Report of the Disaster Related Statistics Framework (DRSF) Pilot Studies

October, 2016

prepared by the Asia-Pacific Expert Group on Disaster-related Statistics

Contents

i. Acknowledgements

The pilot studies reviewed in this report were conducted in four countries (Bangladesh, Fiji, Indonesia, and the Philippines) through the volunteer collaboration from national government agencies led by the national disaster management agencies and national statistics offices. In most cases new or existing national technical coordination groups were established or utilized for a coordinated response to the study requirements (much of the data useful for the scope of statistics in the drat Disaster-related Statistics Framework (DRSF) is collected by many government ministries or agencies. The Focal point agencies were the Bangladesh Bureau of Statistics, Bangladesh Ministry of Disaster Management and Relief, Fiji Bureau of Statistics, Fiji Ministry of Rural and Maritime Development and

National Disaster Management, Indonesia National Statistics Office (BPS), Indonesia National Agency for Disaster Management (BNPB), the Philippines National Statistics Authority, and the Philippines Office of Civil Defence.

The draft DRSF was developed through a consultative process involving all member of the Asia and Pacific Expert Group and its large network of collaborating experts from government and from international agencies active in disaster-related statistics production or analyses in Asia and Pacific and other region. As Secretariat, staff members at the Economic and Social Commission for Asia and the Pacific (ESCAP) facilitated the process of collecting and analysing data in order to prepare this report as an input for the Expert Group's discussions towards an agree collection of methodological principles and guidance material for the improvement of the quality of disaster-related statistics at the national level for improve evidenced-based disaster risk reduction (DRR) policy-making.

1 Introduction & Background

The Asia-Pacific Expert Group on Disaster-related Statistics was established through ESCAP resolution 70/2 on "Disaster-related statistics in Asia and the Pacific". The Group consists of experts from national statistics offices and national disaster management agencies, and international experts. Resolution 70/2 called on the Expert Group to address key challenges to improving a basic range of disaster-related statistics, emphasizing the importance for disaggregated statistics and ensuring that statistics meet the needs to risk reduction policy and in support of sustainable development in the region, and to monitor progress toward targets set by national governments and through international agreements, particularly the Sendai Framework for Disaster Risk Reduction 2015-2030 (SFDRR) and Sustainable Development Goals (SDGs).

At its 3rd meeting, held in Bangkok (October, 2016), the Expert Group decided to organize pilot tests for a provisional draft outline and summary of core principles developed as a draft Disaster Related Statistics Framework (DRSF), including descriptions of measurement scope and other basic methodological considerations for a basic range of statistics on disaster occurrences, impacts, and risk reduction. The pilot tests consisted of intensive study of existing data from the volunteer national agencies from 4 highly disaster-prone countries (Bangladesh, Fiji, Indonesia, and the Philippines).

The pilot countries were given 3 months (from January through March) to organize data from historical disasters into compilations aligned with draft DRSF tables. The ESCAP Secretariat facilitated this process through organizing cross-country compilations of the data and producing this summary description of key outcomes and conclusions from analyses of the statistics, data sources, and metadata. Through the process, several potential improvements for the DRSF have been identified. This Report also summarizes some measurement challenges that are in need of further consideration by the Expert Group or further study and experimentation (see next steps).

The scope of the DRSF pilot tests is aligned with the indicators being developed through the agreements on the SFDRR and the SDGs. The goal for the DRSF and its attached technical guidance is to help national statistics systems (NSSs) with strengthening a basic range of official statistics that serve multiple purposes, including for producing indicators that will used by policy makers at local and national levels and for monitoring the internationally developed goals and targets.

DRSF doesn't aim to create new concepts regarding disaster observation and risk management but instead to build upon commonly accepted concepts and definitions used by experts in these domains. In this way it will be possible (i) to start production of statistics from existing databases and (ii) to bridge the representations of the realm of disasters and risk management, on the one hand, with the socio-economic statistics on the other. The bridge between the two domains of statistical information is essential for producing indicators. DRSF implementation depends on a strong partnership between disaster management agencies, national statistical offices, and other official sources of relevant data.

The DRSF can be utilized flexibly by national statistical systems to help manage a diverse collection of data and data sources, for producing the large numbers of variables that would constitute an internationally-comparable basic range of disaster-related statistics.

The best and most practical way forward is to make use of existing data and to identify if there are any critical limitations in data currently available for meeting the national or international statistical demands. A general outcome from this study is that there are many strengths already well-established in national statistical systems and large amount of data available for producing a basic range of a basic range of statistics, but further improvements would also be beneficial so that the statistics (and the underlying data collection instruments) meet agreed quality standards for official statistics, including relevance, accuracy, reliability, and international comparability.

When hazards turn to disasters, how many people (for example in Bangladesh, Indonesia, Fiji or the Philippines) are likely to be exposed to impacts and how well are the regions exposed to hazards prepared to minimize the fatalities and the long term impacts to the society? What is being done to minimize the risks of the populations exposed to these hazards? What are the short-term and long-run impacts and where are the opportunities to further minimize potential impacts and hasten recovery through improved risk prevention and international cooperation? These are among the fundamental questions implied by the SFDRR and SDGs and it is the duty of statisticians and disaster risk specialists to seek out and disseminate the facts needed to answer these questions.

2 Pending issues and Summary of Next Steps for Pilot Testing

The experience of compiling data in the January-March round shows that the DRSF tables and core principles as initially drafted are generally fit for the purpose of developing a basic range of disaster-related statistics at the national level. However, not all components of the DRSF have been covered so far in such a short time allowed for the tests. An additional 2nd round of pilot testing is recommended during 2016-17 in order to complete the compilation and the follow-up on some of the pending quality of measurement and comparability issues identified by this initial study and to broaden the scope of evidence for consideration by the Expert Group for developing its recommendations for the DRSF and associated statistical guidelines.

The next round of pilot testing should be more focused on a smaller selection of technical issues described in this section. The 2nd phase should could continue with collection of sample data, and especially metadata, but for a more limited scope of fewer variables. The continuation of work on pilot testing could also an opportunity to involve an expanded scope of countries and experiences.

Methodological topics that are in need of further investigation through a 2nd round of pilot testing are:

1. Disaster risk reduction expenditure and official development assistance (ODA) for disasters at local and national scales
2. Scope and measurement of affected population in relation to existing data, with particular focus on the issues of displacement and disaggregated statistics on vulnerable groups (especially persons with disabilities and the income poor)
3. Compilation of current practices/possibilities for material impacts in "physical terms", e.g.: partially damaged, damaged, destroyed, and development of a "menu" of measurement units for material impacts
4. Data availability and scope of measurement for damages to critical infrastructure, including disruptions to basic services
5. Methodologies for direct economic loss (direct material impacts in physical and monetary terms)
6. Measuring direct medical costs
7. Measurement of impacts to the environment and natural resources (identifying priority elements for the basic range)
8. Further investigations of basic transferable methods for using GIS for integrating hazard exposure with demographic, economic and social statistics in order to improve understanding of risk
9. Special issues with small disasters or slow developing hazards
10. Accessing big data (e.g. social media and messaging)
11. Understanding risk (risk indices)
12. Frequencies of hazards and investigating links with climate change

Each national working group involved in this initial phase of the DRSF pilot testing had a different approach to the exercise, with different focuses in terms of variables reported and measurement units. One point that the countries generally shared in common is the approach for selecting a limited number of events from a specific time period within the past 3-5 years. Approximately 5-year time periods emerged as a suitable time interval for reporting on summary statistics for historical disasters and could be used for further work in pilot countries and for similar compilations involving other countries. At the same time, the nature and scale of impacts from each event can vary and thus maintaining links within the database system, through a relational database structure is important in order to retain relevant detailed information for disaggregated analysis of relevant statistics according to individual and major events, as needed. Thus, while different from the topical areas listed above, developing advice or tools on relational databases for integrating the various components of disaster-related statistics was identified as another important area for further research by the Expert Group.

Essentially, what is needed for national disaster statistics databases is a design with a suitable design or flexibility so as not to lose the link between the three or more defining characteristics for each variable, i.e.: an identifier (name or code) for the relevant disaster event (also with reference to the hazard type or category), date of the occurrence, and the geographic area or regions affected. A national relational database, built upon a clearly defined statistical framework can be utilized to serve all of the crucial demands for statistics for disaster risk reduction policy development and for monitoring agreed national and international indicators. Development of the DRSF will help to serve this purpose as a general guide for use by experts from across countries in Asia and the Pacific.

2.1 Disaster Risk Reduction (DRR) Activities

Due to the short time given for the first test, direct measurement of DRR has not yet been addressed in this study. DRR statistics respond to the Sendai target of assessing the implementation of national DRR strategies. DRR could be addressed as a satellite account of the UN System of National Accounts (SNA2008) aimed at measuring the national expenditure (current and investment costs) devoted to DRR, considered in terms of production of characteristic services and of financing of this activity. A typical indicator of satellite accounts is National Expenditure (here for DRR) which portrays financing by domestic sectors (enterprises, households, government services and private non-profit organizations) as well as financing received from the Rest of the World net of payments to the Rest of the World (ODA).

While hazards and disasters are events happening randomly (or at least at unusually and most unpredictable intervals) in terms of timing and in relation to the society, DRR is a continuous activity needed to strengthen society's resistance and resilience and thus DRR statistics should be compiled on a continuous and periodic basis (e.g. as annual accounts). Although not yet developed, DRR statistics could eventually become a relatively conventional domain of statistics because of potential to link with the existing national accounts statistical standards. It is an area where close cooperation is needed between disaster agencies and the statistical offices or other government agencies that are used to national accounting methodologies. The next phase of tests should investigate measurement of DRR expenditure in volunteer countries in Asia and Pacific that are willing to experiment with an entirely new national accounts innovation: a satellite DRR expenditure account. The Fiji Bureau of Statistics, and also, more recent ally, focal point agencies from a few of the other Expert Group member countries, have volunteered to participate in a pilot experiment for calculating annual DRR expenditure as part of a 2nd phase of the study.

3 Concepts and Indicators Covered in this Study

DRSF pilot test materials were organized according to four main components: (i) background statistics and hazard exposure, (ii) summary statistics on affected population, (iii) material impacts including economic losses, and (iv) disaster risk reduction activity. Where relevant, tables were organized according to types of hazards, geographic regions, social groups (age groups, gender, and vulnerable groups), and also according to measurement units, including, valuations in monetary terms. A comprehensive collection of draft DRSF tables for pilot testing is posted on the Expert Group's website.[1]

In parallel with the pilot studies, the OEIWG has been working to develop its final recommendations on indicators and terminology for monitoring the Sendai Framework targets. The latest outputs from OIEWG, including a draft list of indicators, can be found on the group's website[2]. DRSF and these pilot studies were designed to be aligned as much as possible to the OEIWG recommendations and to the terminologies emerging from the OEIWG and from the Sendai Framework itself. However, there are many challenges related to current data availability from the official sources in countries or due to limitations or inconsistencies with measurement methodologies that makes it difficult or impossible to compile or analyze a complete set of statistics for the proposed indicators across countries. These methodological issues and challenges are discussed in detail in the rest of this report.

3.1 Counting/Identifying Disaster Occurrences

In order to measure impacts of disasters, there first is a need to identify the discrete disaster events covered by the statistics and the underlying hazard (e.g. flood, cyclone, or earthquake), which is the natural source of the disaster. Besides hazard type, other crucial and basic information for a disaster event are location, timing, and some indication of scale. Although there is a tendency for compilations at the national or international scale to prioritize focus on large events, there are no common or standardized definitions and criteria for distinguishing between large or small disasters across countries. In principle, all types of disasters, large or small in scale, can be included in the DRSF tables used for compiling statistics. However, a scale or hazard or disaster magnitude distinction is often useful and this study found that three out of four pilot countries (Bangladesh, Fiji, and Philippines) utilize similar types of scale characterization for describing disaster events (e.g. large event, small event, national scale, local scale). According to the examples from this study, an indicator for description of scale can be derived from information about the need for a response (e.g. national or local scale call for emergency) and not by some absolute number of casualties or other post-hoc impact assessment. The logic of this method stems from the fact that governments are the sources of official statistics on disasters and it is up to the relevant source agencies to determine their own statistics needs for response, recovery and disaster risk reduction.

