Exposure Elements in Disaster Databases and Availability for Local Scale Application

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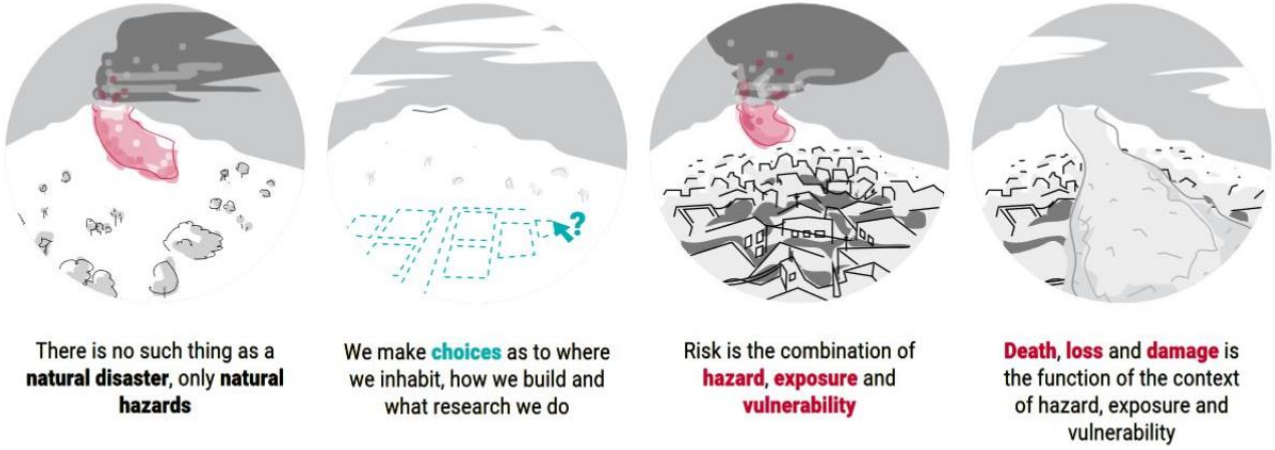
EXPOSURE ELEMENTS IN DISASTER DATABASE

- The term exposure is globally defined as **the situation where people, infrastructure, housing, production capacities and other tangible human assets are located in hazard-prone areas** (UNDRR Terminology, 2017).



(Source: UNDRR 2019)

- The extent of data on exposure elements in global databases have not been examined in detail. The nature of the available information including its availability across scales and systems is largely unknown.
- In conjunction with information on hazards, data on exposure elements is critical for the development of disaster risk reduction strategies to enhance resilience over time.

- The coverage of information on exposure elements in line with the SFDRR and the Sendai Framework Monitor (SFM), to provide an overview of the availability of this data for local scale application in existing disaster databases.
- Reviews the availability of such information within the national system and illustrates its use in facilitating informed decision-making at the local level, through a case study of Kuala Lumpur, Malaysia.

MATERIALS & METHOD

Content Analysis

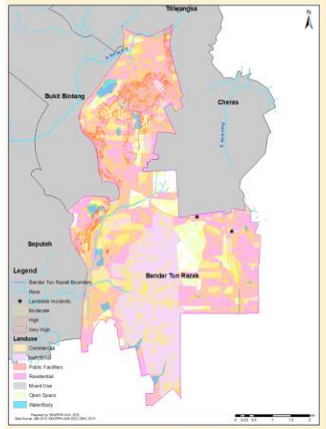
- Keywords screening - “**disaster database**”, “**disaster system**”, “**exposure**”, “**critical elements**”, “**big data**”, “**data gaps**”, “**flood open source**”, “**disaster open source**” & “**flood database**” in all of the search platforms. Targeted platforms include the Web of Science and Scopus database, within a time frame of 2010–2020 as well as the internet.

