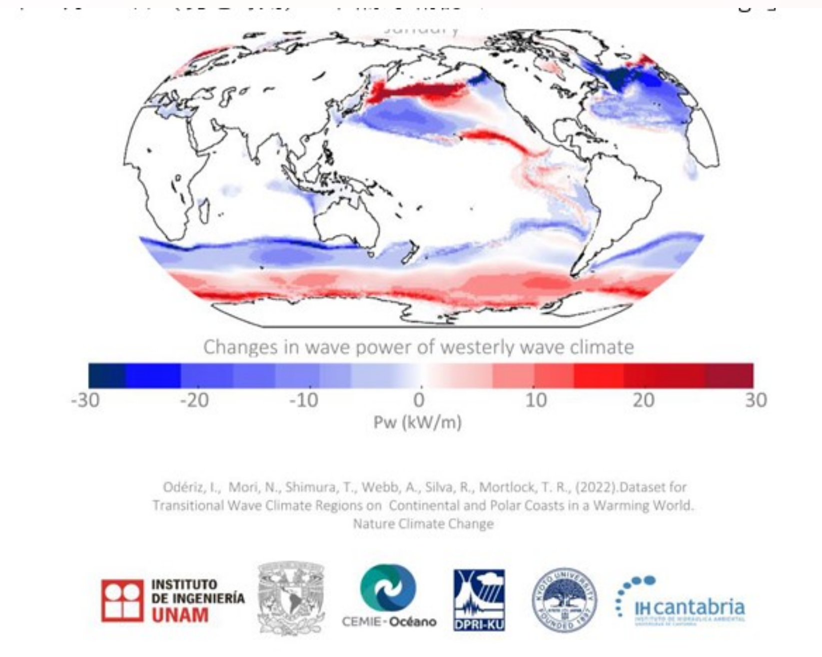
This information appeared at the DPRI, Kyoto University; and Kyoto University websites.

- https://www.dpri.kyoto-u.ac.jp/news/16445/
- KyotoU PEGS away at catching quakes at light speed［Kyoto University］
- Instantaneous tracking of earthquake growth with elastogravity signals [Nature]

Article on Climate-fuelled wave patterns pose an erosion risk for developing countries

By Prof. Nobuhito Mori et.al.

Published in The Conversation in June 2022



Article on "Climate-fuelled wave patterns pose an erosion risk for developing countries" by Prof. Nobuhito Mori et.al. was published in The Conversation in June 2022.

In addition to sea level rise and coastal climate change due to global warming, there is a risk that the coastal environment will change significantly due to changes in global wave characteristics. Therefore, predicting future changes in waves is important for adapting to coastal climate change.

Previous studies have shown that waves can be classified into several global wave climate types. This study analysed future ocean waves climate reproduced by global climate models used by IPCC, and revealed the types of waves and regional hotspots that are susceptible to global warming.

With warming, the power of waves in the polar regions and the Southern Ocean increases, and the frequency of waves propagating from the east on the coasts located in the western part of the ocean such as the Pacific Ocean, and the wave climate propagating from the south on the eastern coast.

In Japan, it was predicted that the frequency of wave climate types propagating from the west in high latitudes would increase. In addition to rising sea levels, this will further intensify the effects of warming in coastal areas and will be a factor in changing coastal environment.

The results of this research are expected to expand into future changes and adaptation measures for coastal vulnerability due to global warming, especially changes in beaches and marine ecosystems.

The results of this research were published online in the international academic journal "Nature Climate Change" on June 16, 2022.

This information was published at DPRI, Kyoto University website.

