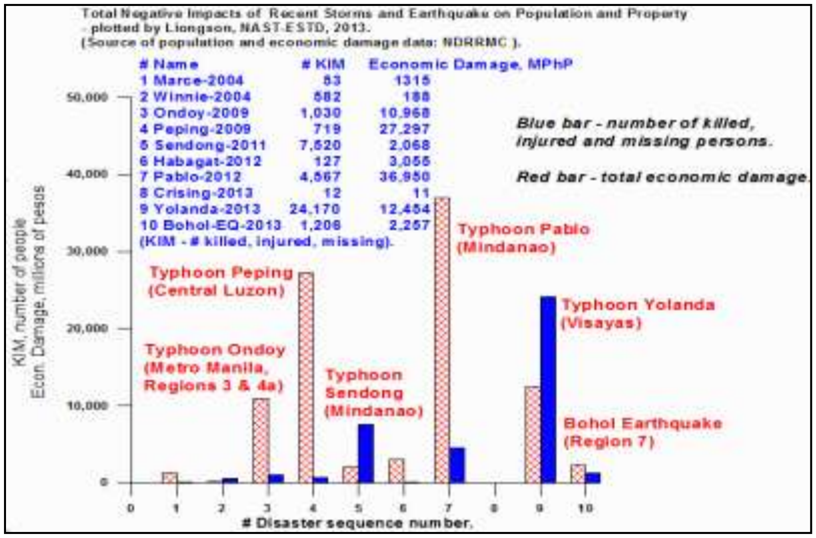

Risk Reduction and Management in Escalating Water Hazards: How Fare the Poor?

Leonardo Q. Liongson, PhD

The article aims to take stock of and rapidly assess the human and economic damages brought about, not only by Typhoon Yolanda, but also by the recent Bohol 7.2 magnitude earthquake and its aftershocks during the period October-November 2013, and comparatively, the most recent typhoons and monsoons (habagat) rainstorm and flood events in the 21st century. It will also cover the positive new steps and efforts of the infrastructure and S&T arms of the national government, and the needed additional steps and tasks which must follow, for alleviating and mitigating the hazard risks of water-based natural disasters, with emphasis on helping and protecting the most exposed and vulnerable to the hazard risks, being the poor sector of the society. The article has emphasized the need for implementing structural mitigation measures in poor unprotected towns and regions in the country, especially under the challenge and threat posed by growing population and climate change. Likewise, non-structural mitigation measures (which have shorter gestation periods of months and few years only, compared to decades for major structural measures) must be provided under the imperative or necessity implied by the structural gap of existing structures to adequately reduce and effectively manage the increasing flood and storm surge hazard risks, caused by growing population and climate change.

NO PRIOR WARNING OF SUPER STORM SURGES

Many days before the first landfall of super Typhoon Haiyan (Yolanda) in Samar and Leyte (in Region 8) last November 8, 2013 (Friday), there was already strong warning and expectation of the super fast cyclonic winds, with a 10-minute maximum sustained speed of 225 kilometers per hour (kph) and gusts of 260 kph coming from PAGASA, with the attendant rains and the wind-blown piled-up sea waves hitting the coastal areas of the region. Upon landfall in Tacloban City —the capital of Leyte which resides in the coastal arc of the famous Leyte Gulf in the 1944 Landing of the Allied Forces — was ravaged and rapidly destroyed, not only

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by the super extreme winds but also by what can now be called the "super storm surges".

The PAGASA website (www.pagasa.dost.gov.ph) explains that "the storm surge is an abnormal rise of water due to a tropical cyclone and it is an oceanic event responding to meteorological driving forces. Potentially disastrous surges occur along coasts with low-lying terrain that allows inland inundation, or across inland water bodies such as bays, estuaries, lakes and rivers. For riverine situations, the surge is sea water moving up the river. A fresh water flooding moving down a river due to rain generally occurs days after a storm event and is not considered a storm surge. For a typical storm, the surge affects about 160 km of coastline for a period of several hours. Larger storms that are moving slowly may impact considerably longer stretches of coastline."

