# A RAPID DISASTER RISK REDUCTION APPRAISAL FRAMEWORK USING THE UNITED NATIONS DEVELOPMENT PARADIGM

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***ABSTRACT***

*This paper examined a rapid appraisal framework for disaster risk reduction and applies the same to key provinces and cities in Mindanao with the end-in-view of recommending disaster risk reduction (DRR) mechanisms to mitigate the impact of both natural and anthropogenic disasters on these locations. Results reveal that The Disaster Risk Reduction (DRR) framework of the UNISDR assumes that risk reduction varies inversely as capacity (C). However, it is shown that the capacity-risk reduction relationship is non-linear and complex so that a unit increase in capacity does not annihilate one unit of risk. More capacity building is needed in order to surmount a unit increase in risk.*

***Keywords:*** *disaster risk reduction, climate change, normal kernel multiplier*

## 1.0 Introduction

Disaster risk reduction (DRR) is a systematic approach to identifying, assessing and reducing the risks of disaster. It aims to reduce socio-economic vulnerabilities to disaster as well as dealing with the environmental and other hazards that trigger them. The United Nations Development Programme (UNDP) and UNISDR define DRR as: "The conceptual framework of elements considered with the possibilities to minimize vulnerabilities and disaster risks throughout a society, to avoid (prevention) or to limit (mitigation and preparedness) the adverse impacts of hazards, within the broad context of sustainable development" (UNISDR, 2004). Recent events in the Philippines, particularly with the two(2) natural calamities spawned by a 7.2 magnitude earthquake in the Visayas and a supertyphoon Yolanda (international name Haiyan) which claimed the lives of over 3,000 people not to mention the damage in properties, have demonstrated the importance of mitigating the effects of natural disasters and the benefit of capacitating communities to cope with these eventualities. This paper examines a rapid appraisal framework for disaster risk reduction and applies the same to key provinces and cities in Mindanao with the end-in-view of recommending disaster risk reduction (DRR) mechanisms to mitigate the impact of both natural and anthropogenic disasters on these locations.

Disaster prevention and mitigation efforts have received little share of support from international agencies. Schwartz (2006) averred, for instance, that of the estimated $10 billion

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in annual humanitarian assistance, only a measly 4% is devoted to prevention. Yet, he argues, every dollar spent on risk reduction saves between $5 billion to $10 billion in economic losses from disasters. To this end, the international community began the process of pushing international agencies and national governments to go beyond mere rhetorics and policy statements towards setting clear goals and targets. These issues were taken up at the UN's World Conference on Disaster Reduction (WCDR) in Kobe, Japan, in 2005, only days after the 2004 Indian Ocean earthquake. The first step in this process was the formal approval at the WCDR of the Hyogo Framework for Action (2005–2015) (HFA). This is the first internationally accepted framework for DRR. It sets out an ordered sequence of objectives (outcome – strategic goals – priorities), with five priorities for action attempting to 'capture' the main areas of DRR intervention. The UN's biennial Global Platform for Disaster Risk Reduction provides an opportunity for the UN and its member states to review progress against the Hyogo Framework. It held its first session 5–7 June 2007 in Geneva, Switzerland.

Climate change is often touted to be the main culprit for most of the unnatural weather patterns that the world is currently experiencing. Rising global temperatures caused by the accumulation of greenhouse gases in the atmosphere precipitate tropical depressions, cyclones and even geologic events like earthquakes at shorter and shorter time intervals. For the most part, the damage to earth's atmosphere is irreversible and so, the only logical course of action is for man to adapt to the changing weather patterns and to mitigate the impact of natural disasters. The impact of natural disasters in various geographical locations vary: some are more vulnerable than others. Thus, to develop a Disaster Risk Reduction program, it is necessary to determine: (a.) the type of natural disaster that a location is most vulnerable to, and (b.) devise a system to mitigate and minimize the impact of natural disasters to these identified vulnerabilities. The framework for such a disaster risk reduction program had been laid out by the United Nations Development Programme (UNDP) using the basic formula:

$$\text{Disaster Risk Reduction} = \frac{Risk}{Capacity}$$

Intuitively, the UNDP framework claims that risk can be reduced by enhancing national capacities to cope with disasters. However, it is noted that if the framework above is utilized, then a unit increase in capacity would imply a 50% reduction in risk which does not appear to be reasonable. The study looks into this dimension of the problem: how should the capacity component of the disaster risk reduction framework be phrased to conform to realities in the field? The proposed framework is discussed in detail in Section 3 of the paper.