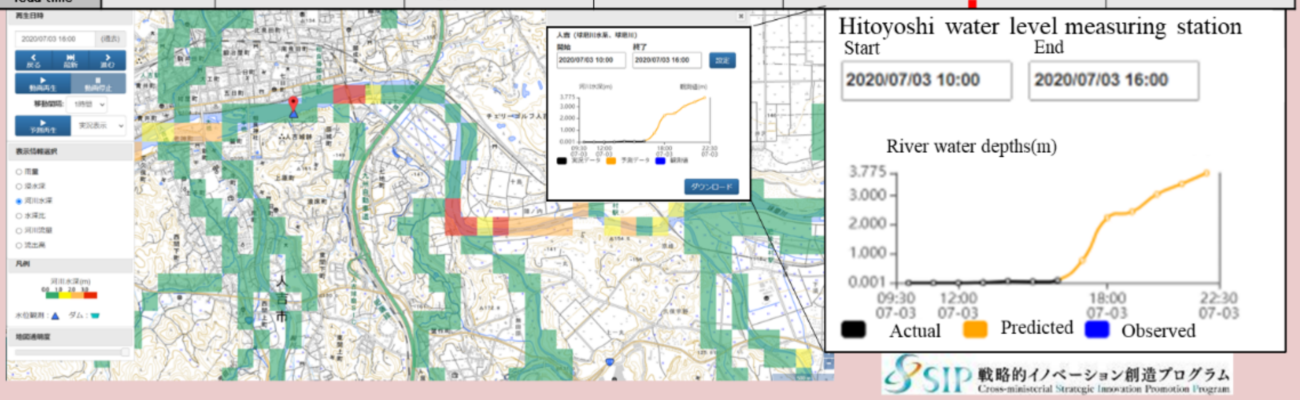
- 地球温暖化により変わる波浪—温暖化に伴う波浪変化リスクの高い沿岸域を解明—［京都大学］
- 地球温暖化により変わる波浪　—温暖化に伴う波浪変化リスクの高い沿岸域を解明—［京都大学・プレスリリース本文］
- Climate-fuelled wave patterns pose an erosion risk for developing countries [The Conversation; 本件の解説記事]
- https://www.dpri.kyoto-u.ac.jp/news_en/16584/

Press Release – Flood Control Timeline of Disaster Base Hospitals

- By:
- Prof. Tetsuya Sumi, and Associate Professor Takahiro Sayama of Disaster Prevention Research Institute (DPRI), Kyoto University;
- Shimizu Corporation (President Kazuyuki Inoue); and
- Hitoyoshi Medical Center (Hospital Director Masami Kimura)

Seven stages and triggers in flood timeline

	Stage 1 Preparation	Stage 2 Starting measure	Stage 3 Arrangement for Disaster Control Headquarter	Stage4-1 Establishment of Disaster Control Headquarter	Stage 4-2 Just before the disaster	Stage 5 Emergency Response	Stage 6 First Recovery	Stage 7 Full-Recovery
【Example】 Alert Level(JMA)	Alert Level 1	Alert Level 2	Alert Level 3	Alert Level 4		Alert Level 5	Alert Level 4→0	
Implementation criteria (triggers)	Early Warning Information on Extreme Weather	Flood Warning River water level at Hitoyoshi station (Kuma river) exceeds 1.5m and Predicted rainfall exceeds a total of 50 mm within 2 to 3 hours	2.0m and RRI predicts rising water levels	3.0m and RRI predicts rising water levels		Information on Flooding Start	Lifting the alert.	
【Example】 Disaster information		(Hitoyoshi City) Evacuation of Elderly people etc.	(Hitoyoshi City) Evacuation Order		Heavy Rain Emergency Warning	River water level exceeds 4.07m. Emergency Safety Measures.	River water level drops.	
Preparation lead time		▼-12h	▼-6h	▼-4h	▼-2h	▼±0	▼+1～2h	



SIP 戦略的イノベーション創造プログラム Cross-ministerial Strategic Innovation Promotion Program

System image of the nationwide Rainfall-Runoff-Inundation (RRI) model (Simulation of the flood event of July 2020)

According to the report issued by the Disaster Prevention Research Institute (DPRI), Kyoto University on 2 April 2022, 34% of medical institutions designated for infectious diseases nationwide are positioned in flood potential areas due to heavy rainfall once in a thousand years, and 26% of them are located in the area even with once every 100 to 200 year floods. The report details the survey conducted on the flooding of the Kuma River in Kumamoto Prefecture and the Hitoyoshi Medical Center.

Prof. Tetsuya Sumi, and Associate Professor Takahiro Sayama of Disaster Prevention Research Institute (DPRI), Kyoto University, Shimizu Corporation (President Kazuyuki Inoue), and Hitoyoshi Medical Center (Hospital Director Masami Kimura) have developed a timeline for flood management and verified its effectiveness by conducting a disaster prevention training at the Hitoyoshi Medical Center on 6 May 2022.