[1] http://communities.unescap.org/asia-pacific-expert-group-disaster-related-statistics/reference-materials
[2] http://www.preventionweb.net/files/47136_workingtextonindicators.pdf

The UNISDR defines a disaster as "*a serious disruption of the functioning of society, causing widespread human, material or environmental losses which exceed the ability of the affected society to cope using only its own resources*" Different countries may have slightly different practices with regards to defining the scale of events to serve their own purposes in their statistical tables, But, in principle, all disaster events aligned with the UNISDR definition (regardless of scale) can be included in the official databases used for developing evidence-based DRR policies and for calculating indicators.

Background Statistics

By definition, disasters significantly disrupt the normal functioning of society and the capacities of that society to cope with direct impacts such as destruction to dwellings and infrastructure. For each disaster, there is a baseline context of population and economic and social activity that can be described according to the existing official statistics produced by national statistics offices (NSOs). The denominators of ratio indicators under development by the OEIWG explicitly imply some of the core baseline statistics variables, i.e. population, economy activity and land cover or land use. For this study, baseline statistics were compiled, where possible, with geographic referencing as available (e.g. population by municipalities), and information was gathered on the current efforts by NSOs and disaster management agencies to coordinate their work towards harmonized data systems that make the best possible use of existing data.

It will be important for the Expert Group to continue to develop clear recommendations on integrating baseline statistics with information on disasters to improve the use of baseline statistics for developing improved indicators, appropriately, aligned to the relevant context, to inform integrated disaster risk reduction policies. One of the most potentially valuable tools for achieving this kind of integration is geo-referencing data and ustilizing GIS tools (see section 3.3).

3.2 Classifying Disaster Hazard Types

The Expert Group has discussed a distinction between single-hazard and cascading multiple hazard events and whether there is a need to classify impacts from cascading multi-hazard events in order to capture the full extent of impacts and to avoid double-counting of disasters.

Three out of the four pilot countries reported only single hazard events, including events where different specific hazard types (e.g. flood or earthquake and landslide) existed in the type of linked cascading manner that was discussed by the Expert Group. In these cases, impacts statistics are attributed to the main "source event", meaning the original hazard, e.g. a flood that initiated impacts and, potentially, a cascade into other hazards like landslides. Indonesia was the only exceptional case whereby the classification system utilized in the national disaster loss and damages database (Data Dan Informasi Bencana Indonesia, or DIBI) includes two examples of cascading multi-hazard events (see analysis section for Indonesia).

Generally, applying the IRDR Peril and hazard glossary, as recommended by the Expert Group, seemed to work well, with no major discrepancies found with respect to statistics held by the national agencies in terms of terminology or definitions, as long as the international compilations are aggregated to the hazard "family" level in the IRDR classification utilized for the purpose of pilot cross-country compilations.[3] For the most part, statistics can also be reported at the "main event" level in the IRDR classification, i.e. a flood instead of a "meteorological hazard", but it is not clearly evident whether the main event terminologies are always consistent, especially for meteorological hazards, e.g. for convective storm and tropical cyclone[4]. Also, notes provided by Bangladesh identified two additional hazard types: waterlogging and salinity[5], which are important in the Bangladesh statistics but not apparently covered by the IRDR Peril and Hazard Glossary. Incidentally, during the period of this study, UNISDR has announced a review of the IRDR Peril and Hazard Glossary by OEIWG for the purpose of monitoring Sendai Framework targets and is collecting comments from members and stakeholders.

Returning to the issue of cascading multi-hazard events, Indonesia is the exception that proves the rule because included in the descriptions of the two cases of multi-hazard events is the indication of the "source" hazard (i.e. Tsunami or flood) as is indicated for the other countries. Particularly if statistics are compiled at the hazard "Family" level, the difference becomes irrelevant because either way the hazard category for each event could be classified the same way (see descriptions in the Indonesia analysis section). Therefore, for the purposes of an internationally comparable compilation of a basic range of statistics, countries do not necessarily need to standardize their classifications or definitions of hazard types, as long as the statistics for individual events (including multi-hazard events) can be harmonized at the IRDR hazard Family level (or equivalent level of classes or terminology as adopted by OEIWG).

3.3 Hazard Exposure & the Geospatial Platform

A geographic information system (GIS) integrated to a database management system (DBMS) is a good choice as a basic IT platform for storing disaster-related data and for dissemination purposes (i.e. interactive maps). Information on exposure to natural hazards are commonly developed using GIS, and as hazard or risk maps, by disaster management agencies from across the region. Geo-referencing data collection for other types of information is also becoming a common practice.

GIS is also increasingly used by national statistical offices, either for data collection or dissemination, starting with population and agriculture censuses. For this project, we have processed statistics (converted into .dbf tables, a

[3] http://www.irdrinternational.org/wp-content/uploads/2014/04/IRDR_DATA-Project-Report-No.-1.pdf

[4] The Philippines compilations refer only to tropical cyclones whereas Bangladesh statistics maintain a distinction between the two; it is not obvious if there is a consistent and relevant difference between the hazard definitions as applied in practice in these countries.

5 Waterlogging: deterioration of drainage condition in a number of southern coastal rivers leading to temporary to permanent inundation of floodplains along those rivers, causing enormous difficulties towards maintaining livelihoods and disrupting land-based productive system including agricultural crops; Salinity: Water and soil salinity are hazards affecting different uses of water including drinking, household, irrigation, fisheries, and ecosystem functioning.

database format read by DBMS, GIS and spreadsheets) and we've made special requests for additional geospatial data from relevant agencies in the pilot countries (or to the Secretariat for the Pacific Community in the case of Fiji). We used QGIS, a free and open source software, to produce illustrations and new estimations and for geographical analyses shown in the report[6].

International geographical databases from where data relevant to DRR in the Asia Pacific Region can be freely downloaded include:

FAO Geonetwork	http://www.fao.org/geonetwork
UN OCHA (Office for the Coordination of Humanitarian Affairs):	https://data.hdx.rwlabs.org/organization/ocha-roap
ICIMOD International Centre for Integrated Mountain Development,Regional Database System	http://rds.icimod.org/
ISCGM International Steering Committee for Global Mapping	http://iscgm.org/aboutus/disaster.html
OpenQuake	https://platform.openquake.org/layers/oqplatform:ghec_viewer_measure
PDC Pacific Disaster Centre	http://atlas.pdc.org/atlas/
PRIS Pacific Risk Information System	http://52.64.9.136/layers/?limit=100&offset=0
WFP Geonode World Food Programme	http://geonode.wfp.org/layers/?limit=10&offset=0

Exposure to natural hazards can be assessed as areas assigned with a probability of hazard due to historic prevalence and information from monitoring networks and scientific models. The methods for determining exposure, including thresholds for determining low to moderate to high levels of exposures to hazards differ across countries. Disaster management agencies within the countries have the best adapted knowledge and experience for monitoring the relevant data and developing their own national or regional guidelines for defining the relative extent of exposure. In general, statistics on hazard exposure appear to be among the most well-developed of the disaster-related statistics described in the DRSF.

Integration of statistics through Geographic Information Systems (GIS) is one of the key pieces for DRSF implementation and there are relatively simple and inexpensive methods to integrate hazard exposure information produced by the disaster management agencies with demographic statistics and data on built-up areas using existing data.

Sophisticated methods are already used and well-known by disaster management agencies as part of the precise operational data needed for emergency response to a disaster event and for data dissemination. For statistics purposes, and specifically for indicators to inform disaster risk prevention and management policies, the data demands for GIS integration can focus on more aggregated statistics to produce reports for local levels as well as from the national perspective. It is useful to keep in mind that the level of precise detail and timeliness of data are

[6] Similar application can be developed with other commercial or free advanced GIS software packages.

different for the purposes of a basic range of statistics for disaster risk reduction policy as compared to emergency response and impacts assessment.

Geographic information on hazard exposure is important for developing indicators that show the impacts of disaster in comparable terms that are calculated in proportion to the relevant populations or exposed areas. Hazard exposure (along with basic statistics on population, infrastructure, land cover and economy activity) is one of the core components of the "baseline statistics" that are needed in order to calculate the ratio indicators under discussion by OEIWG and in the context of SDGs. For example, indicators under discussion for Sendai Framework and SDGs for the affected populations are proposed with respect to a baseline (denominator) population – i.e. Number of affected people *per 100,000*. There are basically two possibilities for the scope of measurement of this denominator, each with a different and useful analytical interpretation. First is to consider the general population within the country or relevant administrative area (region or municipality). The second is to estimate and analyse specifically the population within the geographic area exposed to the relevant natural hazards. The approach for this study was to make some pilot estimates for population and other relevant variables in areas exposed to natural hazards. The pilot study started by using the most accessible and publically available data sets as a means for simply demonstrating what is possible now for countries, including for less developed cases where use of GIS and accessing basic datasets for disaster risk reduction is relatively new.

Hazard exposure is a combination of natural phenomena and the ways and degrees to which the human population and built-up areas are located in hazardous areas. In the event of a flood, for example, the size of the exposed population depends on whether human settlements are close to the river or further away or at higher ground. Population data by municipalities may be not sufficient to assess risk according to these more detailed criteria.

Thus, the more detailed the geographic level of the data (e.g. population according to census sampling units, urban blocks, villages or even isolated houses or farms) the greater the potential value for risk assessment. In absence of such data directly from the primary sources, estimations can be done by modelling (downscaling) population census data by regions to maps of built-up areas. Recent global maps of buildings allow doing such estimation of population distribution within municipalities and some experimental work to redistribute population data to a gridded and more detailed layer in GIS was conducted for this pilot study in order to provide inputs for the Expert Group to consider for improving methods and availability of statistics on hazard exposure for all countries in the region.

An example of integration of geographic and statistical data is given here to illustrate what can be done with limited time and utilizing publically available data and free software. This case study uses the example of a breakdown of population census by buildings for an assessment of people exposed to natural hazards in Bangladesh.

Application of GIS methods to assess buildings and population in hazard perimeters carried out with statistics and data from Bangladesh.

Population census results are generally displayed by municipalities, districts or regions. More and more data are recorded at the municipal level, but it is far from being the general case, in particular in rural areas. In the case of Bangladesh, population data and geographic files of administrative boundaries (shapefiles) can be easily accessed from the Redatam website of the national bureau of statistics (BBS) by districts (Zila) and sub-districts (Upzila) and at the most detailed level (municipalities, wards, unions, villages) as .pdf reports.

In the short period devoted to the DRSF test, it was not possible to access the GIS official hazard exposure data[7] (provided on the web as maps in .pdf format only) but it was possible to download a GIS file of Bangladesh Flood Prone Areas from the World Food Programme website.[8] For the test, the Global Urban Footprint data used were aggregations of native 12m x 12 m data by pixels of circa 77m x 77 m. Simply computing an average value of Zila population by Zila GUF pixels would have limited interest as long as the density of population in cities is by far more important than in villages, not to speak of dispersed habitat. Technically, the solution used is based on smoothing GUF data which enhances the relative value of agglomerations as compared to the countryside. From the produced digital maps of built areas and population in areas prone to flood risk statistics by country, regions (Zila), district (Upzila), municipality etc. can be easily extracted with GIS tools. The test carried out is a second best in the case of Bangladesh where detailed population census data are available (below the municipal level). Quality assessment has been carried out by comparison with municipality data. It shows that in most cases, there is an acceptable match between census data and the estimations derived from Zila statistics and GUF data. The model used should be tuned up to minimise such gaps. Nonetheless, in the case when no such statistics are available, the methodology allows producing quickly comparable estimations useful for DRR assessments.

