Framework for natural disaster impact assessment:

Indicators of resilience, risk, and vulnerability in victims of Typhoon Haiyan

Stephanie Sangalang

Abstract

Typhoon Haiyan has been associated with serious environmental, health, and socioeconomic impacts which continue to adversely affect victims nearly two years later. Existing impact assessment (IA) methodologies--environmental impact assessment (EIA), health impact assessment (HIA), and social impact assessment (SIA)--are inadequate in providing comprehensive measurements of the complex impacts of natural disasters. The aims of this paper are to: outline a framework, based on integrated impact assessment, which is specifically for natural disasters; propose a set of indicators that are holistic and sustainable; and apply findings to the case of Typhoon Haiyan.

1. Problem background (word count: 1,928)

The super typhoon, Haiyan (also known as Yolanda), made landfall in Eastern Visayas, the Philippines, on November 8, 2013, and resulted in unprecedented destruction and loss. According to the Situation Report No. 108 (NDRRMC, 2014a) more than one million homes were damaged across 57 cities. The typhoon affected over 3,400,000 families and 16 million individuals (about 17% of the country's population), leading to over 890,000 displaced families and over four million displaced individuals (NDRRMC, 2014a). The public health consequences were over 28,000 reported injuries and 6,300 deaths (NDRRMC, 2014b). The financial cost, estimated to be over $892 million USD (NDRRMC, 2014a), is especially worrisome for an impoverished country where more than 19% of the population (estimated to be 96.7 million in 2012) live on less than $1.25 USD per day (World Bank, 2012).

1.1. Ways to measure impact

Impacts may be measured by various methodologies such as objective measurements, like cost-benefit analysis and Disability Adjusted Life Years (DALYs), and subjective measurements, like satisfaction ratings. This paper will specifically discuss impact assessment (IA), which uses both quantitative and qualitative measurements.

1.1.1. What is IA? IA is "the process of identifying the future consequences of a current or proposed action" (IAIA, 2009). As tool to guide decision making IA encourages public participation and is characterized by features such as purposiveness, cost-effectiveness, and transparency (IAIA, 1999). IA consists of six to eight steps, depending on the focus: screening, scoping, appraisal / risk assessment, preparation of report (including recommendations), submission of report to decision makers, implementation, and monitoring and evaluation (Quigley et al., 2006).

1.1.2. What are the existing IA methodologies? *Environmental impact assessment (EIA)* (Table 1) is focused on gathering information about a specific site where a project is proposed to take place. Quantitative measurements (e.g. collection of biological specimens) are performed via field work and data are analyzed in laboratories or by using statistical software. *Health impact assessment (HIA)* is focused on gathering information to predict the potential effect of a project or policy on public health. HIA can be prospective, concurrent, or retrospective in nature; HIA can be performed rapidly (mini-HIA) or comprehensively (maxi-HIA).Quantitative and qualitative data are collected via checklists and literature reviews. Although in the past most HIAs were based on the biomedical (disease-focused) model, today many

HIAs are also based on socioeconomic models. *Social impact assessment (SIA)* is focused on gathering information about the local community's resources and institutions in order to characterize the possible effects of a policy or project at the population level. Examples of data include national censuses, vital statistics, and financial information; data are collected via interviews, focus groups, and literature reviews. Examples of socioeconomic impacts include changes in the unemployment rate and degree of social disruption.

1.1.3. How are existing IA methodologies inadequate? A common criticism about EIA is its narrow scope, which focuses primarily on site-specific effects but may exclude serious consequences like adverse mental health outcomes. Other criticisms include: a failure to fully consider alternative solutions, optimism bias, and planning fallacy (i.e. underestimating the time required to perform the task). HIA is also associated with criticisms such as: uncertainty regarding when to perform health assessments; great risk of missing health impacts that are not measureable / predictable; and high costs and staffing needs. A major criticism of HIA is that emphasis is placed on outcomes rather than on determinants. SIA has the following disadvantages: inability to consider differences in beliefs, interests, and values of stakeholders; tendency to focus on quantitative variables (e.g. economic indicators) while ignoring qualitative variables (e.g. culture); and uncertainty about how to select the most appropriate indictors, depending on the target audience.

1.2. Challenges of assessing natural disaster impacts

Challenges include: lack of time and financial and material resources; lack of technical expertise and research capacity; lack of coordination and process management capabilities; ineffective communication; lack of standardized methodology and inconsistent compliance with protocols; lack of universally accepted definitions, measures, and documentation and reporting standards; and inadequate monitoring and evaluation. Natural disasters are infrequent but high intensity events whose effects transcend professional disciplines, sectors, and geographical borders. Timely action is often a matter of life or death. When the list of action items is very long but there is not enough time to complete everything, one must prioritize. Thus, perhaps the greatest challenge of assessing natural disaster impacts is prioritizing which impacts should be measured, analyzed, and reported in order to facilitate effective decision-making, sooner rather than later.

2. Proposed solution – natural disaster impact assessment (NDIA) framework

2.1. Why a new approach is needed

Taken separately the existing IA methodologies described above are inadequate for characterizing impacts of natural disasters. This is due to the complexity of impacts, the severe time and resource constraints, and the presence of competing interests from different stakeholder groups. One possible solution is to integrate EIA, HIA, and SIA methodologies into a single natural disaster impact assessment (NDIA) methodology. Integration would allow for a comprehensive assessment of impacts that is based on a holistic approach and is supportive of sustainable development.

2.2. NDIA indicators and process

In the proposed NDIA framework the contributions of EIA, HIA, and SIA are equally respected, as three indicators from each methodology are integrated into a single model (Table 2). Selection of these indicators was based on findings reviewed in literature (Gilbuena et al., 2013; Lane et al., 2013; Veerman et al., 2005). They were also chosen because they are convenient and cost-effective (as they rely on existing data), which allows them to be measured even in

low-resource settings with limited research capacity. Finally, three new indicators, based on principles of holism and sustainability, were added. The integrated NDIA process is comprised of seven steps (Figure 1).

