Asia & Pacific Expert Group on Disaster-related Statistics

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Disaster statistics for Analysis of Vulnerable Groups

1. Concept of vulnerability

In its Resolution establishing the Expert Group[1], the Economic and Social Commission for Asia and the Pacific (ESCAP) emphasized the importance of disaggregated statistics and the need for evidence-based policies in support of the most vulnerable groups. The Asia and Pacific Expert Group on Disaster-related Statistics advised compilers, where possible, to produce disaggregated statistics of human impact statistics according to social groups, with a focus on vulnerable populations. Identifying and producing indicators on vulnerable populations and their characteristics is a clear example of how improved disaster-related statistics could dramatically improve the capacities of disaster management agencies, and their partners, to develop targeted disaster risk reduction (DRR) policies for achieving national and international goals and targets.

Winser et al. (2003) offered a definition of vulnerability for disasters, which is useful for the context of developing statistics: "the characteristics of a person or group and their situation influencing their capacity to anticipate, cope with, resist and recover from the impact of a natural hazard". Many of the papers reviewed stressed the social and economic context of disasters recognizing the crucial importance of the social context as one of the main factors for disaster occurrences and impacts. Winser et al. summarize the concept and the importance of the social context of disasters in an excerpt worth quoting at length:

"The crucial point about understanding why disasters happen is that it is not only natural events that cause them. They are also the product of social, political and economic environments (as distinct from the natural environment), because of the way these structure the lives of different groups of people. …humans are not equally able to access the resources and opportunities [or knowledge and information about hazards]; nor are they equally exposed to the hazards. Whether or not people have enough land to farm, or adequate access to water, or a decent home, are determined by social factors (including economic and political processes). And these same social processes also have a very significant role in determining who is most at risk from hazards: where people live and work, and in what kind of buildings, their level of hazard protection, preparedness, information, wealth and health have nothing to do with nature as such, but are attributes of society" (Wisner et al.,2003)

On the other hand, characteristics of the underlying natural hazard, which is the original source of the disaster, can also be important factors for understanding vulnerability. A clear example are cases of biological hazards and diseases, like cholera. As one of the case studies in an IPCC Report on vulnerability (Murray et al. 2012) noted: "cholera is one of a handful of diseases whose incidence has been directly associated with climate variability and long-term climate change (Rodó et al., 2002).

[1] E/ESCAP/RES/70/2 *Disaster-related statistics in Asia and the Pacific,* https://www.unescap.org/sites/default/files/E70_RES2E.pdf

One driver of cholera's presence and pathogenicity is the El Niño-Southern Oscillation (ENSO), which brings higher temperatures, more intense precipitation, and enhanced cholera transmission." Similar examples could be postulated and tested for other slowly evolving catastrophic risks, such as from droughts or rising sea levels, which are hazards that do not necessarily put groups of the population at immediate risk from death, injury or evacuation, but may create gradual negative impacts, leading towards the threshold point of a disaster occurrence at a point in which certain groups have already been made vulnerable. According to the series of case studies published in Murray et al. (2012), which is organized according to different hazards types, there are significant differences in findings on vulnerability and in terms of approaches to the studies depending upon the nature of the underlying hazard. Sources of vulnerability to disasters can also, in certain special cases, be primarily physiological, for example there is evidence that people, especially children, in blood group O may have higher health-related vulnerabilities. Very young children or the elderly face special difficulties with avoiding direct harm or be may be inherently more susceptible to the long-term indirect economic effects.

Many of the social factors of vulnerability are well documented, such as poverty and its symptoms like poor access to basic services, or people who are in a disadvantaged social or political position, due to, for example, an ethnic or religious minority status. However, even for these types of social situations that could be expected to significantly influence vulnerability, statistics tend to be limited or unavailable at a suitable scale for analysis for development of national or local DRR policies.