The US National Weather Service (NWS)-National Hurricane Center-Storm Surge Overview website states that "storm surge is an abnormal rise of water generated by a storm, over and above the predicted astronomical tides. Storm surge should not be confused with storm tide, which is defined as the water level rise due to the combination of storm surge and the astronomical tide. This rise in water level can cause extreme flooding in coastal areas particularly when storm surge coincides with normal high tide, resulting in storm tides reaching up to 20 feet or more in some cases."

The storm surges may then be visibly described as a rapid train of successive piled-up seawater waves, blown in and carried by the high winds, propelling the swift water currents to break in and run further inland, inundating with one- to two-floor depths the coastal villages and towns, further aggravated (according to the news) by the high astronomical tide as well as the low (cyclonic) atmospheric pressure which had raised the pre-surge sea level, and causing unprecedented and massive death, injuries and destruction with a very short time warning.

Although there was prior mention of storm surges coming with the winds, there was no fearfully strong warning of super storm surges (as far as I can gather from the news before November 8, 2013), either in the Philippines and abroad, which would cause deaths and destruction on a grand scale similar to the havoc of the tsunamis in the Indian Ocean (2004) and Japan (2011). After the storm-surge disaster had already happened, there was a remark read in local news articles that if the misnomer but familiar "tsunami" warning had been raised, the people would have understood fast and made a rapid run inland or to higher places or shelters in order to escape the invasion of the extreme storm surge, which was not yet so well-known with that name. With 20-20 hindsight, a coastal engineer can now predict the "super extreme storm surges" which will indeed be brought to the coastal areas by 225–360 kph cyclonic winds. Ten days after the typhoon passage (November 19, 2013), the DOST Secretary explained in the media that PAGASA and Project NOAH had beforehand predicted a wave height of 4.5 meters at Tacloban City, but there was not enough time to prepare an inundation map which would serve as guide for the evacuation of the people.

While the relief and recovery efforts are still underway in the typhoon-stricken areas, and also many months and years of the tasks of rehabilitation, rebuilding and adoption of a new and improved "disaster risk reduction and management" (DRRM) programs are still ahead for all affected regions and sectors of the country, it is not too early in this article to take stock of and rapidly assess the human and economic damages brought about, not only by Typhoon Yolanda, but also by the recent Bohol 7.2 magnitude earthquake and its aftershocks during the period October-November 2013, and comparatively, the most recent typhoons and monsoons (habagat) rainstorm and flood events in the 21st century of the national experience (Liongson 2009, 2012, 2013, NAST 2012).

This article will also cover the positive new steps and efforts of the infrastructure and S&T arms of the national government, and the needed additional steps and tasks which must follow, for alleviating and mitigating the hazard risks of water-based natural disasters (floods, debris flows, storm surge and tsunami), with emphasis on helping and protecting the most exposed and vulnerable to the hazard risks, being the poor sector of the society.

HUMAN AND ECONOMIC DAMAGES DUE TO WATER-BASED DISASTERS

The level of public awareness in the Philippines about floods, typhoons and monsoons, and the fear and insecurities created by that knowledge, have grown strongly in the recent months and years (compared to previous decades or the past century), having seen in many places with increasing frequency and intensity the suffering, casualty, injury, damage, losses and dislocation caused by these natural disasters. The awareness and perception of the threat and risk have been raised and developed through direct experience, advocacy, training, education and journalism in many sectors. The magnitude of the flood hazards, although partly reduced by engineering mitigation measures, remain to pose major threat and significant risk to the population due to its exposure and vulnerability, more so among the poor sector, whether rural or urban, which are caused by the lack, insufficiency and/or inadequacy of protection (and care through social services) provided by the so-called structural and non-structural mitigation measures against the natural hazards risks.