The timeline is designed to evaluate flood risk based on the actual conditions of hospital architecture and facilities, and organizes necessary disaster response operations and implementation criteria (triggers) as well as coordination methods among staff members. It specifies to execute them in chronological order according to the seven disaster stages.

In addition to public weather information, the most important implementation decisions are based on data from the nation-wide RRI Model, which was developed by DPRI as part of the Strategic Innovation Promotion Program (SIP) of the Cabinet Office. It is expected that the activity will become a new framework for disaster risk reduction plans in the flood timeline of hospitals in the future.

This article appeared at the DPRI, Kyoto University website.

- https://www.dpri.kyoto-u.ac.jp/news_en/16159/

Click here to view the press release in Japanese.

- 災害拠点病院の水害対策タイムラインを策定～令和2年豪雨を想定した防災訓練で効果を検証～［京都大学］

Visit the Disaster Prevention Research Institute (DPRI), Kyoto University, Japan to check out various research results and activities.

京都大学防災研究所
Disaster Prevention Research Institute, Kyoto University
- Joint Usage/Collaborative Research Center for Multidisciplinary Disaster Prevention Study -

- Website in English: https://www.dpri.kyoto-u.ac.jp/en/
- Website in Japanese: https://www.dpri.kyoto-u.ac.jp/

Article on Mangrove-induced resistance to water waves and its parameterization

By Program-Specific Assistant Prof. Che-Wei CHANG and Prof. Nobuhito MORI, DPRI, Kyoto University, in collaboration with the Port and Airport Research Institute (PARI) and Tohoku Gakuin University—published online in the international academic journal “Journal of Geophysical Research: Oceans”

Program-Specific Assistant Prof. Che-Wei CHANG and Prof. Nobuhito MORI of the Disaster Prevention Research Institute (DPRI), Kyoto University, in collaboration with the Port and Airport Research Institute (PARI) and Tohoku Gakuin University, used 3D-printed models to replicate the complex root structure of mangroves, studied mangrove-induced resistance and parameterized mangrove effects on ocean waves by laboratory experiments. The study was published online in the international academic journal “Journal of Geophysical Research: Oceans” on June 8, 2022.

Climate change and sea-level rise pose greater challenges to worldwide coastal communities, urging more efficient strategies to mitigate natural hazards and enhance coastal resilience. Green infrastructure/Eco-DRR (Ecosystem-based Disaster Risk Reduction)/Nature-based solution (NBS), which utilizes ecosystems to provide an eco-friendly approach to coastal protection and climate change mitigation, has been gaining attention in recent years.

Specifically, mangrove forests are the major type of nature-based infrastructure in the tropics and subtropics. Mangroves, featured by the special root system, are well-known for their resistance against ocean waves and coastal disasters. To quantify mangrove effects on wave attenuation, we need to properly parameterize mangrove-induced resistance, which relies on a better understanding of wave-mangrove interactions.

This study used 3D-printed models to replicate a mature mangrove, the first time in literature to the best of our knowledge, to study wave-mangrove interactions in model-scale experiments.

We directly measured fluid velocity and wave forces on mangrove models in different wave conditions. Based on the measurements, we proposed empirical relationships of force coefficients to parameterize mangrove effects which could be used in numerical simulation. Additionally, we observed that as waves propagate through mangroves, the irregularly-shaped mangrove roots caused the fluctuation of fluid velocity and the enhancement of turbulent kinetic energy. Please refer to the published paper for more details.

This information appeared at the DPRI, Kyoto University website.