Spatial Analysis

- Compare information on **exposure elements and flooded vicinities from a recent event in the city, to flood hazard zones** (DID Malaysia) **and areas susceptible to flash floods** (previous NUOF Kuala Lumpur project).
- Information on exposure was obtained from open-access international and national databases that was previously evaluated using content analysis, to identify indicators that could be used to develop an exposure inventory for Kuala Lumpur. It was then translated into the form of a map depicting the distribution of exposure elements in the city

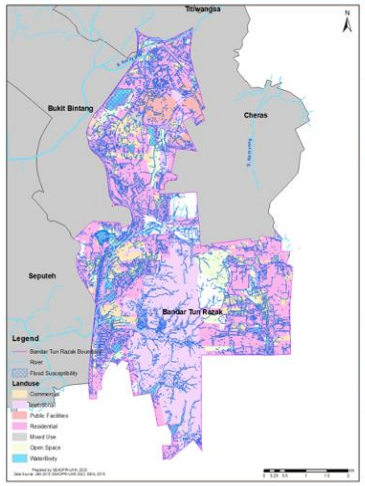
KL-MHP: Bandar Tun Razak
http://13.212.51.113/mhp/public/signin

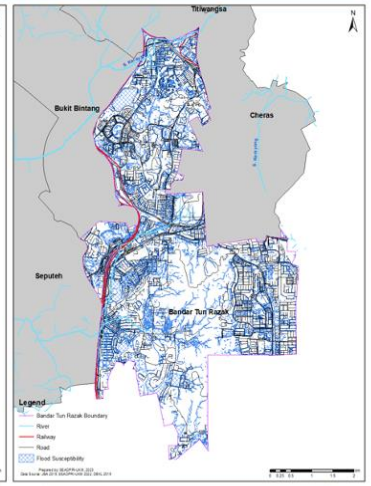
Landslide Hazards



4% of landuse (2% residential) is susceptible to high and very high landslides

Flood Hazards

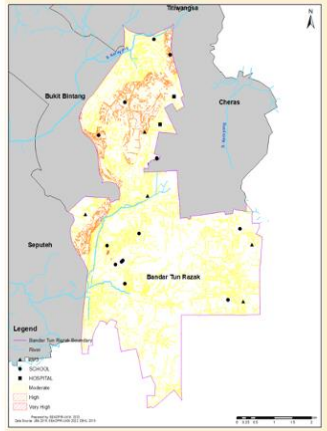




25% of landuse (13% residential) is susceptible to floods

1 PPS and 2 schools are exposed to floods

PPS – Evacuation Centre



1 PPS and 3 schools are exposed to landslides

Pusat Kajian Bencana Asia Tenggara, SEADPRI, UKM

RESULTS - Overview of disaster database

TABLE 2 | An overview of disaster related databases available on the internet (as of October 2020).

Name of database	Database URL	Source of Information	Accessibility of database	Scale of Database	Type of disaster		Type of Information	Mapped exposure elements
					Fast-onset	Sloe onset		
CrisisNET	http://crisis.net/	Internet search	Open access - shutdown on 2018	International			Event data	X
Canadian disaster database (CDD)	https://www.publicsafety.gc.ca/cnt/rsrcs/cndn-distr-dtbs/index-en.aspx	Internet search	Open access	National - Canada	√		Event data, place, fatalities, injured/infected, evacuated, cost	√
CE-DAT	http://cedar.be/	Internet search	Limited access	International			Event data	X
EM-DAT	https://www.emdat.be/	Journal article [3]	Open access	International	√		Event data	X
NatCatSERVICE	https://www.munichre.com/en	Journal article [1]	Limited access	International	√		Event data	X
DesInventar	https://www.desinventar. Net/	Internet search	Open access	International	√	√	Event data	X
National ass. Of radio distress	https://hisz.rsoe.hu/and http://cc.rsoe.hu/	Internet search	Open access	International	√	√	Event report	√
LA RED	https://www.desenredando.org/	Internet search	Open access	Regional - Latin America			Event data	√
PDN	http://www.pacificdisaster.net/	Internet search	Open access	Regional -pacific	√		Event report	X
ReliefWeb	https://reliefweb.int/	Internet search	Open access	International	√		Event report	X
IDMC	https://www.internal-displacement.org/	Internet search	Open access	International	√		Internal displacement data	X
The coastal risk assessment framework (CRAF)	http://www.ricket.eu/hp4/67/	Journal article [1]	Limited access	International	√		Risk analysis	X
High mountain asia (HMA)	https://nidi.org/data/highmountainasia	Journal article [1]	Open access	Regional - high mountain asia	√		Satellite images	X
Damage assessment and needs analysis (DANA)	http://www.odpm.gov.tt/node/75	Journal article [1]	Open access	National - republic of trinidad and tobago	√		Event map	√
FLOPROS		Journal article [1]		International	√			
Global exposure database (GED)	https://preview.grid.unep.ch/index.php?preview = homeandlang = eng	Internet search	Open access	International	√		Event and physical data	√
GEOSS	https://www.geoportal.org/?f: dataSource=dab	Internet search	Open access	International			Satellite images	X

RESULTS - Coverage on the exposure element

TABLE 1 | Exposure elements organized into the five major categories of SFDRR (Target D).