## 2.0 Conceptual Framework

Reactions to hazards are often reactive rather than pro-active. Local government agencies as well as national agencies wait for the disaster to happen before they take action. People likewise often distance themselves from providing responses to coming disasters which characterize most development efforts.

However, the number of disasters are now increasing both in frequency and inter-event times due mainly to climate change and other social, economic, political, environmental and demographic factors. This recent phenomenon demands an urgent need for a shift in thinking in terms of the way we approach hazards. A more pro-active approach is needed at two levels: at the emergency situation level (emergency interventions) and at the long-term development planning level. The approach has to promote the safety and resilience of communities and nations as a part of their sustainable development.

Two(2) DRR techniques are currently being practiced :the Community based (CB-DRR) and Community Managed (CM- DRR). In the former case, external agents gather information from the communities, and then plan and implement the interventions and transfer technologies themselves (Suleiman Mohamed, Program Officer-Elwak Youth for Peace, 2004). The community itself is not involved in the process except in the transfer of technology component. On the other hand, the Community-Managed approach empowers the community to identify, plan, implement, monitor and evaluate activities related to disaster risk reduction. In this approach, the communities take advantage of their own strengths and the entire process is self-managed, enhancing the ownership of the processes and its outcomes. It is not surprising to find that CM-DRR is a more lasting and sustainable option than CB-DRR. However, in situations of emergency, the CB-DRR approach appears to be more tenable. The proposed rapid appraisal framework in this study is more in keeping with CB-DRR and may be considered as a first step towards a more in-depth DRR.

## The Disaster Risk Reduction Formula

For purposes of devising strategies to reduce risks associated with disasters, it is important to define terms clearly. The United Nations International Safety and Disaster Reduction (UNISDR) defines:

1.. $R = H \times E \times V$,

where,

*R = risk*
*H = hazard*
*V = vulnerability*

*Hazard* is defined as "*a dangerous phenomenon, substance, human activity or condition that may cause loss of life, injury or other health impacts, property damage, loss of livelihoods and services, social and economic disruption, or environmental damage*". Hazards may be natural or man-caused( anthropogenic).

*Vulnerability* is defined as: *"The characteristics and circumstances of a community, system or asset that make it susceptible to the damaging effects of a hazard". Exposure* refers to the rate at which a population or community experiences the hazards and the disruptions associated with such hazards.

Note that risks increase as hazards or exposure or vulnerability increases. Likewise, it is possible to have zero risks when one of the factors that figure in the formula is zero. A few notes on these factors are in order. First, exposure relates to the proportion of a community or population which experienced the hazards in the past. Second, hazard relates to the magnitude of these exposures as well as to the probability of their occurrence in the future. Third, vulnerability is the only factor that can truly be controlled by interventions because it relates to the circumstances and characteristics of a community system.

The framework that guides disaster risk reduction is:

2. Disaster Risk Reduction $= \frac{Risk}{Capacity}$

*Capacity* is *"the combination of all the strengths, attributes and resources available within a community, society or organization that can be used to achieve agreed goals".* Obviously (2) implies that an increase in the community capacity reduces risk. However, just how an increase in one(1) unit of capacity induces risk reduction is something that is investigated in Section 3.

**Risk Reduction**

Disaster risk can be reduced by focusing on the following key areas:

*Prevention of hazards* e.g. conflict prevention measures or eradication of contagious diseases. (In the case of natural hazards this is not always possible).