[7] In fact, the Bangladesh Bureau of Statistics was able to combine official hazard exposure data from the Ministry of Disaster Reduction and Management with population data from the census at the level of census block units (PSU) in order to design a sampling frame for an Impacts of Climate Change on Human Life (ICCHL) household survey: http://www.bbs.gov.bd/WebTestApplication/userfiles/Image/National%20Account%20Wing/Disaster_Climate/Disaster_Climate_Statistics%2015.pdf,

[8] http://geonode.wfp.org/layers/geonode%3Abgd_nhr_floodproneareas_dfo, Data Source: Dartmouth Flood Observatory

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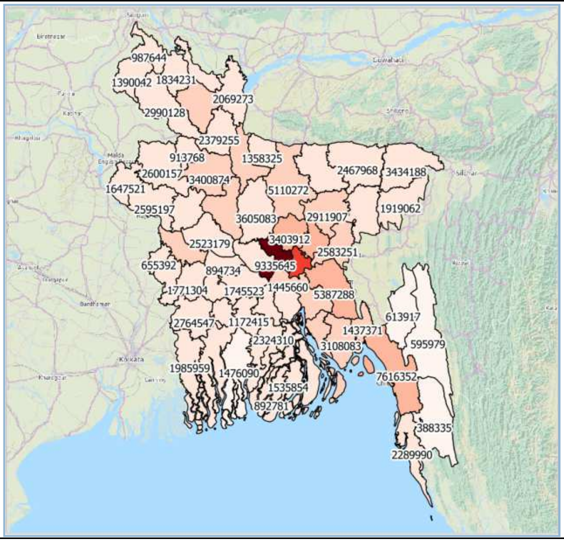
<td>
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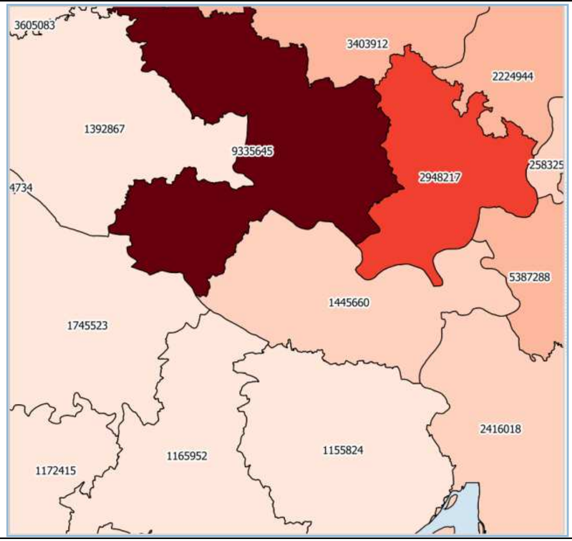
<td>
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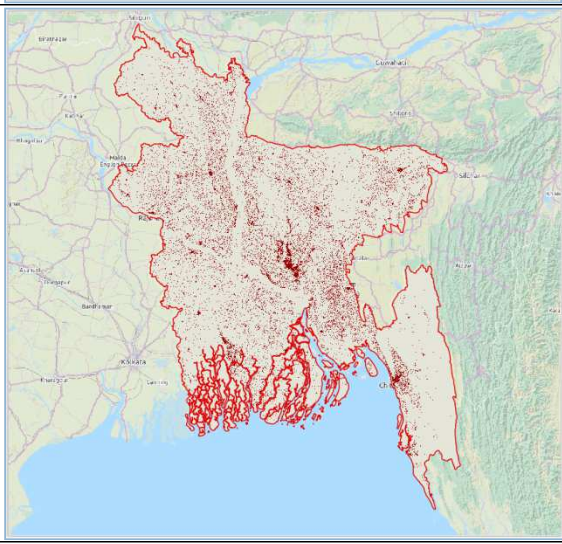
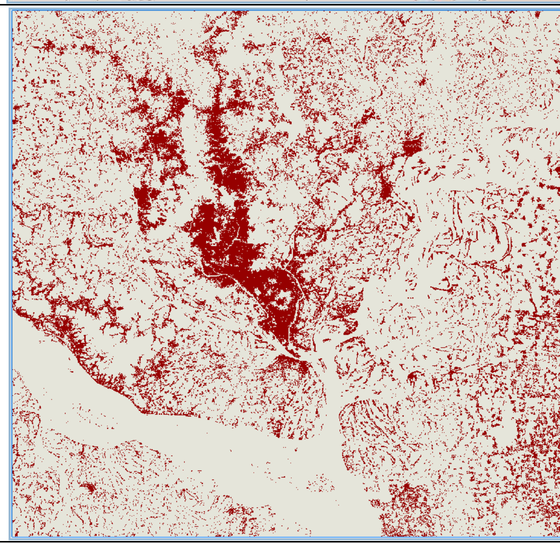
<td></td>
<td></td>
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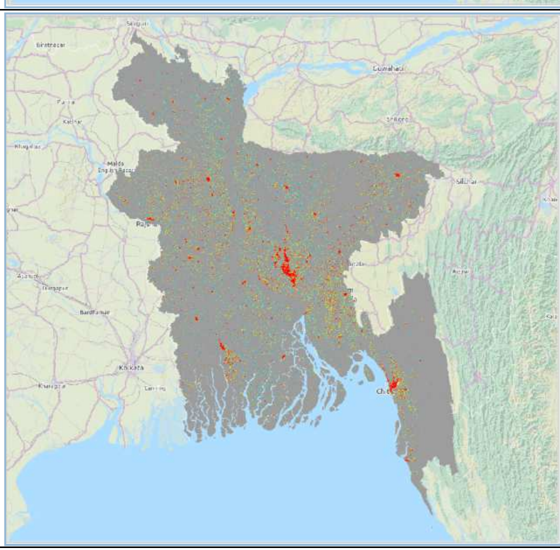
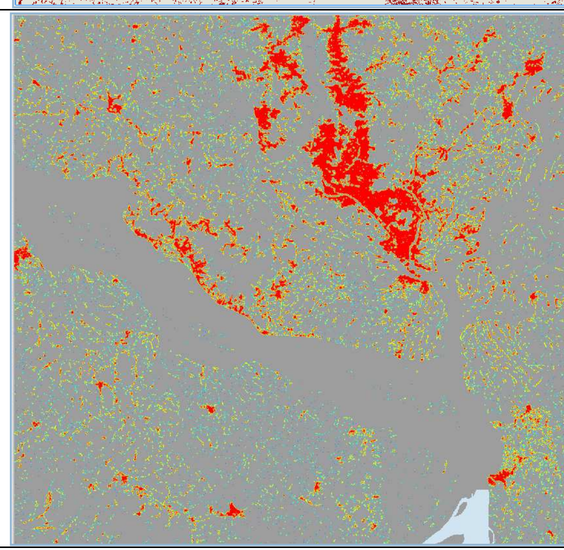
<td></td>
<td></td>
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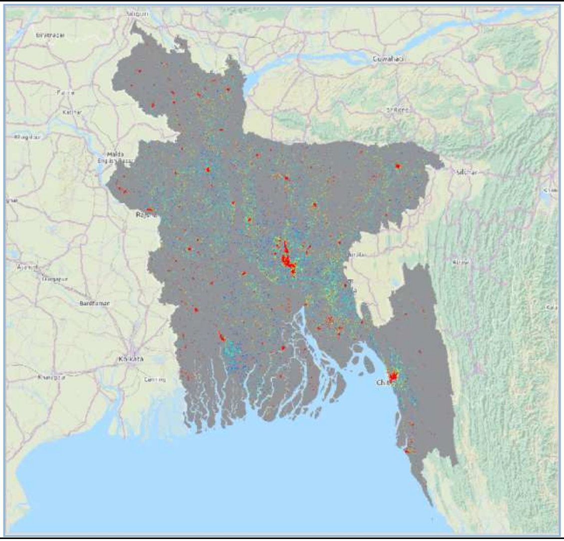
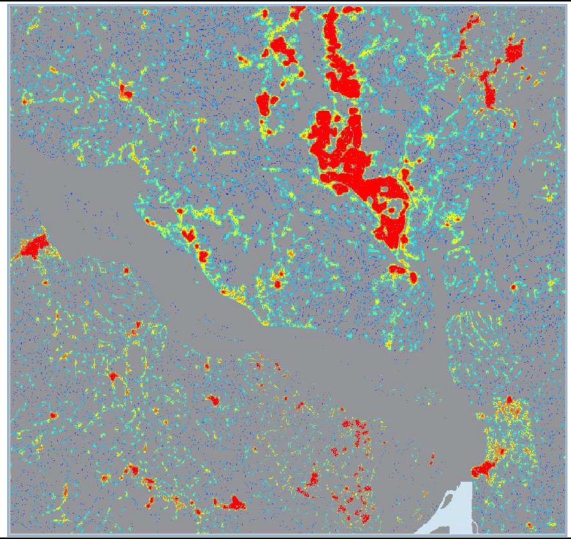
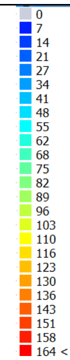
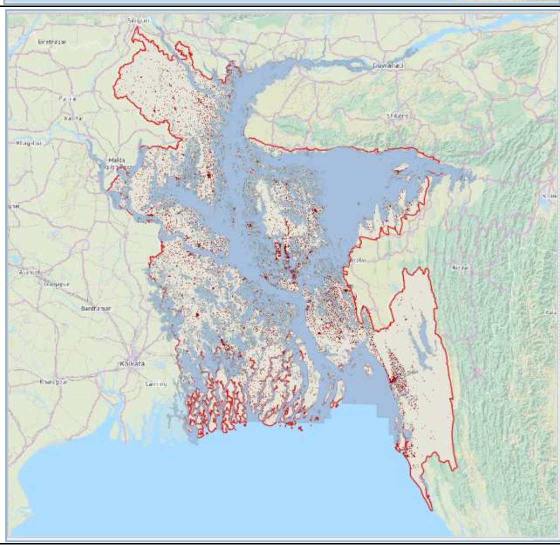
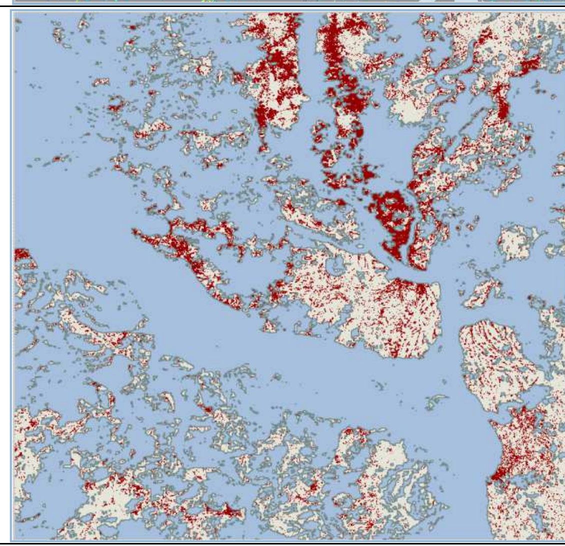
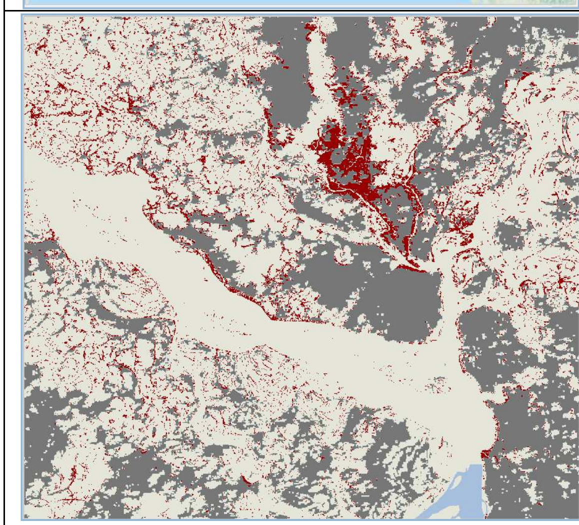
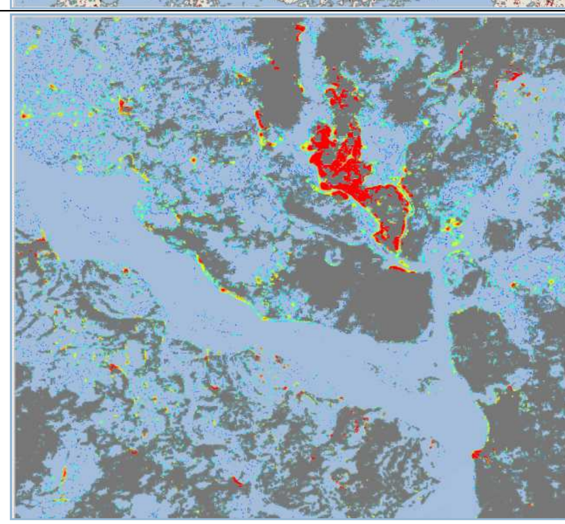
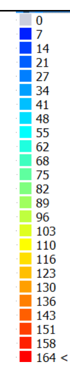
		 **People by GUF pixel (based on Zila statistics)**
		**Flood prone areas (source : WFP Geonode)**
 **Built areas at risk of flood (in red)**	 **Population at risk of flood (estimation per GUF pixel)**	 **People at risk per pixel**