2. Geographic vulnerabilities

One of the key potential characteristics of vulnerability, which has not yet been studied much in the current literature is residence in urban and rural locations. One reason it may difficult to study this issue is because sometimes natural hazards or impacts from disasters could have direct or indirect effects on migration, and particularly urbanisation. This issue has been studied for the case of extreme cold weather events in Mongolia (see, e.g. Groppo and Kraehnernt, 2016) by collecting time series panel data from herding and non-herding households from rural areas, including for some households that migrated following the experience of major impacts from a disaster.

Generally, it seems probable that many rural communities will face special and marginally higher vulnerabilities from generally having poorer access to transport and communications infrastructure and other types of basic support services. But this is one of the topics and potential sources of vulnerability that could benefit from further study and from a larger sample of countries and types of hazard exposure. Rural areas also tend to be home to a relatively larger share of people living in poverty as compared to the more densely population cities. On the other hand, the informal community support systems in rural communities tend to be particularly strong and adaptable.

Agriculture and other kinds of productive activities that are heavily dependent on conditions of the land will usually be relatively most vulnerable to many types of natural hazards, such as extreme weather or floods. As a provisional outcome of the Expert Group's round 1 pilot study on the Disaster-related Statistics Framework (UNESCAP, 2016), agriculture seems to absorb the highest proportions of estimated direct economic loss from disaster across the sample disasters in four countries.

The defining characteristic of the urban centres, particularly Asian megacities, many of which are located in coastal zones or potentially hazardous locations in Asia and Pacific, is their population density, which, in itself, could be considered a factor of vulnerability. Mumbai is a coastal megacity

in Asia with a population of more than 9 million in 2001[2] , which has been projected to increase by two to three-fold by 2070 (Hanson et al. 2011). According to Murray et al. (2012), "coastal megacities are already at risk due to climate related disasters" and "urban poor populations often experience increased rates of infectious disease after flood events." Hanson et al. (2011) found that about 40 million people in coastal cities are already exposed to flooding and sea level rise. Utilizing UN figures on urbanization rates, the authors also predicted that four coastal megacities (Dhaka, Karachi, Mumbai and Lagos) will grow to exceed 50 million people.

Urban slums are often located in parts of the cities with the highest risks due to environmental and social factors for examples settlements on flood plains or on steep slopes. (Murray et al., 2012). This portion of the IPCC Report concludes by noting that standardized and multi-hazard approaches to impact analysis at the city scale have not yet been developed.

The IPCC has also concluded that small island developing states (SIDS) are especially vulnerable to natural hazards and may face special difficulties with responding to disasters. Many studies have been conducted by IPCC and others on the specific factors of inherent vulnerability for small island states in the Pacific and Indian oceans and in the Caribbean. These vulnerability factors for SIDS include both the natural topographical or geographical factors and also some social and economic factors that are especially pronounced for many of the SIDS. Statistical evidence on vulnerability factors should be utilized by SIDS governments, as much as possible, as crucial evidence for designing their DRR policies.

3. Social-economic vulnerabilities

The 2010 orld Development Report "Development and Climate Change" (World Bank, 2010) utilized a wide-ranging scope of evidence and studies of relevant factors to support one of the Report's primary arguments that developing countries are the most vulnerable to climate change. Moreover, "climate change threatens to overwhelm local efforts, requiring more from national and global supporting structures." (World Bank, 2010) Also, based on existing evidence from studies reviewed for this paper, factors of vulnerability are beyond individual choices by households or communities, with significant links shown for factors like age at the time of disaster, income and wealth and employment opportunities and the general characteristics of social-economic status for the affected individuals. There is a general consensus among scientists at the Intergovernmental Panel on Climate Change (IPCC)that a likely outcome scenario from increased greenhouse gases in the atmosphere and climate change is that extreme weather events will increase in frequency, intensity and become less predictable (Murray et. al., 2012).