Exposure elements in SFDRR	Exposure elements		Exposure elements in journal articles	Exposure elements in Kuala Lumpur
	In SFM			
Health facilities	Health facilities		Emergency services	Hospital
Education facilities	Education facilities		n/a	School
Basic services	Electricity power		Electric power systems	TNB stations
	Electric power generation/transmission and distribution		Natural gas and oil	n/a
	Sewage services		Wastewater network	Sewage treatment plan
	Transportation services		Transportation	Road
	Air transport		n/a	n/a
	Bridges/metro trains/subway		n/a	n/a
	Water supply		Water supply systems	n/a
	Water collection/treatment and supply		n/a	Water treatment plan
	Solid waste services		Household waste	Solid waste disposal center
			n/a	Landfills
			n/a	Old landfills
			n/a	Transfer station
	Telecommunication		Telecommunication	n/a
	Relief and emergency services		n/a	Police station
			n/a	Fire station
	Information and communication technology (ITC) system		n/a	n/a
Social aspect	Government buildings		n/a	Heritage building
			n/a	Place of worship
			n/a	Multipurpose hall
Economic aspect	Public administration services		Government services	PPA/PPR
			Banking and finance	Elite condominium

n/a, not available.

RESULTS - Case study of Kuala Lumpur

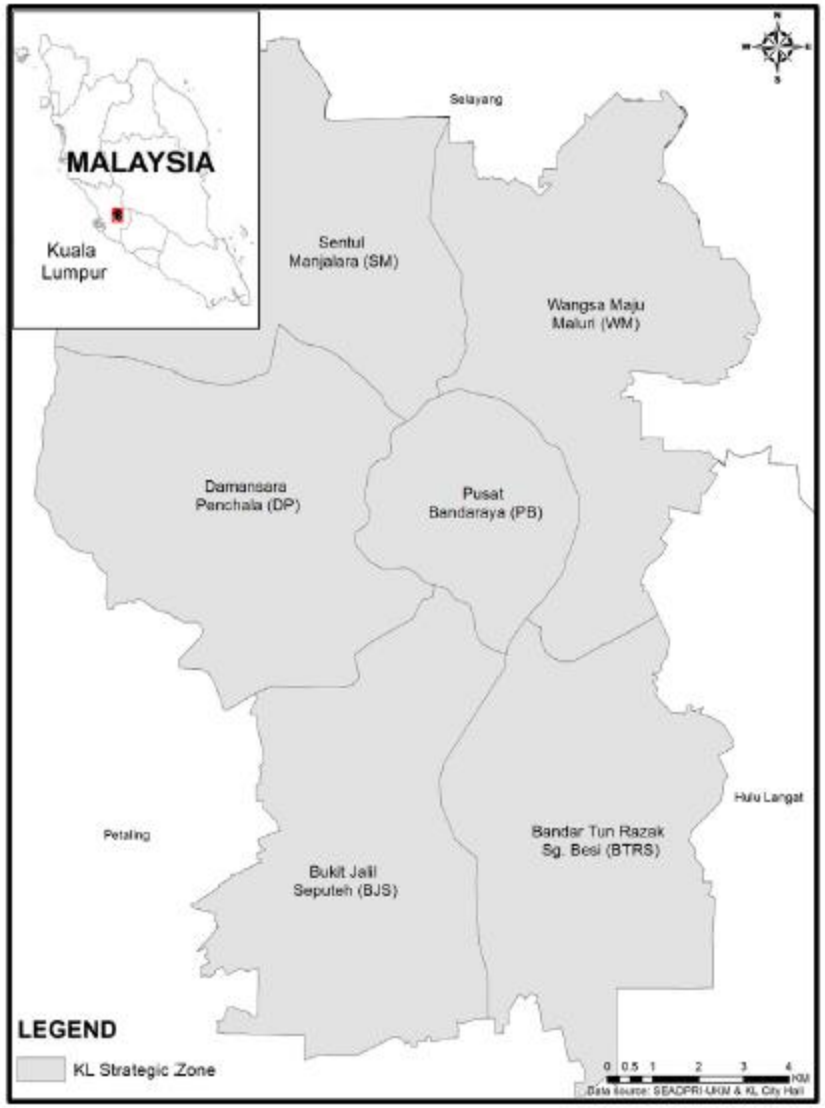
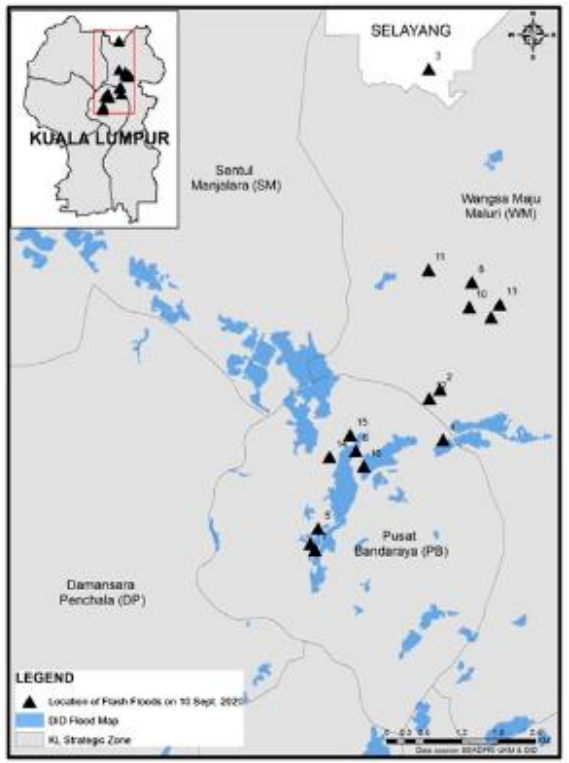