- An Experimental Study of Mangrove-Induced Resistance on Water Waves Considering the Impacts of Typical Rhizophora Roots

- https://www.dpri.kyoto-u.ac.jp/news_en/16403/

Fig.1: Mangrove forests (left: Iriomote, Japan; right: Kiribati)

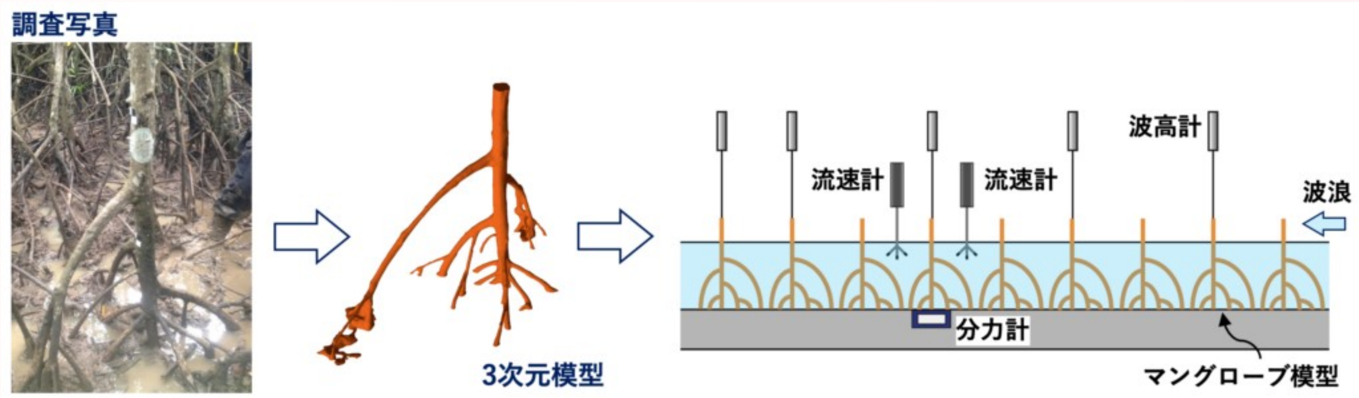
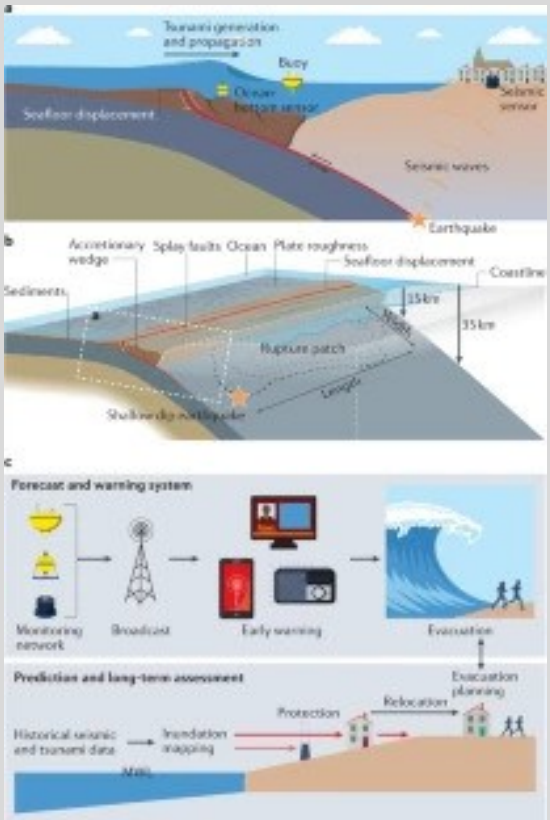


Fig.2: Mangrove forests (left: Iriomote, Japan; right: Kiribati)

Article on Giant tsunami monitoring, early warning and hazard assessment

By Prof. Nobuhito Mori et. al.

Published in Nature Reviews Earth & Environment



Following is the abstract of the article from Nature Reviews Earth & Environment:

“Abstract:

Earthquake-triggered giant tsunamis can cause catastrophic disasters to coastal populations, ecosystems and infrastructure on scales over thousands of kilometres. In particular, the scale and tragedy of the 2004 Indian Ocean (about 230,000 fatalities) and 2011 Japan (22,000 fatalities) tsunamis prompted global action to mitigate the impacts of future disasters. In this Review, we summarize progress in understanding tsunami generation, propagation and monitoring, with a particular focus on developments in rapid early warning and long-term hazard assessment. Dense arrays of ocean-bottom pressure gauges in offshore regions provide real-time data of incoming tsunami wave heights, which, combined with advances in numerical and analogue modelling, have enabled the development of rapid tsunami forecasts for near-shore regions (within 3 minutes of an earthquake in Japan). Such early warning is essential to give local communities time to evacuate and save lives. However, long-term assessments and mitigation of tsunami risk from probabilistic tsunami hazard analysis are also needed so that comprehensive disaster prevention planning and structural tsunami countermeasures can be implemented by governments, authorities and local populations. Future work should focus on improving tsunami inundation, damage risk and evacuation modelling, and on reducing the uncertainties of probabilistic tsunami hazard analysis associated with the unpredictable nature of megathrust earthquake occurrence and rupture characteristics. “ (Nature Reviews Earth & Environment—https://www.nature.com/articles/s43017-022-00327-3)

The above information was published at the Disaster Prevention Research Institute, Kyoto University website.

- https://www.dpri.kyoto-u.ac.jp/

For the full article visit:

- Nature Reviews Earth & Environment—https://www.nature.com/articles/s43017-022-00327-3)

The Main School of Fire Service, Warsaw, Poland will organise the hybrid International Scientific Conference on International Emergency Mechanisms and Disaster Risk Reduction on 15 September 2022.

Scope and objectives

The main objective of the conference is to exchange good practices and experiences in the scope of international mechanisms for prevention and response on crisis situations and disasters as well as to initiate a discussion on improving disaster risk reduction.

The conference will be a platform of exchange for ideas, research results and solutions which connect theory and practice of disaster risk reduction in the field of emergency mechanisms. An ambition is to develop existing and to initiate new networks comprising decision makers, public administration, public services, armed forces, academia, non-governmental organisations and local disaster risk reduction leaders to be more flexible and prepared for XXI century safety and security challenges.

Location

Option 1: The Main School of Fire Service, Slowackiego 52/54 Street, 01629 Warsaw, Poland (after registration)

Option 2: Online via Click Meeting (after registration)

Option 3: Online via Youtube (open access, without registration)

Visit the web site for further information.

- https://www.sgsp.edu.pl/?page_id=29327

Registration:

https://www.sgsp.edu.pl/?page_id=29327

Contact:

- General communication channel: intered@sgsp.edu.pl
- Organisational issues: Sen. Cpt. Monika Wojakowska, PhD, mwojakowska@sgsp.edu.pl
- Merit-related issues: Maj. Pawel Gromek, DSc. Eng., SGSP professor, pgromek@sgsp.edu.pl

The World Bosai Forum will be held to discuss, learn and spread disaster reduction throughout the world.

The 3rd World Bosai Forum will take place at the Sendai International Center, Tohoku University, Kawauchi Hagi Hall, Sendai, Japan from 10 to 13 March 2023.

Click here to visit the website.

- **https://worldbosaiforum.com/2023/en/**

What is the World BOSAI Forum?

Reduction (WCDRR) held in Sendai, the Sendai Framework for Disaster Risk Reduction 2015-2030, a set of guidelines for efforts related to disaster reduction, was formulated. The Sendai Framework for Disaster Risk Reduction also incorporates many of the concepts promoted by Japan, such as the importance of investment in disaster reduction and "Build Back Better”. It is Japan's responsibility to promote the implementation of the Sendai Framework for Disaster Reduction, as a world leader in the field of disaster reduction. Furthermore, the activities of Japan and the Tohoku region in the process of recovery from the Great East Japan Earthquake that occurred on March 11, 2011, have attracted great interest from around the world.

However, while there have been a variety of international conferences on disaster risk reduction held around the world, including UN-led and academic conferences, there has been no international "forum" where specific solutions to reduce damage from disasters can be focused, shared, and discussed.

Therefore, we decided to establish a "FORUM" in Sendai to propose solutions for disaster risk reduction from various perspectives, both domestic and international, industry, government, academia, and civil society, to learn from each other, to create new values, and to promote the Sendai Framework for Disaster Reduction. This is the World BOSAI Forum.

Contact World Bosai Forum Secretariat:

wbf2023@worldbosaiforum.com

6th Global Summit of GADRI

15 - 17 March 2023

DPRI, Kyoto University, Uji Campus, Japan

The prolonged worldwide pandemic and cascading risks have taught us that the conventional approach to disaster risk planning and management is ineffective for the development of sustainable and resilient communities.