Another crucial point from the 2010 World Development Report is that "natural systems, when well managed, can reduce human vulnerability".). For example, the most effective protections against impacts from natural hazards come from nature; habitats such as mangrove forests and protected primary forests upstream from communities in areas potentially exposed to floods. Examining and supporting cases of positive synergies between environmental protections, also called "pro poor environmental policies" is one of the objectives for the UNDP-UNEP Poverty and Environment Inititaive (PEI). Unfortunately, it is also occasionally true that degradations to the environment and to its natural protections and other benefits to humans are more likely to disproportionately affect the poor. For example, the poor are more likely to have settled, for economic reasons, in heavily polluted or degraded environments and these environments are, in many cases, especially vulnerable to the effects of these "technical" or "manmade" hazards, such as a polluted river or exposed landfill, as well as, by extension, natural hazards like floods or extreme weather.

[2] United Nations Statistics Division (data.un.org)

Access to freshwater and sanitation is frequently mentioned as a factor of disaster vulnerability. Access to freshwater and sanitation is also the topic of Sustainable Development Goal 6 and one of the major and conspicuous symptoms of poverty. Disasters can affect water and sanitation systems in many different ways. Direct impacts include rapid salinization or contamination caused by extreme weather hazards. Vulnerability to these types of impacts can be assessed relatively easily if statistics are available on location and other basic characteristics of the water and sanitation infrastructure and people affected. Water and sanitation assets are included in the proposed terminology and indicators for measuring direct impacts to "critical infrastructure" and the item was included in the draft DRSF tables for pilot testing (UNESCAP, 2016) but the statistics were found to be unavailable in many cases and basic methodological recommendations (e.g. standards for units of measurement) also are not yet developed and tested. An exception was the case of the 2015 Survey of Impacts of Climate Change and Natural Disaster Perspectives Survey (Bangladesh Bureau of Statistics, 2016), which collected statistics at the household level in areas exposed to natural hazards for the indicators for types of access to freshwater and sanitation.

There are also economic structural factors that researchers may need to consider for a comprehensive understanding of vulnerability. For example, the tourism industry is likely to face special kinds of direct and indirect impacts from disasters because either important natural or historical monuments were affected or because the occurrence of the disaster directly caused limitations for travel to or within a country. Moreover, as already mentioned above, agriculture (including fisheries and livestock production) are inherently exposed to most forms of natural hazards.

The concept of vulnerability is important when considering both the causes and impacts of disasters. Vulnerability creates the context that can help cause a natural hazard to become a disaster but also the impacts of disaster, e.g. losses of dwellings, create new vulnerabilities or newly vulnerable groups. In other words, poverty or low level of development and disaster vulnerability can be mutually reinforcing. The post disaster assessment study conducted for Samoa after the 2012 Cyclone Evan stated that "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" (Government of Samoa, 2013).

4. Empirical Findings from Previous Studies on Vulnerable Groups

Currently there are no international standards or specific statistical recommendations for identifying and measuring vulnerable groups within countries. In the Expert Group's DRSF Pilot Studies (UNESCAP, 2016), a provisional attempt was made to compile basic statistics on affected populations in the four participating countries according to four groups of pre-selected social categories (see Table 1). Generally, statistics were not available from the pilot countries on impacts to disabled persons or for the poor populations. Available information for assessing affected population variables by age groups or gender was also quite limited. However, the available statistics have proven usefulness in disaster risk reduction analyses and the disaggregated statistics can be useful even for cases where the information is incomplete (UNESCAP, 2016).

Table 1: Social Categories in DRSF Pilot Study (Phase I) for studying available statistics

C2a1 - Age groups			TOTAL
0-4	5-60	60+	

C2a2 - Gender groups		TOTAL
Male	Female	

C2a3 - Urban/Rural population		TOTAL
Urban	Rural	

C2a4 - Specific vulnerability groups		NO TOTAL
Disabled	Poor	

However, disaggregation of affected population variables (e.g. deaths, missing, injured, evacuated etc.) by age, sex or other categories are not sufficient as indicators, on their own, for identifying vulnerable groups and for understanding factors affecting vulnerability and the kinds of interventions that might help to reduce vulnerability. For example, whether more women or men are killed by disasters in a particular year can depend on many factors, such as the types, timing or location of the hazards and by other social or demographic factors different from the gender of the affected individuals.