The crucial advantage from the GIS platform is that it can be used to integrate with any other statistics available with geographic referencing. In this case study, we used population data by Zila from the Bangladesh census along with a global map of built-up areas, called the Global Urban Footprint (GUF 2012), which is available by courtesy of DLR, the German Aerospace Agency. With the processing toolbox of the free downloadable GIS software called QGIS[9], the GUF data were used to resample Zila-base population data down to the more detailed level of a 77m x 77m grid and then to estimate population in the Flood Prone Areas of WFP.

Further work is proposed to validate and further improve the methods for integrating these two types of data and also to consider integrating other types of geo-referenced statistis, including land cover and data location of critical or other certain types of infrastucture (where available). By combining data available from satellite images with population and other relevant social and economic statistics, it is possible to produce detailed statistical information on hazard exposure and the risks, which can be used for sustainable policy development analyses at the local and national levels of government.

This experimental work for the DRSF pilot study is ongoing. The results shown in this section are undergoing further validation and the methodology is being tested for other pilot countries as part of the next round of this study. Moreover, all results and methods are shared with focal point agencies in the pilot countries as an example for their use and for further improvements to the methods.

An addendum presents more detailed methodological explanations of methodologies and other GIS tests carried out in the context of the pilot study.

3.3 Affected Population

A number of key variables relevant for assessing affected population are available in the countries and were reported to the Secretariat from historical disasters. Out of approximately seven categories for the affected population statistics mentioned in current draft guidance from UNISDR for monitoring of the target on affected population (Target B-1)[10], at least two of the variables could be provided consistently across events, countries and over time: (1.1.1), i.e.: deaths or missing and (1.1.2) injuries or illnesses.

The Expert Group should further examine the issue of availability and also international comparability of a basic range of statistics for producing affected population indicators, in order to monitor the proposed indicators for monitoring the Sendai Framework and Sustainable Development goals.

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[9] Similar application can be developed with other commercial or free GIS software packages with advanced processing capacities.

[10] According to draft guidance from UNISDR, number of affected persons should "pertain to numbers of people injured or ill, evacuated, relocated, whose houses were damaged or destroyed, and number of people who received food aid due to hazardous events."

Based on the results from this pilot study, the variable on evacuations and/or displacement requires some particular attention because scopes of measurement and availability of figures differ across countries and events and according to the various types of displacement (temporary, permanent, voluntary, managed, etc). Data on evacuations from the historical hazards were available for Indonesia, Fiji and Philippines, but not in Bangladesh, and further study is needed on how current data collection instruments in countries could produce numbers that are comparable across the countries and to summarize across events and for different hazard types. Factors affecting the scope of measurement (i.e. what populations are counted) and that seem to vary in the current statistics available from the countries for measuring evacuations or displacement include:

- The period of evacuation (e.g. permanent relocation versus a temporary and short-term evactuaion) and
- Whether or not evacuations were voluntary and/or self-funded or legally required and/or supported by government or other sources of aid.

Food aid and counts of individuals with damaged houses are mentioned in the UNISDR proposal for an indicator for Target B-1 (affected population per 100,000 persons) but were not evaluated in this round of the study (thus is it is suggested these items be taken up as part of a 2nd phase of study). In principle, statistics on food aid or other types of government assistance could be derived from the administrative records or registration systems from these programmes. In theory, these statistics could also be disaggregated by social categories (age, gender, etc.) as much as this information is (or could be) collected though the registration systems. But, these practices for data compilation and indicators calculation have not yet been standardized or systematically coordinated across responsible government agencies in many countries and the utilization of this type of administrative data to produce statistics on affected populations from disasters has (in many cases) not yet been introduced for these registration systems. Thus, there is a need to introduce and advocate for the idea of utilizing data collected from disaster response and recovery for the secondary purpose, after the emergency period, of producing disaggregated statistics. Moreover, integration of social and demographic information related to disaster relief and recovery could be one of the major opportunities for improving availability of statistics from existing data sources in countries, particularly for monitoring targets related to the affected population.

At this point, we arrive at the proposed basic affected population table (see Table 2), measured in number of individuals, but with a need for further study of opportunities to improve availability or comparability for most of the variables.

1.1	Human, affected population (total)
1.1.1	Deaths or missing
1.1.1.1	Deaths
1.1.1.2	Missing
1.1.2	Injured or ill
1.1.2.1	Injured

1.1.2.2	III
1.1.3	Evacuated, relocated or displaced
1.1.5	Houses damaged or destroyed
1.1.6	In need of food aid
1.1.7	Otherwise affected
1.1.7.1	Voluntary evacuations
	Multiple counts, individuals (minus)

Table 2: Basic variables of Affected Population

3.4 Disaggregation of affected populations by social categories groups

The Expert Group advised compilers, where possible, to produce disaggregated statistics of human impact statistics according to social groups, with a focus on vulnerable groups. There is a strong and clear relevance to disaster risk reduction policy for having information not only the affected and at risk populations on aggregate, but also specific information on vulnerable populations (such as children and disabled populations). This recommendation recalls the advice of the Commission, which in Resolution 70/3, emphasized the importance of disaggregated statistics and the need for evidence-based policies in support of the most vulnerable groups.

The participating countries in the pilot test were asked to compile affected population statistics according to age groups, gender, urban and rural residents, persons with disabilities, and income poor.

Due to lack of available data, statistics on affected population variables by poverty status or by disability were not submitted through this initial round of pilot testing and it is suggested that these elements be considered further in a 2nd phase of this study. Several alternatives for estimating numbers or shares of individuals affected could be assessed through further research of current practices or experimentation with estimation based on integration with existing background statistics from surveys or from administrative records.

An approach used in Bangladesh, in 2015, was to conduct a household-based survey of hazard-prone areas in the country[11] to collect information about how the population affected by natural hazards and disasters and by climate change. The release of results from this survey, which was the first of its kind in Bangladesh, attracted a lot of interest and users of these statistics. This example of integrating the outputs from a survey with baseline information on hazard exposure could be replicated in other countries to greatly expand the availability of statistics disaggregated according to any number of relevant social group categories.

C2a1 - Age groups				**TOTAL**
0-4	5-60	60+	Unidentified	
12	95	18	10	**135**

Table 3: Number of deaths in Philippines from disasters in 2015

[11] Impact of Climate Change on Human Life Survey, Bangladesh Bureau of Statistics

In some cases data by the social groups are already available but may be incomplete, e.g. if the gender could not be identified for all of the dead or evacuated or otherwise affected individuals across disaster events. In these cases, the information that is available is still useful and need not be discarded. The solution, as demonstrated by the Philippines Statistics Authority, is to introduce a column or category in the tables for the undetermined portion of the affected people. By including the unidentified category, the sum of the grouping is equal to the known total (see example in Table 3).

3.5 Economic loss & Impacts to Critical Infrastructure

The indicator proposed by UNISDR for target C1 is: "Direct economic loss due to hazardous events in relation to global gross domestic product." According to the November, 2015, UNISDR report [12] for Sendai Target C, there is a "lack of uniform approach" to measurement in countries that "is reflected in inconsistencies in economic losses currently reported by both national and international data sources. In the cases these estimates are present it is most often difficult to know which elements of loss were taken into consideration and the methodology, criteria and parameters used for estimation." The UNISDR report advises for developing methodology for this indicator by studying and making use of existing data. In this initial phase of pilot testing, we make use of existing data for this indicator that could be collected from the four pilot countries.

One of the most important economic and social impacts of disasters reported in tables from the pilot countries is impacts to agriculture. Impacts are reported in terms of damages to agriculture land area (measured in hectares), affected crops (measured in tonnes) and the monetary equivalent of the damages (costs of replacement or recovery of the lost assets and works–in-progress). For agricultural assets, impacts can be first observed and recorded in "physical terms" (i.e hectares and tonnes), and then evaluated in terms of monetary value of the direct impacts to assets as a 2nd step. For other types of natural resources, e.g. impacts on forests, including mangroves, the statistics were available for Bangladesh and in the Philippines and recorded at first in terms of hectares and by sub-national regions. In principle, monetary valuations of direct impacts to assets can be done consistently with international standards for economic statistics (the System of National Accounts, SNA) for all economic assets, but not for other types of assets or values beyond the scope of the SNA asset boundary. However, in practice, many different types of sources, including official studies conducted by government ministries and Post-Disaster Needs Assessment Surveys (PNDAs) are used to estimate economic costs of disasters and it is not clear from this phase of the pilot study whether there are comparable valuations of economic costs across countries and across disaster occurrences.

[12] Concept note on Methodology to Estimate Direct Economic Losses from Hazardous Events to Measure the Achievement of Target C of the Sendai Framework for Disaster Risk Reduction: A Technical Review, UNISDR, November 2015

The UNISDR paper recommends multiple indicators for measurement of economic loss (which is equivalent to what in the DRSF is called: direct impacts to economic assets). The OEIWG (see foot note 10) is considering to value economic losses related to the following set of categories: agriculture, houses and critical infrastructure, cultural heritage, industrial facilities, commercial facilities. The actual categories of assets that could be collected from the pilot countries for direct impacts (at least in physical terms) are listed in Table 4.

According to the compilations from this study, the component of economic loss in the Sendai Framework, which also features as an SDG indicator, is likely to one of the most challenging measurement areas for disaster-related statistics and is recommended as one of the topics for further study by the Expert Group. The challenges relate to adopting appropriate and consistent methodology for monetary valuation for direct impacts and also to design a categorization of economic (and other) assets that are fit for purpose for DRR policy monitoring but also, as much as possible, can be made coherent with the existing standard classifications used in economic statistics.

The Sendai Framework and OEIWG have suggested a distinction between Target C on economic loss as compared to Target D: *Substantially reduce disaster damage to critical infrastructure and disruption of basic services, among them health and educational facilities, including through developing their resilience by 2030*. The OEIWG distinction between economic loss and critical infrastructure is founded upon a difference in scope of measurement, with economic loss focussed more on the post-disaster assessments of damages in affected areas while critical infrastructure also defines the notion of "disruption of basic services" resulting from the disaster or during an emergency period.[13]

Disruptions to basic services can be measured in non-monetary terms, e.g. data in physical terms on damages to buildings, roads and other facilities or statistics on temporary closures to the infrastructure responsible for providing basic services. In the current OEIWG proposal, there is also a proposal for a variable on "direct economic loss due to disruptions to basic services." These statistics (i.e. monetary valuations associated with services disruptions) do not seem to be currently available in the countries, but further research could be conducted through a follow-up phase for this study.