A listing can be done of the negative impacts of the major storms and floods (plus the Bohol earthquake) which have occurred in the 21st century within the country, including minor secondary events for comparison of scale of damages from low to high:

2004 August	Typhoon Aere (Marce), Central Luzon
2004 November-December	Typhoon Winnie, Eastern Luzon
2009 September	Typhoon Ketsana (Ondoy), NCR and Regions 3, 4a
2009 October	Typhoon Parma (Peping), CAR and Regions 1, 3
2011 December	Typhoon Sendong, Region 10
2012 August	SW Monsoon (Habagat), NCR and Regions 3, 4a
2012 December	Typhoon Bopha (Pablo), Regions 4b, 6, 7, 8, 9, 10, 11, 12, CARAGA
2013 February	Tropical Depression Crising, Regions 4b, 6, 7, 8, 9, 10, 11, 12, ARMM
2013 October	Bohol Earthquake (7.3 magnitude), Region 7
2013 November	Typhoon Haiyan (Yolanda), Regions 4a, 4b, 5, 6, 7, 8, 10, 11, CARAGA

For purposes of quick assessment, the two tables below show the following selected human and economic damage data secured from the website of the NDRRMC (2009, 2011, 2012, 2013) and the derived ratios to indicate the intensities of damages:

Human damages (**Table 1**)–
Population (P) affected (inside and outside evacuation centers).
Number of killed persons (K).
Number of injured persons (I).
Number of missing persons (M).
KIM/P ratio = (number of killed, injured and missing persons) per 10,000 of people affected.

Economic damages (**Table 2**) –
Agricultural damages.
Infrastructure and other damages.
Total economic damages.
Economic Damage/per capita of population affected.

The data show two essential contrasts. Within Luzon, the relatively more developed and protected regions (NCR, CAR, Regions 1, 3, 4A, 4B) which were visited by 2004 Typhoon Aere (Marce), 2009 Typhoon Ketsana (Ondoy), 2009 Typhoon Parma (Pepeng) and 2012 SW Monsoon (Habagat) show relatively lower values of human damage intensities or KIM (killed, injured or missing) persons per 10,000 of affected population (P) while their economic damage intensities or total damage per capita of people affected are higher, being in more developed regions. In contrast, higher human damage intensity is indicated for the mountainous rural Eastern Luzon as a result of 2004 Typhoon Winnie. It can be verified that the rural areas will have more poor people (lower income) living in exposed and vulnerable lands which lack mitigation infrastructure for protection, and hence are subject to higher hazard risks, compared to the more urban and developed regions in Metro Manila, and Central and Northern Luzon.

Much higher by two to one order of magnitudes are the damage data for Visayas and Mindanao, compared to those for Luzon. The cases of 2011 Typhoon Sendong in Region 10 and the 2012 Typhoon Pablo in much of Mindanao, have the highest human damage intensities. The case of 2013 Typhoon Yolanda (as of November 20, 2013), is that of having maximum human damage in absolute numbers, but is similar to 2004 Typhoon Winnie in eastern Luzon in terms of both human and economic damage intensities. Highest in economic damage intensity nationwide is found in the large agricultural regions in Mindanao affected by 2012 Typhoon Bopha (Pablo), followed by the economic damage intensity of 2009 Typhoon Peping in Central Luzon. Shown for scaling comparison of damages are the data for the weaker 2013 Tropical Depression Crising in Mindanao and the recent 2013 Bohol Earthquake, the latter having high economic damage intensity but lower human damage intensity.

In summary, the Visayas and Mindanao damage data in the recent years have indicated increasing hazard risks and damages (human and economic) for Southern Philippines, exceeding most of the

Table 1. Human Damage Data and Intensities.