*Mitigation of hazards* e.g. measures that reduce or moderate the impact of hazards before they arise e.g. flood walls, erosion control and measures to reduce run off.

*Reduction of vulnerabilities to hazards* by enhancing individual survivability e.g. increasing capacities that help individuals to survive during hazard event and bounce back after the event. E.g. Livelihood diversification, swimming skills for flood event, etc.

*Reduction of vulnerability* through strengthening community organizations (systems and structures) that help individuals to survive during hazard event and able to effectively bounce back after the hazard. E.g. search and rescue system, credit and savings, early warning, market information etc.

**Disaster Risk Assessment and Analysis.**

Disaster risk assessment and analysis has the following steps:

*Step 1 Hazard Assessment*

Often people refer to a hazard as a disaster, but by using the following definition it is easier to differentiate the two: A hazard only becomes a disaster when it affects a community unable to cope with its effects. If the community is able to cope a hazard event will come and pass—without becoming a disaster.

*Step 2 Vulnerability Assessment*

In a Vulnerability Assessment, the location of people and assets at the time the hazard is likely to strike is assessed as the key determinant of their vulnerability—or degree of exposure. The assessment helps understand how different individuals/assets are exposed to varying degrees, and the underlying reasons for their location in unsafe areas.

*Step 3 Capacity Assessment*:

Capacity Assessment identifies the strengths and resources present or missing among individuals, households and the community to manage resources in times of adversity. Capacity is defined as the strengths and resources that are available to reduce risk levels and/or hazard impacts. They may include physical, social, institutional or economic means, as well as skilled personnel or collective attributes—such as leadership and management. Capacity also refers to strengths and resources that exist for coping with, withstanding, preparing for, preventing, mitigating, or quickly recovering from a disaster

*Step 4 Disaster Risk Analysis*

Disaster Risk Analysis is a systematic process of consolidating the findings of hazard, vulnerability and capacity assessment to determine the risk levels for various elements at risk. It contributes to the community's awareness about potential disaster risks it was unaware of before, and enables the community to define their community action to reduce disaster risk. It is an essential precursor to decision-making in disaster risk reduction, as well as the formulation of development policies, strategies, plans, programmes and projects.

## 3.0 Rapid Appraisal Framework: A Proposal

We examine the usual Disaster Risk Reduction framework given by equation (3) and provide the metrics necessary for a rapid appraisal.

3.1. Rapid Hazard Computation

The first level of computation has to do with the various categories of disaster:

D1: Natural Disaster
- D1.1. Typhoons and Cyclones
- D1.2. Earthquakes
- D1.3. Others

D2: Anthropogenic Disasters
- D2.1. War and Terrorism
- D2.2. Accidents
- D2.3. Deforestation
- D2.4. Others

Hazard is location specific. The occurrence of any natural or anthropogenic disaster can be estimated based on available past information. Thus, the probability of observing a typhoon visiting a location X can be computed as:

$$3.2.\quad P\,(\text{typhoon}) = \frac{\text{No.of typhoons visiting X}}{\textit{No. of Typhoons visiting the country}}$$

Let $D_{ij}$, be the *jth* consequence of the *ith* disaster, $i$ =1, 2,..., s and $j$= 1,2,..., m, then:

$$4\ldots\quad P\left(D_{ij}\right) = \frac{\#\ of\ D_{ij}\ events\ visiting\ X}{\#\ of\ D_{ij}\ events\ visiting\ the\ country}$$

For each category of disaster, we have a second level of computation which refers to the consequences of a disaster $D_{ij}$.