In the DRSF, also included within this category of direct materials impacts are damages to critical environment resources, particularly agricultural and forest land but also impacts to other important resources like protected areas and resources like mangrove forests that can provide natural and very efficient support to building resilience. The preliminary results show relatively good availability of statistics (in physical terms) from this round of pilot testing support this notion of 1including environmental assets as one of the components within the framework. However further studies could be used to help reveal more specifically an appropriate scope for min

[13] Examples of basic services include water supply, sanitation, health care, education, housing, and food supply. They also include services provided by critical infrastructure such as electricity, telecommunications, transport, finance or waste management that are needed for all of society to function. *Background paper on Proposed Updated Terminology on Disaster Risk Reduction: A Technical Review by The United Nations Office for Disaster Risk Reduction, August 2015*

recommendations with a respect to a minimum basic range in the DRSF regarding some basic statistics for monitoring the risks and other relationships between disasters and a nation or community's natural wealth and environmental resources.

An objective for these pilot studies is to investigate available data used by the different countries for monitoring the statistics on critical infrastructure. The table below summarises the relevant variables for which statistics on damages (direct impacts) were provided in this round of the pilot tests, at least in physical terms:

	Bangladesh	**Fiji**	**Indonesia**	**Philippines**
Houses/dwellings	√	√	√	√
Hospitals, health facilities	√	√	√	√
Education facilities	√	√	√	√
Religious facilities	√ (temple, mosque)		√ (praying facilities)	
Other critical public administration buildings		√		√
Public monuments		√		
Roads	√	√	√	√
Bridges	√ (Bridges, roads and culverts)	√		√
Transport equipment		√		
Electricity generation facilities		√		
Electricity grids	√	√		
ICT Equipment	√	√		
Dams	√	√		
Water supply infrastructure	√	√		
Water sewage & treatment systems	√ (Water control, sewage & treatment systems)			
Agriculture land, livestock, fish stocks, and managed forests	√	√ (Agricultural and forest land damaged from fires)	√	
Other critical infrastructures	√			

Table 4: Data reporting for direct impacts to critical infrastructures

Pilot countries submitted compilations of data on damaged, partially damaged and destroyed dwellings and other structures. Descriptions, including definitions, for the statistics were provided by the countries and the definitions and use of terminologies vary. Thus, further investigations would also be helpful regarding the scope for measurement within several of the variables or terminologies, particularly ICT equipment and transportation infrastructure.

3.6 Using Post-disaster Needs Assessment Studies (PDNAs) for Producing Statistics on Economic Loss

Results of PDNAs are used to define and guide the undertaking of post-disaster recovery and reconstruction. Particularly when it comes to producing statistics on economic loss in monetary terms, PDNAs aslo have the potential to be a highly valuable source of statistical information. However, it is not presently clear whether PDNA studies reliably have the level of methodological comparability across studies to be used for producing aggregate statistics covering multiple events.

Post-disaster needs assessment (PDNA) studies, or related post-disaster assessments of impacts, which typically follow the DALA conceptual methodology are typically conducted after major disasters via collaboration among many government agencies and nvolving experienced international consultants to advise on methodologies. Assessments of economic loss in the PDNAs includes a process of evaluation which goes beyond statistical compilations. However, statistics can be developed on the basis of the various calculations and evaluations in order to produce a collection of common indicators on disaster impacts.

The general PDNA (or DALA) methodology is described as a bottom-up approach. The bottom-up approach means that data is collected sector by sector, e.g. through sample surveys and other observations collected from the field, and then aggregated upwards to calculate the total implications for recovery. Usually, sample surveys are conducted for affected “sectors” mainly to supplement and fill in gaps of data that couldn’t be captured from reports from the disaster emergency response. The World Bank advocates that all the DALA “sectors” be included in a PDNA. However, in some cases, baseline data or expertise is insufficient for the analysis of all the components so that different historical studies may have different scopes in terms of the aggregate measures for economic loss. Further study across PDNAs is recommended to improve the understanding of the components of economic loss that are the most consistently incorporated into the PDNA results.

It is difficult to conclude on issues of comparability and compatibility among PDNA reports and in relation to DRSF because there are measurement issues that are not very specifically explained in the DALA or PDNA literature, currently managed by the World Bank’s Global Facility for Disaster Risk Reduction and Recovery (GFDRR). For example, in the PDNAs for the 2016 Cyclone Winston in Fiji and the 2013 Typhoon Yolanda (Haiyan) in the Philippines, statistics are presented both on damages (in monetary terms) to structures such as dwellings and hospitals and "reconstruction costs” for the housing and health sectors. These values represent measurements of different concepts. The values for reconstruction costs tend to be several orders of magnitude different (see table 1) from the valuation of damages. However, the reports lack precise details on the differences in valuation methods used in practice for calculating these two different indicators. According to investigation of the case of the PDNA for Tropical Cyclone Winston, it was revealed that damages estimates tend to be very rough approximations of economic losses made according to the initial observations of damages in physical terms. Reconstruction costs, however, may be calculated based on observations and more detailed information on actual transactions or reconstruction activities. At least for this example of Cyclone Winston, the damages estimates may not sufficiently meet quality criteria for official statics, but the methods for reconstruction costs estimates could be developed as a more suitable alternative for estimating direct economic impacts in line with the current standards for economic statistics (e.g. national accounts).

	mio USD	**DAMAGES**	**RECONSTUCTION COSTS**
Typhoon Yolanda	**Infrastucture**	201.264	592.221
	social	902.601	902.601
	productive	513.051	513.051
	cross-sectoral	64.449	189.630
	TOTAL	**1681.365**	**2197.503**
Tropical Cyclone Winston	**Infrastucture**	30.080	24.464
	transport	2.794	2.414
	communication	0.559	0.000
	electricity	2.107	2.597
	water	1.443	1.846
	gov't building	0.207	0.207
	housing	22.971	17.400
	social	3.132	2.486
	health	0.247	0.212
	education	2.885	2.274
	productive	24.672	27.555
	agriculture	1.599	1.286
	foresty	3.064	3.371
	hotels & restaurants	19.600	21.560
	commerce	0.409	0.000
	TOTAL	**59.549**	**70.566**

Table 5: Comparison of economic losses caused by tropical cyclone Winston and Typhoon Yolanda

The current recommendation in the draft DRSF is to value (where relevant) damages (or the "direct impacts to infrastructure") according to the replacement costs. Thus the statistics from PDNAs on reconstruction costs, would be applicable for measuring the component of direct economic loss from disasters in an official statistics context, particularly if these outputs (meaning statistical tables on reconstructions costs) were accompanied by complete metadata documentation on definitions and data sources used (e.g. survey or other records).

Reconstruction costs are reported in PDNA studies according to "sectors" (e.g. productive and social sectors). The use of this sectoral categorization appears to be a well-established concept within the PDNAs as it is consistently applied across many of the studies. However, again, the precise details on definitions use for the sector classifications is lacking in the reports. A more detailed description of the classifications and a mapping or correspondence table to the classification systems used in the national accounts is needed in order to compare economic impacts across events and across countries and to make a proportionate analysis in relation to the affected economy under normal circumstances.

There is no mention of sectoral breakdowns for monitoring in the Sendai Framework. Instead, the Sendai Framework emphasizes the need to assess the "affected population" and the direct impacts to "critical infrastructure" and "disruptions to basic services". Concepts like "critical infrastructure" could be incorporated into the language of the PDNAS, which cover a much broader coverage of direct impacts, so that statistics directly relevant to Sendai Framework monitoring could be derived from the reports. The DRSF could be utilized as a tool to help bridge and adapt between the post disaster economic assessments and producing official statistics to meet a broader set of needs, including monitoring of Sendai Framework targets.

Post disaster needs assessments are usually not conducted after every disaster event. They are conducted wherever the authorities consider such reports necessary, which is typically only the case for relatively large disaster events. Statistics on economic impacts for small scale events will need to be covered from other means. Although designed for a different purpose, the PDNAs are potentially a crucial source of statistical information for the larger events.

Tropical Cyclone Evan

In this pilot study, we also took the opportunity to review a case where two Post-disaster Needs Assessment (PDNA) reports were produced for a single disaster event (Cyclone Evan) for 2 countries: Fiji and Samoa. The reports were produced separately by the World Bank's Global Facility for Disaster Reduction and Recovery (GFDRR). On 16-17 December 2012, tropical cyclone Evan caused severe damage to Northern Vanua Levu and Western Viti Levu regions of Fiji. In the same month, Evan hit Samoa, resulting in significant damage and losses there as well.

In addition to a typical DALA-based assessment methodological approach, the Samoa case also utilized the social impact assessment concept(SIA) in its report. SIA methodology seeks to measure impacts related to social cohesion, social relationships and governance.

	Fiji	Samoa
Population	862,233	194,320
Annual Growth Rate in the Population (percent)	0.5	0.6
Life Expectancy	65.75	72.98
Population in the Urban areas (percent)	52.90	19.3
GDP per capita (USD)	4,375.41	4,212.36
Human Development Index	0.688	0.702

Table 2: Background statistics of Fiji and Samoa

Samoa is exposed to numerous natural hazards, including tropical cyclones, floods and volcanic eruption. Fiji is also prone to frequent natural hazards as well. According to a 2014 World Bank report[14], Fiji suffers high relative annual disaster losses compared to Samoa. Another finding from this report is that infrastructure in the pacific island region (including buildings and crops) of value US $ 112 billion are at risk from natural disasters in general.

TC Evan is considered to be the largest disaster event which took place in both the countries individually in 20 years' time period.

Although the PDNA reports analyse mostly losses and damages[15], a lot of other relevant information is available from the reports, as discussed for comparison below.

Affected population

Although there were no causalities reported, many people were affected either directly or indirectly. In Fiji, more than half a million people, or nearly 60 percent of the total population was affected[16]. The highest shares of affected population, i.e. 52 percent belonged to the Northern Division, followed by the Western Division [17](38 percent) and the Central and Eastern divisions (23 percent). In Samoa, 606 households, or approximately 4,242 people, needed financial and technical assistance after Cyclone Evan.

For the Fiji study, the affected population was evaluated according to the standard recommendation from the DALA methodology, which has 3 possible categories of consequences, as follows:

(i) Primary Affected – includes those persons living in the affected areas whose assets have been destroyed; as well as dead and ill persons.

(ii) Secondary Affected – includes persons living in the affected area that have sustained losses in production and income.

(iii) Tertiary Affected – those persons living outside of the affected areas that are sustaining higher costs of services as a result of the cyclone (Transport, Water, Sanitation and Electricity).

Clearly, the same households or individuals may be affected by more than one of these categories, so presumably counts of total affected population is a count of individuals experiencing one or more of these types of impacts (the primary affected group seems to consistent with the counts of directly affected as described in DRSF and in the current OEIWG materials).

During the evaluation of the Evan post-disaster situation by UN Office of Humanitarian Affairs, it was observed that there were 1,202 and 4,500 people in the evacuation centres of Fiji and Samoa on the 28th of December 2012, more than 10 days after the cyclone made landfall. The following week, on 3rd of January 2013, 281 people and 810 people remained in evacuation centres in Fiji and Samoa respectively.

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[14] http://www.worldbank.org/content/dam/Worldbank/Climate%20change%20and%20natural%20disasters.pdf

[15] According to GFDRR, damage refers to the total or partial destruction of assets and losses to the changes caused in the economic flows of income

[16] The magnitude of the effect was divided into three categories: people dead or ill and assets damaged fall under the primary category which accounts for 8%, secondary category 26% covered people living in affected area that have sustained losses in production and income and indirect disruptions make up 27% of tertiary category

[17] Western division(319,611) is densely populated than the Northern division(135,961) Reference : http://www.citypopulation.de/Fiji.html

The Samoa report cited a number of interesting points regarding vulnerable populations, noting, for example, that "subsistence livelihoods and low-income households have been heavily impacted by the storm and will require support in order to restore and maintain livelihoods".