LIONGSON, L.Q. (NAST 2013)								
Year-Month-Dates	Severe Storm or Disaster	Regions	Human Damage P–Population Affected	Human Damage K–# Killed Persons	Human Damage I–# Injured persons	Human Damage M–# missing persons	Human Damage KIM	**Human Damage KIM/P Ratio (per 10,000)**
2004-August	*TS Aere (Marce)*	Region 3 (Central Luzon)	1,185,082	43	9	1	53	**0.45**
2004-Nov29-Dec02	*TS Winnie*	Region 4a (eastern Luzon	242,952	407	33	142	582	**23.96**
2009-Sept26	*TS Ketsana (Ondoy)*	NCR, Regions 3 & 4a	4,901,234	464	529	37	1030	**2.10**
2009-Oct03	*TS Parma (Peping)*	CAR, Regions 1 & 3	4,478,284	465	207	47	719	**1.61**
2011-Dec16	*TS Sendong*	Region 10	698,882	1268	6071	181	7520	**107.60**
2012-Aug07	*SW Monsoon (Habagat)*	NCR, Regions 3 & 4a	4,236,151	109	14	4	127	**0.30**
2012-Dec02-09	*TS Bopha (Pablo)*	CARAGA, Regions 4b, 6, 7, 8, 9, 10, 11, & 12	973,207	1067	2666	834	4567	**46.93**
2013-Feb18-21	*TD Crising*	ARMM, Regions 4b, 6, 7, 8, 9, 10, 11,12	262,880	4	4	4	12	**0.46**
2013-Nov06-09	*TS Haiyan (Yolanda) as of Nov. 20, 2013.*	Regions 4a, 4b, 5, 6, 7, 8, 10, 11, CARAGA	10,008,955	4011	18557	1602	24170	**24.15**
2013 Oct15 onward	*Bohol 7.2 magnitude earthquake*	Regions 6, 7	3,221,248	222	976	8	1206	**3.74**

Table 2. Economic damage data and intensities.

LIONGSON, L.Q. (NAST 2013)				
Agricultural Damage (PhM)	Infra & Other Damage (PhM)	Total Damage (PhM)	**Damage/Affected Population (Ph per person)**	Severe Storm or Disaster
1,167.551	147.488	1,315.039	**1,110**	*TS Aere (Marce)*
185.43	2.86	188.290	**775**	*TS Winnie*
6,669	4,299	10,968	**2,238**	*TS Ketsana (Ondoy)*
20,495	6,802	27,297	**6,095**	*TS Parma (Peping)*
309	1759	2,068	**2,959**	*TS Sendong*
2404	651	3,055	**721**	*SW Monsoon (Habagat)*
26,527	10,423	36,950	**37,967**	*TS Bopha (Pablo)*
11		11	**43**	*TD Crising*
10,482	1,972	12,454	**1,244**	*TS Haiyan (Yolanda)*
	2,257	2,257	**701**	*Bohol 7.2 magnitude earthquake*

damage intensities due to typhoons experienced in Luzon. The higher human damage intensities can be explained by the lack of adequate protection and mitigation measures in several affected municipalities in Visayas and Mindanao, compared to the better protected regions of Luzon. It also worth noting that within Luzon, the damages due to the SW monsoon are less than the damages due to the typhoons which entered the PAR because of the higher rainfall intensities associated with crossing typhoons.

STRUCTURAL AND NON-STRUCTURAL MITIGATION MEASURES

The above lesson of higher human damage intensities experienced in unprotected rural areas compared to more protected areas has an implication towards a national policy and program of more, immediate and massive structural measures (infrastructure) as well as non-structural mitigation measures in the unprotected rural areas, in order to diminish human casualty and reduce agricultural damages in the poor rural areas. The social and economic benefit of flood mitigation and coastal protection in the rural areas is tightly pegged to both the reduction of human casualty and the reduction of agricultural damage. The case for partially protected urbanized/developed areas will be one of viable incremental structural improvement (dikes, floodways, large underground drains and cisterns, flood shelters, sea walls, breakwaters). The structural measures shall be coupled with advanced non-structural measures, such as watershed data (topography, soils and geology, land use/cover, drainage network) monitoring and collection, hydro-meteorological data (temperature, humidity, wind speed and direction, rainfall and river/lake water level) monitoring-archiving-reporting, multi-hazard mapping (and zoning), storm track-rainfall-flood forecasting (using hydrological/hydraulic computerized models), flood warning, evacuation, followed up by search and rescue, after using the latest S&T tools (LIDAR, GIS, Doppler radar, etc.) so as to effectively minimize both human casualty, infrastructure and property damage and indirect losses.