Let $D_{ijk}$, I = 1,2 ; $j$ = 1, 2, …,m ; k=1,2, ... s, then:

$$5\ldots\quad P(D_{ijk}) = P\,(D_{ij}) \times P\,(D_{ijk}/D_{ij})$$

where P(A/B) is the probability that an event A will happen given that B has happened. For instance, suppose that a typhoon ($D_{ii}$) passed through X then the possibility of a flood of a certain magnitude ($D_{iii}$) is computed as follows and hazard computation is arranged in tabular form as shown in table 1.

$$6\ldots \quad P(D_{iii}) = P(D_{ii}) \times \frac{\#\ of\ floods\ of\ given\ magnitude}{\#\ of\ typhoon\ visiting\ X}$$

Table 1. Hazard Computation

| Hazard Category (A) | Probability of Occurrence (B) | Hazard Consequences (C) | Maximum Damage Level (D) | Probability of Occurrences (E) | Hazard Measure at Maximum Damage Level (B) x (E) |
|---|---|---|---|---|---|
| **1. Natural** | | | | | |
| 1.1. Typhoon/ Tropical Depression | $P_{1.1}$ | 1.1.1. Floods | $L_1$ | $P_{111}$ | $P_{1.1}$ X $P_{111}$ |
| | | 1.1.2. Landslide | $L_2$ | $P_{112}$ | $P_{1.1}$ X $P_{112}$ |
| | | 1.1.3. Storm surge | $L_3$ | $P_{113}$ | $P_{1.1}$ X $P_{113}$ |
| 1.2. Earthquake | $P_{1.2}$ | 1.2.1. Landslides | $L_4$ | $P_{121}$ | $P_{1.2}$ X $P_{121}$ |
| | | 1.2.2. Tsunami | $L_5$ | $P_{122}$ | $P_{1.2}$ X $P_{122}$ |
| **2. Anthropogenic** | | | | | |
| 2.1. Industrial Accident | $P_{2.1}$ | 2.1.1. Chemical Spills | $L_6$ | $P_{211}$ | $P_{2.1}$ X $P_{211}$ |
| | | 2.1.2. Fires | $L_7$ | $P_{212}$ | $P_{2.1}$ X $P_{212}$ |
| 2.2. War/ Terrorism | $P_{2.2}$ | 2.2.1. Fires | $L_8$ | $P_{221}$ | $P_{2.2}$ X $P_{221}$ |
| | | 2.2.2. Bombs/ Stray Bullets | $L_9$ | $P_{222}$ | $P_{2.2}$ X $P_{222}$ |
| 2.3 Deforestation | $P_{2.3}$ | 2.3.1. Landslide/ Erosion | $L_{10}$ | $P_{231}$ | $P_{2.3}$ X $P_{231}$ |
| | | 2.3.2 Watershed Destruction | $L_{11}$ | $P_{232}$ | $P_{2.3}$ X $P_{232}$ |

We note that the sum of the probabilities of occurrence of the maximum damage level for the consequences equals the probability that a hazard category will hit the locality:

7…. $\sum P_{ijk} = P_{ij}$, for all $i$, $j$ and $k$.

Consider the last column of Table 1 which gives the marginal probability that a hazard consequence will occur at the maximum damage level. We can construct from its column the total probability that consequence 1 or consequence 2 will occur. For instance, we look at "typhoon" with these (3) consequences:

P(flooding or landslide or storm surge) =
P(flooding) + P (landslide) + P(storm surge) – P(flooding) P(landslide) – P(flooding) P(storm surge)- P(landslide) P(storm surge) + P(all these).

This can be displayed in tabular form as shown in table 2:

Table 2. Hazard that one or more of the consequences will occur

| | | Consequence Probability | (1) A+B+C | (2) AB | (3) AC | (4) BC | (5) ABC | Typhoon Hazard (1)-(2)-(3)-(4) +(5) |
|---|---|---|---|---|---|---|---|---|
| Hazard Typhoon | (A) Flood | $P_{11} P_{111}$ | $P_{11}$ ($P_{111}$+$P_{112}$ +$P_{11}$) | $P_{11}^2$ ($P_{111}P_{112}$) | $P_{11}^2$ ($P_{111}P_{113}$) | $P_{11}^2$ ($P_{112}P_{113}$) | $P_{11}^2$ ($P_{111}P_{112}$ $P_{1113}$) | |
| | (B) Landslide | $P_{11} P_{112}$ | | | | | | |
| | (C) Storm Surge | $P_{11} P_{113}$ | | | | | | |