"Vulnerable groups have been impacted, and new vulnerabilities have been created. The elderly, children, and people with disabilities were recognized as the most vulnerable, but were well taken care of by families and communities. A less visible group of individuals and families that are outside of community structures emerged as particularly vulnerable in disaster contexts. In addition, a new group of vulnerable people has been created due to severely damaged or destroyed homes"

Material impacts & Economic loss

In the DRSF, material impacts refer to the direct damages to fixed assets, such as dwellings and critical infrastructure. Tropical Cyclone Evan caused different effects amongst the different DALA "sectors". The most intensively affected sectors were transport, agriculture, the environment, electricity, and tourism in Samoa.

	Fiji: Value of Damages (USD)	Fiji: share of sector in total damages and losses (%)	Samoa: Value of Damages (USD)	Samoa: share of sector in total damages and losses (%)
Agriculture	3,705,866	19.6	1,960,038	1.3534434
Forestry	3,479,726	3.3		
Environment			6,493,900	15.618507
Hotels & Restaurants	22,256,000	35.5		
Tourism			11,069	10.729836
Transport	3,172,393	5.2	26,128,885	18.993054
Housing	26,083,528	26.1	15,325,179	9.3206039
Health	280,724	0.5	1,442,116	11.300753
Education	3,275,845	3.1	2,885,951	1.6876604
Total	121,529,145		94,195,910	

Table 3: Selected indicators for comparison of damage and losses in different sectors across the countries Fiji and Samoa due to the tropical cyclone Evan (approximate USD equivalent)

From Table 3, it can be observed that some comparisons between impacts from Cyclone Evan to the two countries can be made, provided that coherence in the monetary valuation techniques can be confirmed. There are also some cases where the measurements are similar but caution is required to avoid mixing different concepts about or between the sectors.

Although Table 3 shows that the total values of damages from Cyclone Evan were similar in Fiji and Samoa, the shares of economic impacts, including the value of losses (indirect impacts) reveals significant differences between the two. For example, assessment of impacts to tourism in Samoa were conducted by reviewing statistics on tourism activity before and after Cyclone Evan. In the case of Fiji, the report focussed on recovery costs associated with direct damages to hotels and restaurants costs for the brief (less than a week) period where about 41% of hotels were closed and a 24-hour closure of the international airport in Nadi. Since Cyclone Evan struck during Fiji's tourism low season, the impacts to tourism were noted to be relatively lower than they could have been. Yet, the direct impacts (damages) to hotels and restaurants were among the largest at around 35.5% of total damages and losses in the country. In Samoa, the tourism sector absorbed the third largest share of damages and losses (10.7%), next to the impacts to the environment (e.g. forests) and transport. Damages to transport in Fiji were comparably small but the damages to housing were 1.7 times greater in Fiji. Impacts to damages to health sector (e.g. impacts to hospitals) were about 5 times greater in Samoa. Further guidance, and particularly descriptions of the links to the existing standards and classifications for official statistics (i.e. the SNA) would be useful to assist national agencies to better utilize existing data collections associated with the PDNAs for producing indicators to monitor trends and compare impacts across events.

Every disaster event is different and even the same natural hazard incident can have completely different economic impacts for different regions or different economies according to innumerable factors related to the baseline economic situations and the physical nature of the disaster. But, there is now an international demand to produce general indicators on direct economic losses that are comparable across disaster events over time and across countries. Thus, approaches to collecting a basic range of underlying statistics on impacts should be clearly described and implemented. The economic loss and material damages statistics is apparently an area within the basic range of statistics where a lot of further improvements to guidance for comparability could be made.

Medical costs

Medical costs, in principle, fit within the context of direct economic losses. Although possibly less significant in value on aggregate as compared to direct damages to infrastructure, medical costs are important to measure because costs might be directly incurred by the affected household or by insurance or public financing on behalf of households. One of the ways the affected population variables are classified (see Table 2) is injuries or illnesses. In some cases, a distinction between injuries and illnesses was maintained in the statistics, in some cases a distinction could be made between major and minor injuries, and in some cases not.

Systematic means for collecting data on medical costs absorbed by households or by insurance programmes are not in place for disaster statistics purposes. In the Philippines, data reported for this study are limited to "logistical costs", which relate to additional support managed by the Ministry of Health and distributed to areas affected by a disaster. For Bangladesh, medical costs were estimated by region and by hazard type for children aged 0-17, based on the results from a household sample survey: Impacts of Climate Change on Human Life (ICCHL) Survey conducted by the Bangladesh Bureau of Statistics (BBS) in 2015.

Clearer guidance could be developed based on the existing examples from national statistical systems, perhaps in coordination with Ministries of health, insurance agencies, and other potential data sources for producing comparable statistics on direct medical costs. In Asia and Pacific, medicals costs associated with disasters are often absorbed by government insurance programmes, and thus a part of the solution may be closely related to the topic of disaster risk reduction-related expenditure (section 2.1).

4 Selected Analyses of Findings for Individual Countries

4.1 Bangladesh

According to figures reported for the pilot study, 14 million people of Bangladesh are moderately to highly exposed to hydrological or meteorological hazards, such as floods and tropical cyclones. Different types of hazards that involved loss of life and damages and which took place during the period 2005-2015 were documented. Single hazards are classified according to their intensity and magnitude: very large, national scale, medium to large, and local scale events. Overall, 45,270 individual hazards took place during this time period, including 29 very large events and 128 classified as national scale disasters. The statistics do not record whether events involved cascading multiple hazards. The most prevalent hazard is fog, with 40,000+ occurrences. Fog is included in the 2nd level of the hierarchical classification in the IRDR Peril Classification And Hazard Glossary.

Earthquakes are also frequently occurring natural hazards in Bangladesh, with 385 total events happening during the period (although none of them were considered very large scale disasters). The impacts from meteorological hazards, such as convective storms, extreme temperature, and cyclones have been profound and there were 6 very large disasters caused by convective storms during the 10-year period of study. Meteorological hazards are among the most frequent sources of very large scale disasters in Bangladesh, 2nd only to earthquakes. There were also an additional 25 medium scale national disasters and 8 local scale events attributed to convective storms, which is the type of hazard that has to the largest share of large scale disaster events in Bangladesh.

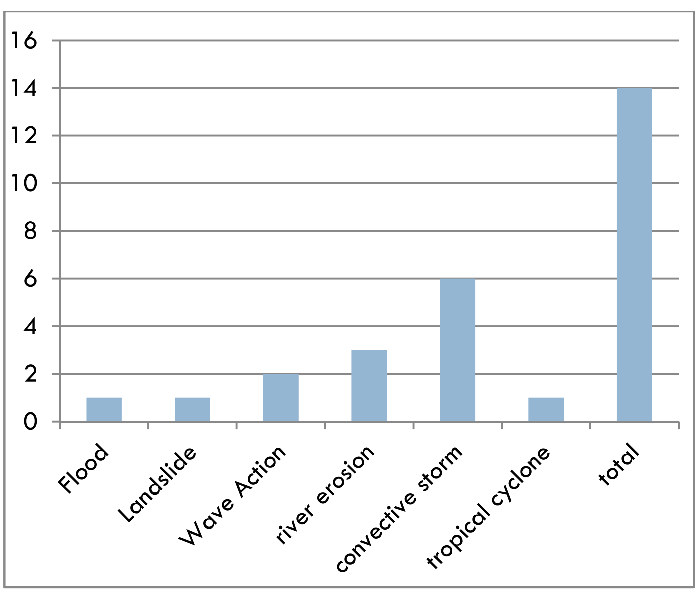


Figure 1: Count of very large disaster events in Bangladesh by Hazard Type, 2005-2015

Earthquakes with an epcenter outside the borders of Bangladesh could have the potential to be felt or experienced within the country. It was the case, to take a different example, that the major 2016 earthquake disaster in Nepal was also experienced to a much lesser but still significant effect in India. The issue of cross-border disaster events, whether caused by earthquakes or other types of hazards, could benefit from some further study or further consideration by the Expert Group for the context of future international compilations of statistics on counts of disaster occurences and their impacts.

Extreme temperature events are also common in Bangladesh, with 333 events reported. Although occurrences have been reported for all regions, extreme temperatures and exposure to other types of meteorological disasters tend to be relatively more confined to smaller geographic areas, with the highest number of cases reported in the regions of Khulna (125) and Rajshahi (119). In contrast, although a less frequent source of disasters, exposure to flood events is spread across the whole of Bangladesh, with all regions having experienced floods during the period. Also, in terms of impacts, hydrological hazards (floods, landslides and wave action) have been the most destructive in Bangladesh (noting that statistics on impacts of earthquakes could not be included in the compilations provided in this round of the study).

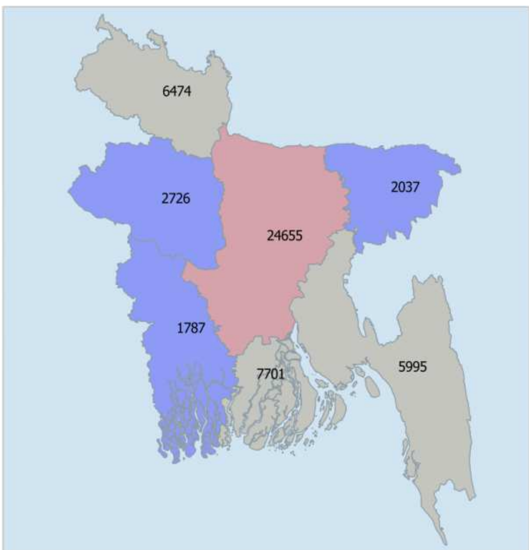


Figure 2: Areas (km2) Moderately or Highly Exposed to Hydrological hazards by Region (hectares)

Two very large cyclones took place in Khulna and Barisal regions. All of the main types of hazards within the hydrological hazards category (flood, landslide, wave action, river erosion and convectional storm) have occurred at some point of time in Bangladesh during the past 5 years, with storms being the most frequent (39).

Injuries and illnesses directly caused by natural hazards were reported across incidents in Bangladesh. The regions with the largest numbers of affected population, in per capita terms, are Khulna and Barisal. Nationwide, nearly 2 million people in Bangladesh were affected by natural hazards through injuries or illness or deaths or missing. Illness is several times more common as direct impacts of disasters compared to injuries. In Barisal, 51 injuries per 100,000 population were recorded over the period from 2000-2015 along with 2700 for illnesses, compared to the average for the other regions of about 26 and 1471 individuals per 100,000 population for injuries and illnesses, respectively.

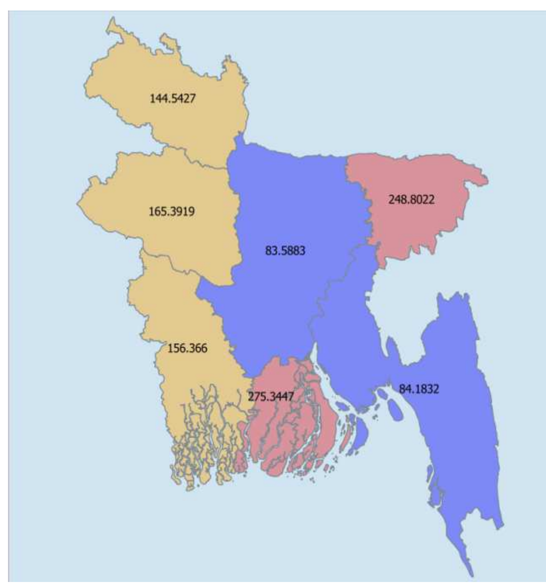


Figure 3: Illnesses Directly Caused by Natural hazards by Region (No. of incidents per 1 million people)

A majority of individuals who were made ill by natural disasters were in Dhaka (affected mainly due to hydrological hazards), reflective of the higher population density in Dhaka.

The national figures for injuries and illnesses directly caused by disaster includes more than 75,000 infant children, 4 years of age or younger. Males are very slightly more likely to be injured or ill as result of a natural hazard as compared to females.