FIGURE 1 | Kuala Lumpur is located within the State of Selangor in Peninsular Malaysia and comprises several strategic zones.

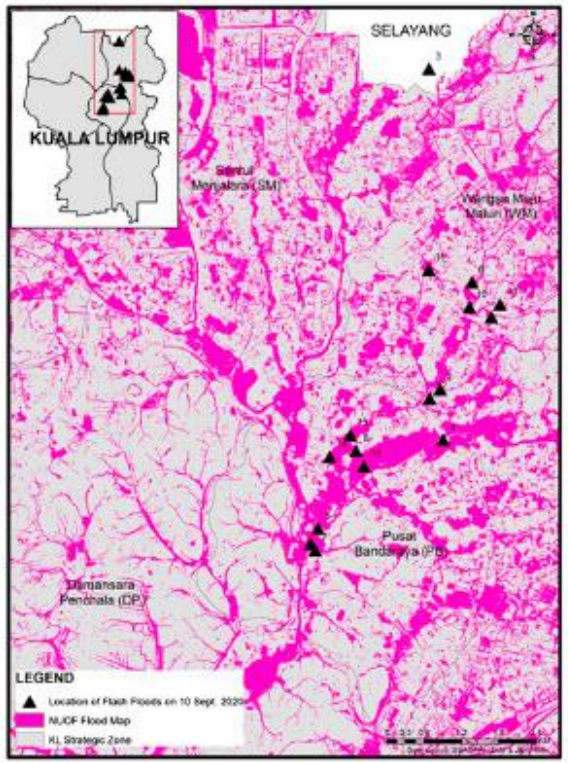
TABLE 3 | Local open-sources of information on exposure elements in Kuala Lumpur.