### 3.2 Rapid Vulnerability Assessment

Vulnerability refers to the geographic location which makes City X susceptible to the damages brought about by the consequences of the disaster. Thus,

Vulnerability to flooding = % of lowland area

Vulnerability to landslides = % of area near slopes

Vulnerability (flooding or landslides) = vul(flooding)+vul(landslides)–vul (flooding) vul(landslides)

### 3.3 Rapid Exposure Assessment

Exposure refers to the percentage of population living in vulnerable areas:

Exposure to flooding = % of population living in lowland areas

Exposure to landslides = % of population living near slopes

Exposure (flooding or landslides) = expos (flooding)+ expos(landslides) – expos (flooding) expos (landslides)

### 3.4 Capacity Estimation

For capacity estimation, we categorized the capacities of the various areas in terms of: physical resources, community organizations, social organizations, political organizations and institutional readiness.

The capacity score is equal to the average over all the eight dimensions. The maximum capacity score is 10 while the maximum risk score is 1. From the formula:

DRR = Risk/Capacity

We see that at maximum risk but maximum capacity, risk is reduced to only 1/10 or 10%. The minimum capacity score is 0. Hence, the risk of 1 is reduced to 1/0 or the risk is infinitely magnified. Suppose that the capacity score is 1, then the risk is not reduced at all (1/1= 1); however, just increasing the capacity score to 2, reduces the risk to ½ or 50%.

Table 3. Capacity estimation table

| Capacity Dimension | Criterion | Points | | Verbal Des. | Actual (Please rate) |
|---|---|---|---|---|---|
| | | Percent | Score | | |
| 1.Physical | C1: % safe and adequate evacuation centers | 91-100%: | 5-10 | Very capable | C1: |
| | | 81-90%: | 3 – 4.9 | Capable | |
| | C2: % of LGU budget for emergency food and water provisions | 70 – 80%: | 1 – 2.9 | Moderate Cap. | C2: |
| | | 61 - 69%: | .51 – 0.99 | Low Capability | |
| | | Below 61% : | 0 | Incapable | |
| 2.Community Organizations | C3: % of barangays with Disaster risk organizations | | | | C3: |
| | C4: % of barangays performing disaster drills on regular basis | | | | C4: |
| 3. Social Organizations | C5: % functionally literate | | | | C5: |
| | C6: % non-government organizations involved in civil society/relief work | -same- | | | C6: |
| 4. Political Organizations | C7: % of barangays with the same Political Party with the Mayor | -same - | | | C7: |
| 5. Institutional *(Media, DSWD, DILG, DPWH, DOH, DepED, DA, CHED, DENR, Banks)* | C8: % of offices/agencies with Emergency Response Team (ERT) | -same - | | | C8: |

The UNDP formula does not appeal intuitively to policy makers viz. a single increase in the capacity score reduces risk by 50%. We propose to revise this formula to:

$$DRR = (Risk) \times (e^{\frac{-1c^2}{2}}),\ 0<risk<1, 0< c$$

where the multiplier of the risk is the kernel of the normal probability density function. Risk is expressed in percentage while capacity ***c*** is a non-negative real number. Figure 1 shows the behavior of DRR versus capacity.

## 4.0 Simulation using selected areas in Mindanao

Using current year's data on tropical depressions and typhoons that visited the Philippines since January 2013 from various sources, we attempted to compute the parameters of the rapid appraisal system. The simulation exercise attempts to answer the question:

*"What if the risk situation in each of the places in Mindanao are as calculated, by how much should their capacity be increased to minimize damage (in terms of lives lost per 10,000 population)?.* Table 4 on the next page shows the summary of the computations under a zero capacity assumption:

By how much should the capacities of these places be enhanced to reduce risk to 1%, .1% and .01%? Table 5 shows the necessary capacity improvements for each of the places .