Nearly 3 million dwellings incurred damages in Bangladesh, with the economic costs estimated at over 2 million US dollars, averaging around 100 US dollars in replacement costs per dwelling. The majority of damages to dwellings, accounting for more than 2 million of the incidents, resulted from meteorological hazards.
The region of Barisal has incurred the largest impacts to dwellings, composing about 40% of the national total losses during the past 5 years.

The most economically important types of direct material impacts from disasters are damages to agricultural land and other agricultural goods and assets. The regions with the largest areas of damages to agricultural land (measured in hectares) are Dhaka, Barisal and Rangpur. Overall, nearly 113,578 hectares of land including soil and 47,211 hectares of other natural resources were damaged. Statistics are also available by regions on damages from historical disasters to other natural or cultivated resources are available such as impacts to forests, livestock and fish stocks.

Damages to critical infrastructure nationwide amounted to 3,555 millions of Taka, the equivalent of about 45 million US dollars (USD). Nearly 10,000 kilometers of roads, plus around 4,585 bridges, roads and culverts, have been damaged from floods, river erosion and other hydrological disasters in Bangladesh over the 5 year reporting period. Nearly half a million (567,213) people lost their jobs in all sectors of the labor force, all of which have been attributed to meteorological disasters.

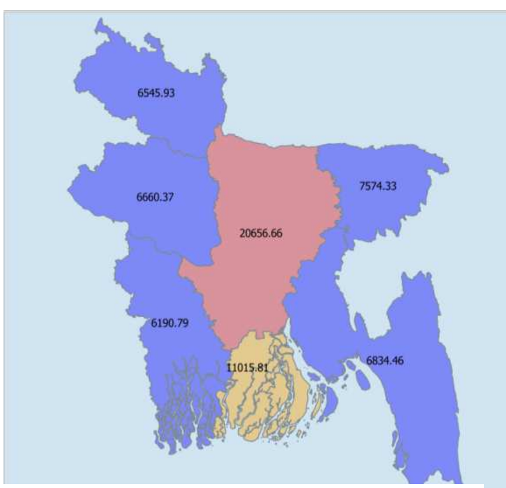


Figure 4: : Economic Cost of Damages to Dwellings by Region

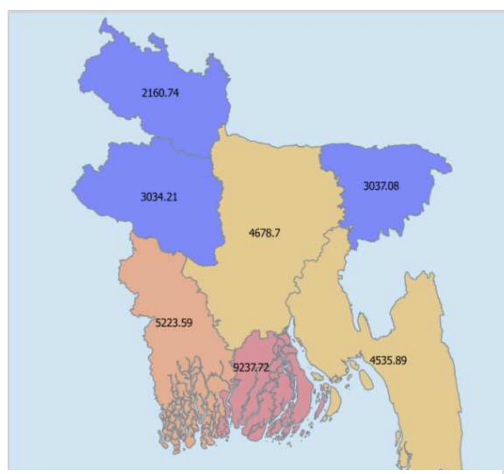


Figure 5: Damages to Agricultural Land by Region (Hectares)

Figure 6: Direct Impacts on Critical Infrastructures by Hazard Types in Bangladesh

2.2 Indonesia

Statistics for Indonesia were extracted from Data Informasi Bencana Indonesia (DIBI))[18], a disaster damages and losses website, managed by the Indonesian Government disaster management agency (BNPB), and supported by UNDP and UNFPA. For this report, we review only a few selected variables on disaster occurrences and affected population, which is only a small selection of the rich data on disasters available for download from DIBI. Our review covers statistics for the time period 2010-2016.

BPS-Statistics Indonesia has been supporting BNPB in supplying basic data for their disaster data base (DIBI), including from the 2010 Census and the 2011 Village Potential (PODES) statistics. This collaboration is ongoing and improvements are being made continuously to the data and to the functions of DIBI. Presently, there are some accessibility challenges due to some functionality constraints in DIBI, but these are being addressed by BNPB as part of an ongoing process to integrate DIBI into a new BNPB data centre.

As noted earlier in this report, each of the 3 pilot countries reviewed for this study utilize a different selection of natural hazards to determine the scope of statistics that are published and that were shared with the Secretariat for the purpose of this study. The hazards included in DIBI are broader in scope and slightly different in organization and terminology as compared to the IRDR Peril Glossary and Hazard Classification. But, with some creative caveats, it is possible to structure the information on disaster occurrences and impacts roughly according to the IRDR "Family Level" in the Peril classification as was done for the other 3 pilot cases:

Earthquake	Geophysical
Earthquake and Tsunami	
Volcano	
Eruption	
Tsunami	
Floods	Hydrological
Floods and Landslides	
Landslides	
Surge	Meteorological
Strong Wind	
Drought	Climatological
Forest Fire	
Industrial Accident	Other
Fire	
Transportation Accident	
Terrorism	
Conflict	

Table 4: List of Hazard Types in DIBI (unofficial translations from Bahasa) and Proposed Relationships with IRDR Family Level Classifications

Because the DIBI list of hazards covers a broader range of types of incidents compared to the other countries, and also incorporates cases of cascading multi-hazard events, this list could be a good benchmark for other countries to study and possibly to adapt (as relevant) for their own national needs.

Indonesia was the only case where statistics are recorded according to cascading multi-hazard types (earthquake and tsunami and floods landslides). This practice can be made coherent with the hazard type classifications in other countries according to the family level groupings by IRDR (see table 4). For example, a flood and landslide event would be classified as a hydrological disaster and the summary statistics on impacts would still be comparable, in

[18] dibi.bnpb.go.id

theory, with the statistics on hydrological disasters as they are recorded in Bangladesh, Fiji and the Philippines since in those cases statistics are usually attribute according to the trigger or source incident (e.g. flood).

In DIBI, counts of occurrences of individual events by hazard types cannot be queried directly without some manual assessment of possible double-counting for cases where hazards have affected multiple regions. A lot of important characteristics of the incident are given with each record in DIBI (date, province affected, etc.) but there are no unique identifiers for individual disaster events.

Based on our attempts to interpret this information we found that Indonesia experienced the following hazards (approximated number of occurrences in parentheses) during the study period of 2010-2016: Geophysical: earthquakes (84) and eruptions (40); hydrological: floods (app. 2800) and landslides (app. 1300); Meteorological: Strong wind (1900), tsunami (2) and surge (112); Climatological: drought (191), forest fire (120) and fire (1200); others: conflict (54) and transportation (193).

Floods are the most frequently occurring disasters and nearly 29 out of 33 Indonesian provinces have experienced flooding. Central Java has been flooded the highest number of times: 420 times in 15 years. East Java experienced floods 413 times. Apart from floods, Central Java is heavily prone to various other disasters as well, such as fire, strong winds and landslides. After floods, landslides (about 1300 incidents) are the most frequently occurring disaster events in Indonesia.

Overall, it is evident from the DIBI statistics that the Java provinces are the most highly exposed to hazards compared to other regions. Riau islands reported no hazards at all whereas Central Sulawesi and West Papua were the least affected in terms of disasters. Earthquakes were reported twice in Central Sulawesi and once in West Papua.

A total of 7709 people were reported dead as a result of disasters, along with 4162 missing, 13341 injured and nearly 1.6 million individuals evacuated due to disasters during the period 2010-2016.

The most impactful hazards in terms of total numbers of people affected are hydrological (floods), including nearly 1.5 million evacuations. However, in terms of deaths, meteorological hazards (strong winds, surges and Tsunamis) have been the worst, causing about 3,700 (close to half of the total) deaths recorded. Meteorological hazards comprise of hazards that can be characterized as relatively severe and sudden, like storms and cyclones. Thus the implications for risk management are quite different between the different hazard types, a fact that is born out clearly in the DIBI statistics, especially for the statistics on numbers of deaths.

The number of people injured tells a slightly different story because injuries are more often primarily due to geophysical hazards (39 per cent), particularly earthquakes in this case (3,842 in number). A total 277 deaths are recorded at Yogyakarta region from eruptions, apparently due to the proximity of an active volcano, Mount Merapi, which is located at the border between Yogyakarta and Central Java.

Some clarifications on the variables used in DIBI (definitions, methodologies, data source, etc.) are needed for a more complete analysis of disaster impacts statistics. For example, how the difference between a heavily or lightly damaged house is measured is not evident from the website. Such information could be derived from many different means, including surveys, a post-disaster economic assessment, or approximations using post-disaster satellite imagery. A lot more could be learned through this pilot investigation from studying the documentation of measurement methodologies for the DIBI variables.

A clear of advantage of the DIBI website is useful tools for querying the dataset in a variety of ways (through filtering, cross-tabulations and interactive mapping). Information that can be filtered for producing summary statistics from DIBI are:

Variable	**Descriptive characteristics**
Death	Province
Disappeared	District
Injured	Disaster [hazard] type (see above)
Suffered	Year
Evacuated	Month
Heavily Damaged House	Date
Moderately Damaged House	
Lightly Damage House	
Praying Facilities	
Educational Facilities	
Health Facilities	
Roads (KM)	
Damages to Crops (Ha)	

Geographic referencing according to the 33 provinces in Indonesia and at district levels creates the possibility to look at geographic distributions and to integrate the summary statistics with other variables currently outside of the DIBI system through use of GIS tools.

DIBI has the potential to be an important bench-marking example for the region for other countries to learn from an emulate, as relevant for dissemination of their direct impacts statistics. However, a more complete documentation of the variables metadata (definitions, data sources, calculation methodologies, etc.) is also need for a more complete analysis of DIBI statistics.

2.3 The Philippines

Data on disasters in Philippines and their direct impacts and losses were documented for the time period of 2013-2015. During this tim e period, there were 60 natural hazards recorded by the relevant government authorities, including 34 wildfires. Wildfires are frequently occurring hazards in South East Asia.

Although wildfires are the most frequent hazards of recent years in the Philippines, there are no direct human impacts of these hazards except that it is known that 785 hectares of forests were affected by the fires in 2013, affecting two water sheds: Upper Agno and San Roque, with the majority of past impacts from forest fires occurring in Upper Agno.

Impacts to agricultural land area were classified as *total* and *partial* depending on the extent of the damage. Partially damaged agricultural land area (1,442,219 hectares) is about 5-times larger than the areas of totally damaged agricultural land area (287,321 hectares).

Statistics compiled in the draft DRSF tables on material damages for other types of assets or infrastructure were recorded for the Bohol earthquake in terms of number of physical units for education facilities (82), public administrative buildings (38), roads (40), bridges (19). More detailed statistics on infrastructure damages in numbers of units and in terms of monetary costs are usually also compiled into tables for individual events of relatively large scale, including many cyclones and other tropical storms. The task of compiling and integrating results from all NDRRMC disaster reports from the past 3 years could not be completed in this initial round of the DRSF pilot test. Thus, this is a provisional partial analysis of available statistics in the Philippines, which could be helpful to inform a process towards a more integrated compilation of disaster-related information for the national database in the Philippines and other countries in the future.

Approximately 133,350 hectares of Philippine land are exposed to meteorological hazards (tropical storms) and hydrological hazards (floods and landslides), affecting 2,810 Philippines municipalities. The regions with the highest number of municipalities exposed to flood and landslide hazards are Eastern Visayas (281), Colbarzon (258), Western Visayas (244), CALABAZON (CALABARZON- Cavite, Laguna, Batangas, Rizal and Quezon Provinces), Ilocos (218) and Bicol (214), each of which have over 200 individual municipalities exposed.

The scope of disaster impacts statistics compiled for Philippines in this pilot test round covers the disaster events with Declaration of State of Calamity[19].

The 2013 Bohol earthquake resulted in 227 deaths and 8 missing. The number of deaths or missing from tropical cyclones reached 7,464 in 2013, 326 in 2014 and 161 in 2015. 2013 was the year of tropical cyclone Yolanda (Haiyan), which was one of the strongest storms and one of the worst disasters experienced by the Philippines or any country in many years. According to the official statistics for 2013, 21.8 million people were affected by tropical cyclones, which includes around 6.5 million evacuations.