A deeper analysis is required to understand relationships between factors or sources of vulnerability among different groups in the population. In many cases, these factors are closely related to the more general concepts and measurement of risk and resilience. Measurement of risk often relies on use of models and regression analyses or other probabilistic methods to establish evidence of the most likely underlying causes of past impacts and the risk or vulnerability to future disasters. In this brief note, we review a few selected examples of studies that have focussed on identifying vulnerable groups and used empirical analyses to test various hypotheses to determine the critical factors and consequences of vulnerability

Neumayer and Plumper (2007) analyse the impact of disasters on the gender gap in life expectancy. The paper presents evidence for a significant inverse relationship, suggesting that female life expectancy is negatively impacted by disasters more than men. The authors also found that introducing metrics related to a rising social status of women in some places appears to cause this effect on the gender gap of life expectancy to decline and become negligible. Thus, according to this study, the significant difference of disaster impact is not a not a difference of gender, directly, but rather an impact of the generally lower socio economic status of women, on average, for many of the places included in the study, creating this apparent effect of relative vulnerability to disasters of women as compared to men.

This concept of linking socio-economic status to disaster impacts is well aligned with the concept of vulnerability as described above and this correlation is well supported by many other studies for many different types disasters and from around the world.[3]

[3] See for example, Abarci et al. (2005) studied how fatalities from earthquakes relate to per capita income and the level of inequality. Fothergill, A., and L. A. Peek. (2004) and Khan (2005) also found that impacts are worse for income poor for disasters across hazard types.

The same basic type of analyses as in Neumayer and Plumper (2007) could also be conducted to verify the significance for any number of other potentially vulnerable groups, such as young children, the elderly, and disabled persons. These studies, which could be conducted at national or local scales, limited only by availability of data, not only help to identify the degree of significance for expected vulnerability for the specific groups in the population but also to find the significance of the underlying root sources of vulnerability, such as social or economic status for the case of women, and relative importance ofphysical versus social factors of vulnerability for disabled persons, children and the elderly. Different hypotheses about sources of vulnerability and differences across groups and across countries should be analyzed from the available data on impacts from historical disasters in order to deepen our understanding of disaster vulnerability and help policy-makers to better focus their development strategies and work on building resilience.

The common trait across these analytical studies is they make use of one of the basic indicators on affected population (especially deaths) as a proxy for assessing overall vulnerability to disasters. Thus, studying vulnerable groups depend heavily on the quality of the core affected population indicators (especially accuracy and comparability for disaggregated analyses). In many of the studies, number of deaths is as a dependent variable not just because it was considered a good general proxy for direct impacts but because researchers considered it to be most reliable measurement currently available, as compared to some of the other affected population indicators, such as number of injuries or illnesses, displacement, persons whose dwellings were damaged or destroyed, etc.

A household panel survey called “Coping with Climate shocks in Mongolia” was conducted as a collaboration between (DIW-Germany) and the Mongolia National Statistics Office during 2012-2015. This survey, which focussed on two rural provinces of Mongolia, is being utilized to produce a series of studies on rural populations exposed to extreme cold weather hazards, a natural hazard called a “dzud” in Mongolia. This survey is producing original and insightful contributions to the literature for a better understanding of vulnerability to natural hazards and how to utilize official statistics to identify vulnerable groups and design DRR policies.

Extreme weather disasters in Mongolia affect children from livestock herding households the most and these effects come about through losses in household assets and income, with children from households that lost more livestock, and/or children from relatively low wealth or low income households, bearing the largest consequences. These consequences include a reduced likelihood to complete mandatory schooling as well as other potentially long-term effects, such as impacts found in a 2nd study (Groppo and Kraehmart, 2016), which showed significant impacts from the sample panel survey data causing stunted growth and malnutrition of children from herding households.