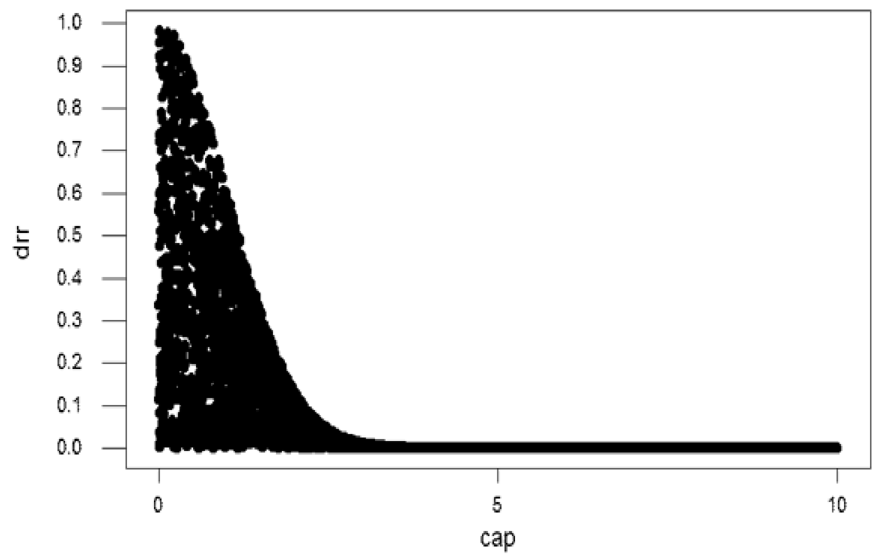


Figure 1. Graph of the behavior of DRR versus capacity

Table 4. Summary of the risk parameters for selected places in Mindanao under a zero capacity assumption and magnitude 5 to 7 flooding (high)

| Location | Hazard | Exposure | Vulner. | Risk | BASE DAMAGE (per $10^3$ population) |
|---|---|---|---|---|---|
| Surigao City | 0.82 | 0.74 | 0.66 | 0.40 | 4019 |
| Tandag City | 0.83 | 0.75 | 0.67 | 0.42 | 4168 |
| Butuan City | 0.8 | 0.72 | 0.65 | 0.37 | 3732 |
| Bayugan City | 0.75 | 0.68 | 0.61 | 0.31 | 3075 |
| Gingoog City | 0.55 | 0.50 | 0.45 | 0.12 | 1213 |
| Cagayan de Oro | 0.7 | 0.63 | 0.57 | 0.25 | 2500 |
| Iligan City | 0.7 | 0.63 | 0.57 | 0.25 | 2500 |
| Tangub City | 0.44 | 0.40 | 0.36 | 0.06 | 621 |
| Ozamis City | 0.4 | 0.36 | 0.32 | 0.05 | 467 |
| Oroquieta City | 0.35 | 0.32 | 0.28 | 0.03 | 313 |
| Dapitan City | 0.48 | 0.43 | 0.39 | 0.08 | 806 |
| Dipolog City | 0.4 | 0.36 | 0.32 | 0.05 | 467 |
| Zamboanga City | 0.6 | 0.54 | 0.49 | 0.16 | 1575 |
| Pagadian City | 0.5 | 0.45 | 0.41 | 0.09 | 911 |
| Compostela Valley | 0.8 | 0.72 | 0.65 | 0.37 | 3732 |
| Malaybalay City | 0.45 | 0.41 | 0.36 | 0.07 | 664 |