A worldwide pandemic underscores the importance of integrating the following key areas: -

- Disaster risk should not be treated in isolation but should be integrated with health risks, climate change, and environmental risks;
- DRR objectives and vision should be integrated with sustainable development goals to foster a resilient world;
- Short-term DRR objectives need to be integrated with a long-term vision and plans for a resilient society.

Towards a sustainable and resilient society, the GADRI's five-fold objectives need to be directed toward the above-mentioned three key areas for integration in research and development.

The 6th GADRI Global Summit aims to systematically identify the processes, techniques, evidence, challenges and opportunities for achieving the GADRI objectives for a sustainable and resilient society against hazards and working to keep them from becoming disasters. Program participants will communicate academic science across scientific disciplines to policymakers and practitioners.

Sub-themes:

1. COVID 19 recovery and building disaster resiliency
2. Disaster risk governance
3. GADRI for realizing the SENDAI Framework
4. Inclusive and equitable DRR
5. Sustainable DRR: Integrating climate action, SDGs and DRR
6. GADRI Objective - I (global research network) for Sustainable and Resilient Society Against Disasters (SRSAD)
7. GADRI Objective - II (developing research roadmaps and plans) for SRSAD
8. GADRI Objective - III (building the capacities of research institutes) for SRSAD
9. GADRI Objective - IV (mutual sharing information and engaging in collaborative research) for SRSAD
10. GADRI Objective - V (serve as an advocacy organization) for SRSAD

(Note: Sub-themes 6 to 10 will identify the gaps, discuss what we can do/what should be done and suggest recommendations towards realizing GADRI objectives)

Pre-conference survey:

- Related to the five committees - contributions –

Website of the 6th Global Summit of GADRI

—https://gadri.net/summit/

Important Dates:

- 15 to 17 March 2023—6th Global Summit of GADRI at DPRI, Kyoto University, Uji Campus, Kyoto, Japan

Registrations and Accommodations

- 1 October to 31 December 2022—Early Bird Registrations
- 1 January to 28 February 2023—Regular Rate
- 1 January 2023 to 28 February 2023—Completion of Accommodation

Posters and Presentations

- 1 October 2022 to 31 January 2023

Pre-conference Survey

- 1 October to 31 January 2023

GADRI Members

Established in March 2015, the Global Alliance of Disaster Research Institutes 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 (UNDRR).

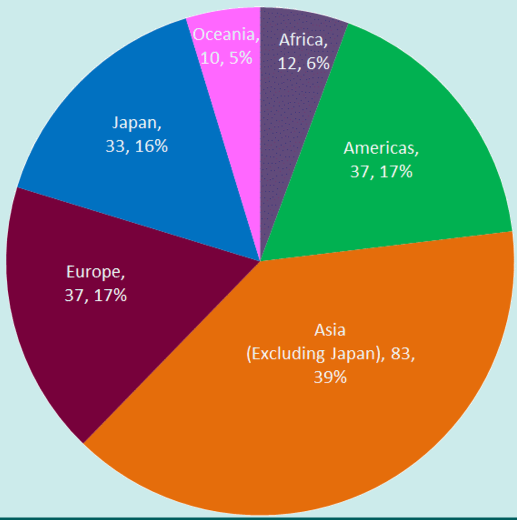
In line with its vision, GADRI strives to deepen the understanding of disasters and find implementable solutions to achieve disaster resilience; i.e. human, technical system and infrastructure resilience, survivability and well-being, by integrating knowledge and technologies from around the world. Over 200 institutions have joined GADRI.GADRI membership is free; and completely voluntary and non-binding.

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

To join GADRI, please contact the GADRI Secretariat: secretariat-gadri@dpri.kyoto-u.ac.jp

Geographical Distribution of GADRI as of 31 July 2022

Area	Members	Economies
Africa	12	**7**
Americas	37	**8**
Asia (Excluding Japan)	83	**23**
Europe	37	**13**
Japan	33	**1**
Oceania	10	**2**
Total	**212**	**54**
	54 economies	



Global Alliance of Disaster Research Institutes (GADRI) Secretariat

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