The dependent variable the first study (Groppo and Kraehnert, 2015) is children aged 6-14 enrolled in schools. The study produces evidence of a strong negative impact of a major disaster event, the 2009-10 dzud, on enrolment of children from livestock herding households, extending two to three years after the shock. Children from herding households that resided in the districts experiencing high livestock mortality during the 2009/10 dzud are significantly less likely to be enrolled in school in 2012/13 compared to children who resided in less affected districts. This negative effective was confirmed by various validation techniques and by including control groups from non-herding households in the same areas. The negative effect is visible only for the herding households in the

affected areas and was far more significant for children at primary school age (6-10 years old) and hardly significant for older children (11-14 years). Thus, the age of children in the impacted areas at the time of the hazard affects the magnitude and expected duration of impacts to the population, with very young children being the most vulnerable to these impacts. These age differences to vulnerability were especially significant for the relatively severe examples of dzud disasters, such as the 1999-2002 triple dzud incident.

There also seems to be a relationship between the school enrolment effect and the percentage of livestock lost as result of the dzud – in other words a correlation between the economic impacts to households and the negative effect on education. This finding lends further credence to the idea (mentioned above using an example from Samoa) that disasters also can exacerbate or create new vulnerabilities for certain groups within the population.

Groppo and Kraehnert (2015) also found a relationship between education levels for the heads of the household, particularly the female heads of households. Poorer households will tend to be affected worse by the disasters but, all else equal, where the mother of the household is better educated, on average the impacts are less.

Perhaps one of the most striking results of the Groppo and Kaehnart (2015) study was the length of period of impact. In a model designed to assess whether exposure to extreme weather events also has long-term effects, using the case of the 1999-2002 triple dzud (a particularly harsh occurence of this hazard), the researchers found a significant negative effect, particularly for the herding households, on the probability to complete basic education ten to eleven years after the shock. This suggests that there may be significant indirect impacts of relatively extreme disasters on the most vulnerable populations for up to a decade or longer after an extreme event.

The panel household survey provided this special research opportuntity for analysing the short and long-term impacts of the disasters on education and other effects to children of rural households in Mongolia. But, for cases where this kind of panel survey data are not available, estimates of relevant statistics for these types of analyses should still be possible, especially after specific sources of vulnerability have been identified through empirical research.

In addition to looking at human impacts of disasters, *post hoc*, another important type of statistic for identifying and analyzing vulnerable groups are the baseline statistics on the populations living in areas known to be *ex ante* relatively exposed to natural hazards. At first, this simply means utilizing census data, along with other sources of social-demographic information, as available, focusing on the sample within boundaries of hazard exposure areas as defined and mapped, to the best quality available, from disaster management agencies. GIS creates the possibility for calculation of various new statistics on populations in hazard exposure areas along with integration all other types of data available with geographic referencing at a suitable level of resolution. Some of the information could be directly estimated from satellite images. For example, certain kinds of relatively low-cost dwelling structures are more vulnerable to natural hazards simply because of poor durability. Identification of such structures might be observed, or at least estimated, directly from remote sensing. Other sources of geo-referenced data, including data from surveys or administrative records could be utilized to improve the scope for information available on exposed populations, while carefully protecting individual identities following the usual confidentially-protection measures of national statistics offices (NSOs). UNESCAP is currently conducting research to potential fo leveraging new and geo-referenced "big data" sources, including data sourced from the private

sector, to develop methodologies that could be applied by national statistics offices, in connection with their existing datasets, to improve the detail, scope, and depth of content of statistics available on *ex ante* exposure to natural hazards.

Conclusions for a basic range of disaster-related statistics

It is important to use statistics to improve understanding of vulnerability for developing targeted DRR polices. From the measurement point of view: identifying vulnerable groups can help governing authorities with creating priorities for their statistics operations. Not only is each disaster a unique event, each of the places affected by disasters are different with respect to the baseline vulnerabilities and these factors should be taken into consideration, as much as possible, for efficient and targeted design of data collections and for conducting analyses.