Table 5. Summary of capacity improvement for various risk reductions

| Location | Risk | Cap to Reduce Risk to 1% | Cap to Reduce Risk to .1% | Cap to Reduce Risk to .01% |
|---|---|---|---|---|
| Surigao City | 0.4 | 2.72 | 3.46 | 4.07 |
| Tandag City | 0.42 | 2.73 | 3.48 | 4.08 |
| Butuan City | 0.37 | 2.69 | 3.44 | 4.05 |
| Bayugan City | 0.31 | 2.62 | 3.39 | 4.01 |
| Gingoog City | 0.12 | 2.23 | 3.09 | 3.77 |
| Cagayan de Oro | 0.25 | 2.54 | 3.32 | 3.96 |
| Iligan City | 0.25 | 2.54 | 3.32 | 3.96 |
| Tangub City | 0.06 | 1.89 | 2.86 | 3.58 |
| Ozamis City | 0.05 | 1.79 | 2.80 | 3.53 |
| Oroquieta City | 0.03 | 1.48 | 2.61 | 3.38 |
| Dapitan City | 0.08 | 2.04 | 2.96 | 3.66 |
| Dipolog City | 0.05 | 1.79 | 2.80 | 3.53 |
| Zamboanga City | 0.16 | 2.35 | 3.19 | 3.84 |
| Pagadian City | 0.09 | 2.1 | 3.00 | 3.69 |
| Compostela Valley | 0.37 | 2.69 | 3.44 | 4.05 |
| Malaybalay City | 0.07 | 1.97 | 2.91 | 3.62 |

Tabular values show that higher risks imply higher capacity requirements in order to reduce risks at various levels. In general, however, capacities that exceed 3.5 are sufficient to reduce risks at acceptable levels. Capacity enhancement is context-based. This means that the resource requirements to enhance the various capacities by, say, fixed percentage, of the different locations will vary according to the location and specific circumstances. That is, a unit increase in the capacities of the different locations will require different amount of resources to be put in place. Table 6 shows the projected damage (in terms of loss of lives per thousand population) at various capacity improvements.

Table 6. Damage at various risk reduction efforts

| BASE DAMAGE | 1% Risk Damage | .1% Risk Damage | .01% Risk Damage | Location |
|---|---|---|---|---|
| 4019 | 100 | 10 | 1 | Surigao City |
| 4168 | 100 | 10 | 1 | Tandag City |
| 3732 | 100 | 10 | 1 | Butuan City |
| 3075 | 100 | 10 | 1 | Bayugan City |
| 1213 | 100 | 10 | 1 | Gingoog City |
| 2500 | 100 | 10 | 1 | Cagayan de Oro |
| 2500 | 100 | 10 | 1 | Iligan City |
| 621 | 100 | 10 | 1 | Tangub City |
| 467 | 100 | 10 | 1 | Ozamis City |
| 313 | 100 | 10 | 1 | Oroquieta City |
| 806 | 100 | 10 | 1 | Dapitan City |
| 467 | 100 | 10 | 1 | Dipolog City |
| 1575 | 100 | 10 | 1 | Zamboanga City |
| 911 | 100 | 10 | 1 | Pagadian City |
| 3732 | 100 | 10 | 1 | Compostela Valley |
| 664 | 100 | 10 | 1 | Malaybalay City |

The Tacloban, Leyte experience during the last calamity brought about by typhoon Yolanda (Haiyan) registered over 7,000 deaths (estimated population of 1,600,000 as of 2012) . This means that death-per-ten thousand population is about 44 people. Because of the specific location of the province, it is vulnerable to the consequences of typhoons and around 75% of the population live in the lowland (coastal) areas. Of the 26 typhoons that visited the country last year, 18 passed through the province. Leyte's risk to the consequences of typhoon is thus estimated at:

$$\text{Risk (Leyte)} = (18/26) x (75/100) \times 1 = 52\%.$$

From this figure, it is possible to back -cast the capacity of the province to absorb the effects of typhoons. Since DRR = .0044, we compute:

$$\text{Capacity} = \text{sqrt}(2)\ (\ln(.52/.0044) = 3.09$$

Thus, the provincial capacity to absorb the effects of typhoons of magnitude as large as Yolanda was already at 3.09 (**capable**) but because Yolanda was of such magnitude, capability should have been in the range 4.0 to 5.0.

## 5.0 Conclusion

The Disaster Risk Reduction (DRR) framework of the UNISDR assumes that risk reduction varies inversely as capacity (C). However, it is shown that the capacity-risk reduction relationship is non-linear and complex so that a unit increase in capacity does not annihilate one unit of risk. More capacity building is needed in order to surmount a unit increase in risk.

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