CLIMATE CHANGE

The picture of climate change given by PAGASA and the Manila Observatory in a published ADB (2012) report may be summarized for the Philippines (and partly S.E. Asia and Asia Pacific) as follows: <u>higher temperature and CO_2 concentration, higher hydro-meteorological disaster risk for the population, more hot days, less cold days, more rainy days, more typhoons crossing and affecting southern Philippines (Visayas and Mindanao), and also more heavy rainfall events in Luzon, all of which translate to more heavy rainfall producing typhoons and monsoons for the same average 20 typhoons per year entering the PAR (both a wider redistribution in space and a narrower concentration in time,</u>

Flood management and DRRM are faced with the impacts and challenges of more widespread and more intense flood and other water multi-hazard risk (storm surges in islands and coastal areas, debris flows in mountains, etc.) which are strongly driven by a growing population and climate change.

REPORT CARD OF 2013 SONA TOWARDS DRRM

The main highlights of some of the positive efforts of the national government towards Disaster Risk Reduction and Management (DRRM) can be read from selections from the 2013 State of the Nation Address of Pres. Benigno C. Aquino III last July 2013 (which programs can also be updated to November 2013 status at DOST and DPWH), here quoted in outline format:

<u>Department of Science and Technology (DOST) Programs</u>:

Joint force (pagsasanib fuerza) of Geohazard Mapping and Assessment Program and Project NOAH

- 2012 - multi-hazard maps of 28 most hazardous localities in the country.
- 2014 - complete multi-hazard maps in Greater Metro Manila
- ready geohazard maps for 496 cities and municipalities.
- 2015 - to complete the rest of 1,138 cities and municipalites.
- sharper-resolution (matalas) and detailed (detalyado) maps - more exact location of hazardous places.

Project NOAH (Nationwide Operational Assessment of Hazards).

- deployed 525 automated water level monitoring stations & automated rain gauges in 18 river basins.
- distribution of modern equipment - Doppler radars, tsunami detectors, alerting sirens.
- not enough to give modern technology but there is a need for training the receivers on how to interpret, use and spread the information.
- during storms, not enough to know wind speed but also rainfall for correct and timely warning for readiness.

<u>Department of Public Works and Highways (DPWH) Programs</u>:

- Metro Manila flooding (Ondoy flood flow estimate of 3600 cubic meter per second (cms) from the Sierra Madre).
- 1000 cms capacity waterway capacity, but where goes the 2600 cms, which causes overflow in low-lying areas and flooding?
- problem of building obstruction in esteros, and clogging by garbage thrown by dwellers around.
- coordination with LGUs to resettle informal settlers.
- Department of Justice preparing legal cases against the owners of buildings which close or obstruct the waterways; not contented with blaming.
- action worth P6.2 B for flood control in Metro Manila,
- includes Blumentritt Interceptor Catchment area, 3.3 km long, with equivalent water volume of 14 Olympic-size swimming pools; started in March 2013, to finish in 2014.

There are several other planned and ongoing DPWH flood control projects in Metro Manila and mostly Luzon, which were not mentioned in the 2013 SONA probably due to lack of time.

CONCLUSION AND RECOMMENDATIONS

1. The main highlights of DRRM efforts of the national government mentioned in the 2013 SONA indicate significant positive starts, but as the SONA also admits, there is a need to train people nationwide in the use of the new S&T tools of Project NOAH, which can be expanded to cover multi-hazard mapping, improved project planning and design of structural mitigation measures, non-structural measures such as enhanced flood forecasting and flood control operations, and also coastal protection and management at the river basin levels, combined with the adoption of the participatory, multi-stakeholder process of Integrated Water Resources Management (IWRM).