In addition to the other social and economic factors reviewed above, another potential source of vulnerability is uncertainty and access to information. Thus, the better the investments made by governments and their development partners for understanding and identifying vulnerable groups the more and better the options for building resilience collaboratively with these groups.

An aim for this brief review of literature analysing vulnerable groups to disasters is to help improve the delineation of scope for a basic range of disaster related statistics in the DRSF for meeting the demands for statistics and for a better understanding of vulnerable populations. Many useful variables can be identified for measurement in relation to exposure to natural hazards and for assessing impacts after a disaster. The central examples are income, type of employment, household wealth (ownership of fixed assets), and access to basic services, which are usually correlated to income, such as education, freshwater and sanitation, and insurance or other opportunities for relief and recovery support after a disaster.

In order to develop integrated approaches in which disaster risk reduction policies are mainstreamed as part of the broader national or local economic and social development plans, as has been advocated for in the Sendai Framework, there is a basic need to produce indicators related to socio-economic status as important components of the disaster-related statistic framework and to link the existing data on the social and economic conditions of households with information on areas exposed to natural hazards and that have been affected by disasters in the past.

The greater the geographic detail available for the affected population statistics, the better and more accurate the basic statistics for conducting vulnerability assessments and to design interventions. Indicators on poverty, school enrolment, or other relevant types of human development statistics, are collected around the world in a time series for several decades, but the particular idea of linking with information exposure to natural hazards is a relatively new concept, with its own special measurement challenges, requiring a careful cooperation between NSOs and disaster management agencies. These kinds of statistics may be compiled via specially designed sample surveys (as has been done in Bangladesh and Mongolia) or via some other type of techniques for geographic disaggregation of statistics. Increasingly remote sensing and use of satellite images are being combined with other data sources via GIS to assess demographic and social-economic situations at very high level of geographic detail.

The previous studies can suggest a provisional short-list of geographically disaggregated variables for compilation for improved understanding of vulnerable segments of the population in relation to disaster risk:

- education enrolment, by age group and education achievement by male and female heads of households
- income, value of household-owned assets and assets lost by a disaster
- other human development statistics, by age group, including evidence related to nutrition and childhood health,
- information on income and assets of households
- type of employment, particularly for households engaged in agriculture of fishing
- urban versus distribution of affected or exposed areas
- dwelling structures, particularly in terms of durability to particular types of hazards (to some extent, this variable might also be approximated, or verified, through correlations with income or other related variables)

If these and other relevant variables could be gathered and updated on a regular basis for areas within countries exposed to natural hazards, disaster management agencies would have *a priori* information on extent and specific locations and qualities of vulnerability and this information could be used both for more efficient disaster response and relief and for developing long-term DRR strategies at local and national levels.

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Questions

Q1. What challenges are faced by your agency to produce information on populations geographically disaggregated for areas exposed to natural hazards and/or areas affected by a disaster according to factors of vulnerable, especially income and assets ownership? *(may select more than one option)*

- □ Limited ***availability*** of data with suitable level of geographic detail for demographic and social data for linking with hazard exposure information
- □ Limited ***availability*** of geographic information on hazard exposures or areas affected by a disaster
- □ Limited ***access*** to data with suitable level of geographic detail for demographic and social data for linking with hazard exposure information
- □ Limited ***access*** of geographic information on hazard exposures or areas affected by a disaster
- □ Lack of experience with methodologies for creating analytical links between difference sources of geographically-referenced data
- □ Other challenges (please describe in space provided below)

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Q2. Which of the following types of demographic information, which are typically collected from the census and from household surveys are most relevant, in your opinion, for conducting identifying and producing indicators on vulnerable groups for disasters in your country? *(may select more than one option)*

- □ Urban vs. rural communities
- □ Age
- □ Gender
- □ Income and wealth of households
- □ Type of employment (e.g. agriculture, manufacturing, etc.)
- □ Status of employment (full-time, part-time, unemployed)
- □ Disability
- □ Race, ethnicity, and religion
- □ Other social or demographic characteristics not list (please describe in space provided below)

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