Prior to its making landfall, 161,973 families and 792,018 persons were evacuated as a result of Yolanda. Casualties were 6300 deaths, with another 1,062 missing and 28,688 injuries. A total of 1,140,332 houses were partially or totally destroyed, most of them in Western Visayas (Region VI) and Negros Island (Region VIII), but with significant damages in other regions as well.

Between 2013-2015, there were 39,774 deaths injured or missing as a result of disasters. This count includes 7043 dead (97% of which were from meteorological hazards), 1143 missing (8 due to geophysical and 1135 due to meteorological hazards) and 31,588 injured or ill (977 due to geophysical and 30,611 meteorological hazards). There were also 10,277,832 people displaced by disasters from 2013 to 2015.

The nature of hazards in the Philippines, particularly tropical cyclones, is such that impacts are unpredictable and highly erratic when comparing across regions or between years. Because of Yolanda, two of the regions of the Philippines had very large proportions of population affected while other regions experienced hazards but with

19 RA10121, Philippine Disaster Risk Reduction and Management Act of 2010: "a condition involving mass casualty and/or major damages to property, disruption of means of livelihoods, roads and normal way of life of people in the affected areas as a result of the occurrence of natural or human-induced hazard."

relatively little impacts. 2014 and 2015 were generally less destructive in terms of impacts from meteorological hazards compared to 2013.

The design of indicators or other analyses of statistics on impacts from meteorological hazards in the Philippines need to be sensitive to this context of the inherent and natural potential for vast differences between years and regions. This fact underlines the importance of integrating information on disaster impacts with baseline statistics on hazard exposure in order to provide the necessary context for assessing disaster risk reduction policies.

According to the available gender disaggregation of affected population statistics from the past 3 years, males are 3 times as likely to go missing as compared to women and they are also slightly more prone to being injured or killed by a hazard.

Tropical cyclones in 2013 alone were responsible for damaging or destroying about 1.289 million homes in the Philippines. Of which, Yolanda accounted for around 1.1 million (roughly around 90% of the incidents from that year), an effect visible in the year-to-year differences in numbers of damage or destroyed houses (below). Counts of impacted hospitals and other health facilities also followed this trend (Figure 8).

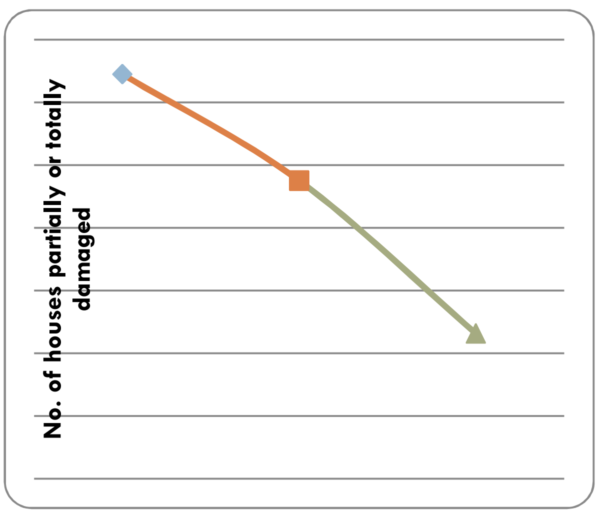


Figure 7: Damaged or destroyed houses from tropical cyclones in the Philippines

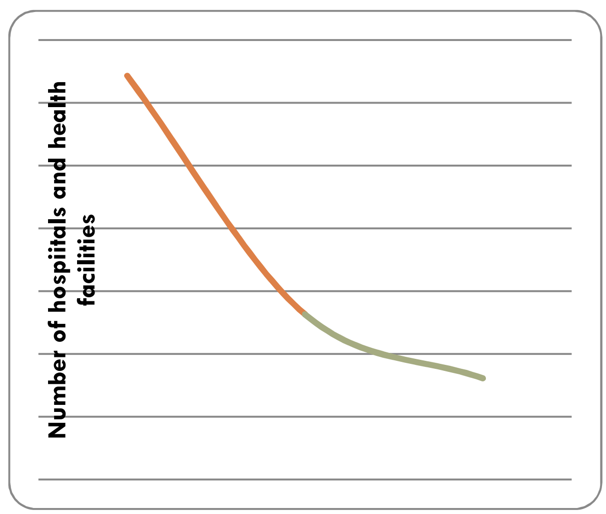


Figure 8: Hospitals and health Facilities Damaged or Destroyed by Tropical Cyclones

More than 1,000 hospitals or health facilities were damaged by natural hazards during the period and the numbers also available by region. Logistical costs for medical treatments associated with the natural disasters covered were estimated at 385 million Filipino pesos (roughly 8 million US dollars), among which close to 40% of those costs were connected to hazards from 2013.

The total affected agricultural area was around 1,729,641 hectares of land area, with a relatively stable annual scope of damages, averaging around a half million hectares per year, compared to the annual average of around

10,000 hectares in Bangladesh. From the NDRRMC report for Yolanda, estimated costs of damages to hospitals and health facilities from that single event were reported at 4,050,000 Pesos (more than 85,000 USD).

Post-disaster reports by the NDRRMC include tables on affected population by numbers of individuals, households, and barangays (villages, wards...) and include data on economic costs of disasters to infrastructure. For the case of Yolanda, the NDRRMC estimated reconstruction and recovery needs for infrastructure at more than 28 million Philippine Pesos, or around 600,000 US dollars (USD). Note, a breakdown of total reconstruction costs according to the NDMA organizations of production, and social sectors is presented in section 3.6 above.

According to Annual reports on estimated economic costs of damages to properties from tropical cyclones, the largest share of economic losses are felt by agriculture, as was the case in Bangladesh.

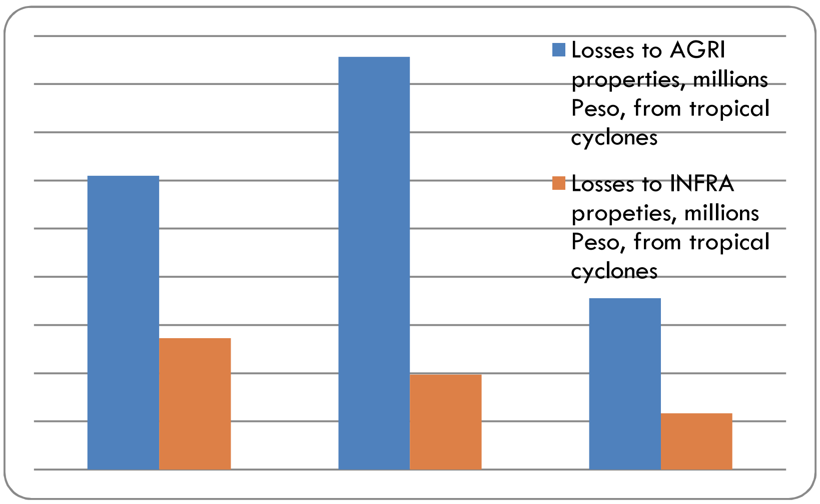
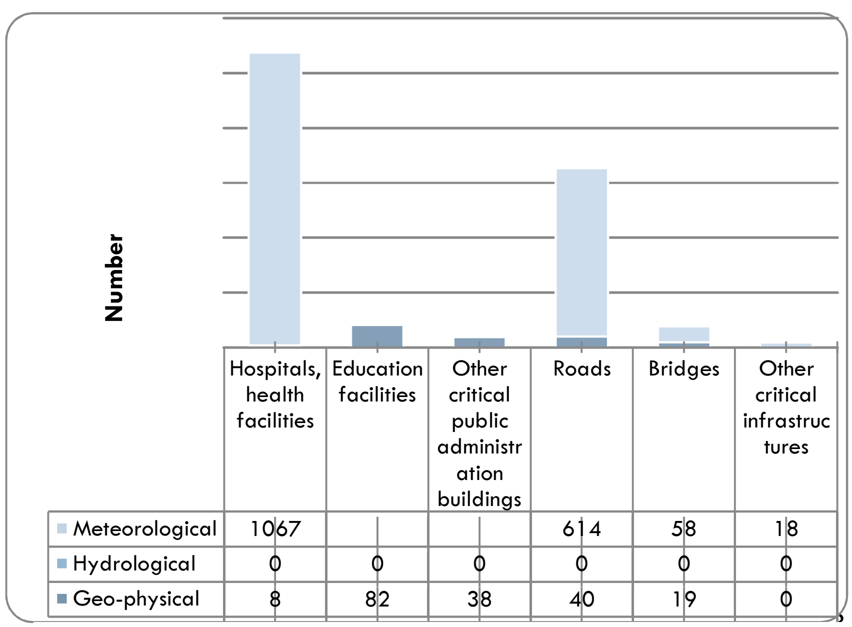


Figure 9: Economic Losses from Tropical Cyclones, 2013-2015

Use of sectoral categorization for damages, and even use of the terms "infrastructure" can vary. For example, if the NDRRC does not conduct a post-disaster study (PDNA), as was done for Hurricane Yolanda, all damages to include land, facilities, equipment, and crops, are grouped in the category for "agricultural damage" (AGRI). On the other hand, in PDNA Report for Yolanda, physical agricultural structures like ponds, farms, farm houses and others are included under "infrastructure" (INFR). Government entities like NDRRC collect a lot of relevant data, but further work is needed to implement a framework towards improved harmonization of classifications and definitions for scope of measurement in order to produce statistics that are comparable across events and over time.

The numbers in Figure 9 are estimations of the "total cost of damages" from tropical cyclones in each year and economic costs calculations are also reported by region. Not included in the total cost of damages estimations are the



	Hospitals, health facilities	Education facilities	Other critical public administration buildings	Roads	Bridges	Other critical infrastructures
Meteorological	1067			614	58	18
Hydrological	0	0	0	0	0	0
Geo-physical	8	82	38	40	19	0

Figure 10: Direct Impacts on Critical Infrastructures (no. of units) by Hazard Types in Philippines, 2013-2015

"total cost of assistance" variable which is distinguished and treated separately from the 'cost of damages".

Road and bridge closures caused by tropical cyclone events also varied between years. In 2014, 139 roads and 39 bridges were closed, covering a length of disrupted transportation corridors of around 80 km. In 2015, the number and length of closures were much greater: about 600 km of closures to 500 roads and bridges.

2.4 Fiji

For Fiji, impacts statistics were collected in relation to one major flood, which took place in 2009 and affected the Northern, Western and Central regions of Fiji. There were 11 deaths and 12,403 were evacuated. A large portion (8,830) of the people evacuated was from the Western region. Disaggregated data by gender or social groups are not currently available. During the time of this pilot test, another major disaster, Cyclone Winston, occurred, significantly constraining the capacity of the team of experts in Fiji to conduct further compilations of data in such limited time. On the other hand, the compilations for the 2009 Flood was a sensible and useful first example for testing DRSF-harmonized compilations in Fiji.

Impacts to critical infrastructures from the flood are available in terms of replacement costs, with the total damages estimated at nearly 46 million of Fijian dollars, or around 21 million USD. The largest share of costs of damages to infrastructure was to the roads, which sustained damages equivalent to 28.45 million Fijian dollars, or about 62% of the total direct economic losses to critical infrastructure. The table below shows the estimated damages in Fijian and approximate USD equivalent for other types of critical infrastructure.

	Fijian $	**USD $**
Hospitals, health facilities	515,000	246,170
Education facilities	1,473,960	704,554
Roads	28,451,302	13,599,750
Electricity generation facilities	3,000,000	1,434,003
ICT Equipments	1,300,000	621,401
Water sewage & treatment systems	11,220,000	5,363,171
Total	45,960,262	21,969,051

Table 1: Direct Economic Loss to Critical Infrastructure from a 2009 Flood in Fiji

In total, 146,725 people and 27,747 households are susceptible to hydrological hazards. A majority of the exposed people and houses (79 percent and 84 percent respectively) are in the Western region.

As part of the continued efforts for this pilot test study, post-Cyclone Winston, the Fiji Bureau of Statistics is investigating the possibility to produce estimations for past annual government spending on disaster risk reduction.