2. Every means possible should be employed to raise needed financial and physical resources and build flood mitigation and coastal protection infrastructure (structural measures) beyond Metro Manila and Central Luzon, for certain towns in high-risk regions such as rural Eastern Luzon (damaged by floods and debris flows of 2004 Typhoon Winnie), urban/rural Visayas (damaged by storm surges and floods of 2013 Typhoon Yolanda) and urban/rural Mindanao (damaged by floods of 2011 Typhoon Sendong and 2012 Typhoon Pablo) which are lacking in protective flood-control and coastal protection infrastructure, for saving the lives and agricultural assets of the rural poor.

3. On the other hand, for more developed areas such as Metro Manila and Central Luzon, the unavoidable presence of structural gap of existing structures necessarily calls for the planning and implementation of more extensive non-structural mitigation measures which shall compensate for the lack of protection offered by structural measures once the actual flood magnitudes exceed the design capacities of structures (Liongson 2012; Figure 1).

4. It also necessary for valid public information and perception of public safety to downgrade the nominal level of protection (in terms of return period, say from 30 years to only 10 years) afforded by existing structures whose present design capacities have been already proven to be under-estimated using recently updated and higher rainfall data statistics. Whether the outright decision to downgrade the existing structures would result in new effort to retro-fit and raise their design capacity is a technical question which can be answered by engineering and economic feasibility studies.

5. As a priority national policy, it is necessary to implement structural mitigation measures in poor unprotected towns and regions in the country, especially under the challenge and threat posed by growing population and climate change; at the same time, non-structural mitigation measures (which have shorter gestation periods of months and few years only, compared to decades for major structural measures) must be provided under the imperative or necessity implied by the structural gap of existing structures to adequately reduce and effectively manage the increasing flood and storm surge hazard risks, caused by growing population and climate change.

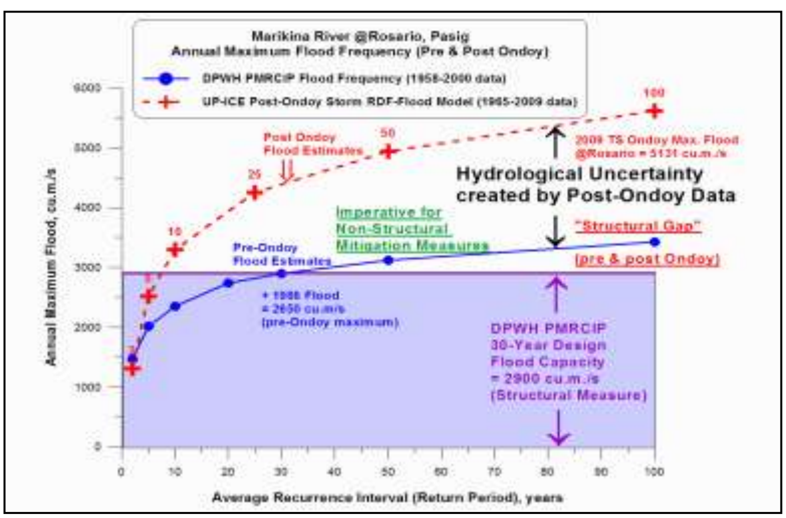

Figure 1 – The hydrological uncertainty and structural gap in the present flood capacity (created by post-Ondoy data), which implies the imperative for non-structural mitigation measures, for the case of Marikina River, Metro-Manila (Liongson 2012; NAST 2012) plotted against return periods. (Note: a return period of 10 years means that a corresponding flood flow discharge given by the chart will be equaled or exceeded once every ten years on the average, all by chance without implication of a fixed time cycle. Thus, the return period of 30 years is when another higher flood flow discharge may be equaled or exceeded once every 30 years on the average by pure chance. It should also be mentioned that the PAGASA 6-hourly rainfall data for Metro Manila showed that two 100-year magnitude rainfall events may closely occur in series by chance, in a space of three years in the same region: 2009 Typhoon Ondoy and 2012 Habagat).

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