Exposure elements in SFDRR	Exposure elements in Kuala Lumpur	Source of information (website)	Database URL	Processing
Health facilities	Hospital	Ministry of health Malaysia	https://www.moh.gov.my/index.php/database_stores/store_view/3	Individual plot of addresses in google earth pro (.kml) were imported to ArcGIS (.shp)
Education facilities	School	Ministry of education Malaysia	https://www.moe.gov.my/en/statistik-menu/senarai-sekolah-mengikut-kumpulan-jenis-dan-negeri	Individual plot of schools in google earth pro (.kml) were imported to ArcGIS (.shp)
Basic services Social aspect	TNB stations	Tenaga national berhad	https://www.st.gov.my/ms/web/general/details/273	Descriptive format (excel list) were plotted individually in google earth pro (.kml) and imported to ArcGIS (.shp)
	Sewage treatment plan	Indah water konsortium	https://www.iwk.com.my/do-you-know/sewage-characteristics	Descriptive format (excel list) were plotted individually in google earth pro (.kml) and imported to ArcGIS (.shp)
	Road	Open street map	https://www.openstreetmap.org/#map=6/4.116/109.455	Imported to ArcGIS (.shp)
	Water treatment plan	Indah water konsortium	https://www.iwk.com.my/do-you-know/sewage-characteristics	Descriptive format (excel list) were plotted individually in google earth pro (.kml) and imported to ArcGIS (.shp)
	Solid waste disposal center	Solid waste management and public cleansing corporation	https://www.swcorp.gov.my/solidwastemngmnt/	Descriptive format (excel list) were plotted individually in google earth pro (.kml) and imported to ArcGIS (.shp)
	Landfills	Solid waste management and public cleansing corporation	https://www.swcorp.gov.my/solidwastemngmnt/	Descriptive format (excel list) were plotted individually in google earth pro (.kml) and imported to ArcGIS (.shp)
	Old landfills	Solid waste management and public cleansing corporation	https://www.swcorp.gov.my/solidwastemngmnt/	Descriptive format (excel list) were plotted individually in google earth pro (.kml) and imported to ArcGIS (.shp)
	Transfer station	Solid waste management and public cleansing corporation	https://www.swcorp.gov.my/solidwastemngmnt/	Descriptive format (excel list) were plotted individually in google earth pro (.kml) and imported to ArcGIS (.shp)
	Police station	Royal Malaysian Police	https://www.rmp.gov.my/	Individual plot of addresses in google earth pro (.kml) were imported to ArcGIS (.shp)
	Fire station	Fire and Rescue dept. Malaysia	https://www.bomba.gov.my/	Individual plot of addresses in google earth pro (.kml) were imported to ArcGIS (.shp)
	Heritage building	Jaburan Warisan Negara	http://www.heritage.gov.my/	Descriptive format (excel list) were plotted individually in google earth pro (.kml) and imported to ArcGIS (.shp)
	Place of worship	Dept. of federal Territory Islamic affairs and Statistical Dept	https://www.jawi.gov.my/index.php/my/and https://www.dosm.gov.my/v1/	Descriptive format (excel list) were plotted individually in google earth pro (.kml) and imported to ArcGIS (.shp)
	Multipurpose hall	Open street map	https://www.openstreetmap.org/#map=6/4.116/109.455	Descriptive format (excel list) were plotted individually in google earth pro (.kml) and imported to ArcGIS (.shp)
Economic aspect	PPA/PPR	Statistical Dept	https://www.dosm.gov.my/v1/	Descriptive format (excel list) were plotted individually in google earth pro (.kml) and imported to ArcGIS (.shp)
	Elite condominium	Real Estate	www.iproperty.com.my and https://www.	Individual plot of addresses in google earth pro

RESULTS - Case study of Kuala Lumpur



Kuala Lumpur Exposure Elements	Impacted Exposure Elements from 10 Sept 2020 in DID Flood Map
Hospital	1
Education Services	1
Basic Services	2
Social Aspects	3
Economic Aspects	0



Kuala Lumpur Exposure Elements	Impacted Exposure Elements from 10 Sept 2020 in NUOF Flood Map
Hospital	2
Education Services	5
Basic Services	2
Social Aspects	5
Economic Aspects	1

FIGURE 4 | The extent of flood hazard zones of DID and flood susceptibility areas of the NUOF research consortium, with number of exposure elements therein. The numbered vicinities are available in **Figure 3**.

- **On September 10, 2020**, about **16 vicinities** in Kuala Lumpur were inundated by flash floods and water ponding as a result of heavy downpour that lasted for 5 h, from 1300 to 1600.
- All of the 16 inundated vicinities were geocoded and plotted in the GIS environment, and compared to the flood hazard zones of DID and flood susceptibility area developed by the NUOF research consortium.
- All of the exposure elements were within the flood susceptibility map of the NUOF research consortium - the map of the NUOF consortium draws on more detailed information and deploys a modeling approach to capture both river and pluvial flooding, to facilitate urban flood management.
- **The case study of Kuala Lumpur also revealed that damages associated with the event on September 10, 2020 is currently not available.**
- **There is no open-source database on damages associated with small-scale disasters, such as those reported in Kuala Lumpur. damages.**

KEY FINDINGS

- The **poor coverage of exposure elements in the research domain is mirrored in the operational domain**; the majority of the 26 databases assessed record loss and damage data, while a limited number compiled information on hazards - **None was useful for developing exposure elements in the local level case study.**
- Detailed exposure analysis is **only possible if explicit geographical data is available** on exposure elements complimented by wellestablished hazard zones
- There is a need of **granular and disaggregated data to develop evidence-based policies** that lead to more inclusive outcomes. The procurement of accurate data and information on exposure elements requires data from multiple agencies. However, **if the origin of the data sources is restricted, it is impossible that the information gathered will be an open-access.**
- It is anticipated that **open-access data that leverages effectively with crowd-sourced information,** will significantly facilitate decision-making processes.
- The case study of Kuala Lumpur has shown that d**ata could be gathered from multiple open-access sources and be spatially attributed where necessary,** to enable the development of a spatial database of exposure elements. This database has been proven to be very useful when coupled with open-source information on flood susceptibility in Kuala Lumpur.
- The availability of prospective information on disaster risks in conjunction with exposure elements will enable decision-makers to make effective interventions even before disaster strikes. In light of climate change, a **prospective approach is critical at the local level** to build longterm resilience.
- Drawing on this experience, a quick search for similar **open-source databases on exposure elements using keywords in English reveals that similar information exists in Southeast Asia**

TABLE 4 | Coverage of information on exposure elements in southeast asia (as of January 2021).

Exposure elements in SFDRR	Exposure elements in SFM	Exposure elements coverage in open-access data for southeast asian countries								
		Singapore	Philippines	Indonesia	Brunei	Cambodia	Laos	Myanmar	Thailand	Vietnam
Health facilities	Health facilities	Hospital	Hospital	Hospital	Hospital	Hospital	Hospital	Hospital	Hospital	Hospital
Education facilities	Education facilities	School	School	School	School	School	School	Not available	School	Not available
Basic services	Electricity power Electric generation/ transmission and distribution Sewage services Transportation services Air transportBridges/ metro Trains/subway Water supply Water collection/ treatment and supply Solid waste services Telecommunication Relief and emergency services Information and communication technology system	Waste-energy plant Sewage Treatment plantReclamation Plant RoadRoad camera taxi spot vehicle type Civil aircraft Landfills Police station Fire station	Power plantUsed-water facilities Road Water facilities Landfills Police station Fire station	Power station	Electrical service Sewage treatment plant Road Water treatment plant Landfills Police station fire station	Power substation Electric power generation Power transmission line Road Water treatment plant Police station	RoadFire station	Power stationRoad	Power plant Sewage treatment plant Road Air transport Water treatment plant Police station fire station	Road
Social aspect	Government buildings	Heritage building Place of worship	Heritage building	Place of worship	Not available	Not available	Not available	Heritage and protected areas	Heritage building	Not available
Economic aspect	Public administration services	Not available	Youth hub	Poverty province agriculture zone	Not available	Cropland	Not available	Not available	Not available	Not available

- Information on hospitals is widely available in the region while data on schools are available in all countries except Myanmar and Vietnam.
- The highest number of open-source database on basic services, social and economic aspects is available for Singapore, presumably because English is the national language.
- Countries such as The Philippines, Brunei, Cambodia and Thailand have several databases on exposure elements while Indonesia, Laos, Myanmar and Vietnam have the least.

Further information, please see full paper :
https://www.frontiersin.org/articles/10.3389/feart.2021.616246/full

CONCLUSION

- Exposure elements **are not well covered in the research domain,** as reflected by scientific literature. There is **no indicator for the category of educational infrastructure, while the coverage is poor for data on basic infrastructure, social and economic aspects.**
- There is limited public accessibility to official information on hazards, exposure and disaster risks in the country. This is the motivation to find alternate scientifically robust avenues to generate information using open-access data
- The case study of **Kuala Lumpur can be easily replicated in other major cities of the country.** Further work is required to delineate emerging hazards due to climate change. A similar effort can also be undertaken in Southeast Asia, to advance open sharing of information on disaster and climate risks.
- The **availability of open-access local information would support efforts to build the resilience of communities that do not have access to information on hazards and are not aware of the emerging impacts to the exposure elements that they depend on.**

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