2.3. Application to Typhoon Haiyan

A rapid IA (NDRRMC, 2014a) provided an overview of the grave situation created by Typhoon Haiyan. During the *scoping* step the extent of Typhoon Haiyan's impact was assessed: over four million individuals were displaced; nearly 2,000 electricity transmission facilities were damaged; airport and sea ports became non- or limitedly operational; and water rationing was implemented (NDRRMC, 2014a).

During the *impact assessment* step field work was conducted to obtain environmental, health, and socioeconomic impact data. Findings included: degradation of coastal waters following the typhoon-related oil spill in Estancia; damaged mangrove trees and coral reefs; deforestation / damage of about 40 million coconut trees; tons of debris from six large ships that had been washed ashore; incidents of burning and dumping of hazardous waste; ineffective management of biological waste (human and animal corpses); wildfires; exploitation of protected natural resources (e.g. beach sand) (Granath, 2014). An especially concerning finding was the construction of settlements in official "No Build Zones" (Granath, 2014), which were designated as such due to their close proximity (only 40 meters) to the shoreline. These areas were identified as dangerous because they placed residents directly in harm's way, in case another typhoon were to occur.

An assessment (GSC, 2014) of 4,127 households described health impact findings such as: 17% of households reported having no access to a toilet; and 66% of households had access to water only via tube wells with a hand pump or piped sources. The same household assessment (GSC, 2014) described social impact findings such as: 82% of households believed that they needed further resources in order to begin / continue to recover from the typhoon; only 38% of households received shelter assistance; and 42% of households lacked access to livelihood opportunities.

During the *impact management* step community outreach was performed to recruit volunteers to help create an interactive, visual map of the damaged area using open source, geographic information systems (GIS). One example is www.openstreetmap.org, which local residents used to create more realistic visualizations of their city, marking key features such as municipal boundaries, commercial establishments, types of land use (e.g. parks, fish ponds), and evacuation and health centers (American Red Cross, 2014; World Bank, 2014a). The advantage of mapping is that it promotes civic engagement, draws upon local knowledge, and supports community resilience.

During the *report preparation* step a document outlining key findings and recommendations was created (Granath, 2014). Sample recommendations included: capacity building in sewage and waste management; rehabilitation of damaged / lost trees and coral reefs; relocation of victims away from "No Build Zones"; support for recycling and sustainable livelihood practices (Granath, 2014). During the *decision making* step recommendations were approved or rejected. Examples of decisions taken after Typhoon Haiyan included: declaration of a state of national calamity by the president on November 11, 2013; provision of relief to victims worth over $28 million USD; provision of relief resources (over 35,000 personnel, 1,500 vehicles, and 28,000 materials / equipment); 24-hour communication of weather alerts; establishment of Task Forces (for food / water distribution, waste management, law and order, relief, rehabilitation, and reconstruction, etc.) (NDRRMC, 2014a).

During the *follow up* step monitoring and evaluation activities were performed. Findings from recent progress reports (NDRRMC, 2014b; World Bank, 2014b) included: updates on the number of injured and missing persons, restoration of utilities (water, electricity, mobile phone and land lines), reopening of airports and sea ports, and status of recovery projects. More data are needed, particularly about the physical, reproductive, and mental health of the victims. Data on socioeconomic indicators also need to be assessed to better characterize the status of vulnerable populations such as single women, children, elders, and disabled individuals. Data on the effectiveness of sociocultural interventions (e.g. livelihood programs) would also be helpful in moving forward.

3. Discussion

3.1. Strengths and limitations

The proposed NDIA framework may be constrained by limitations inherent in other IA methodologies due to the lack of consistent criteria, definitions, measurements, and procedures. Other limitations include insufficient opportunities for public participation, lack of consideration for cumulative and biodiversity impacts, and failure to adequately address alternative policy solutions, programs, or projects. This framework should be pilot tested in other settings and its indicators should be assessed for reliability and validity. Nevertheless this framework provides many advantages: it integrates three approaches (EIA, HIA, and SIA) to provide comprehensive data; it is based on principles of holism and sustainable development; and it facilitates increased stakeholder consultation, civic engagement, and community resilience. Other strengths include cost-effectiveness, accessibility, and user friendliness (as the measurement of indicators requires no specialized training). Perhaps its greatest strength is its potential to increase coordination across sectors and facilitate decision making that is equitable and transparent.

3.2. Policy implications

Successful implementation of the NDIA requires effective policy action at the local, national, and international levels because natural disasters do not recognize geographic or political boundaries. Examples of policies include: establishment of a long-term funding stream to support disaster risk management; adoption of evidence-based disaster risk management guidelines; participation in regional disaster risk management networks that promote knowledge exchange and data sharing; maintaining a budget for research capacity building across sectors (e.g. environmental, medical, natural, political, social sciences); adoption and proper use of disaster “early warning” systems; monitoring and evaluation of interventions; and timely reporting to stakeholders.

3.3. Recommended way forward

Two concrete steps to move forward are: (1) pilot test the proposed NDIA framework, assessing the reliability and validity of its 12 indicators, via consultation with stakeholders (typhoon victims, decision makers, relief workers, etc.); and (2) prioritize indicators via the Delphi process of expert consultation and consensus building. Urgent, effective action is needed to promote resilience and better protect communities from the impacts of natural disasters, anticipating and mitigating problems before they have the chance to harm the environment and threaten the lives and livelihoods of at-risk populations in vulnerable areas such as the Philippines.

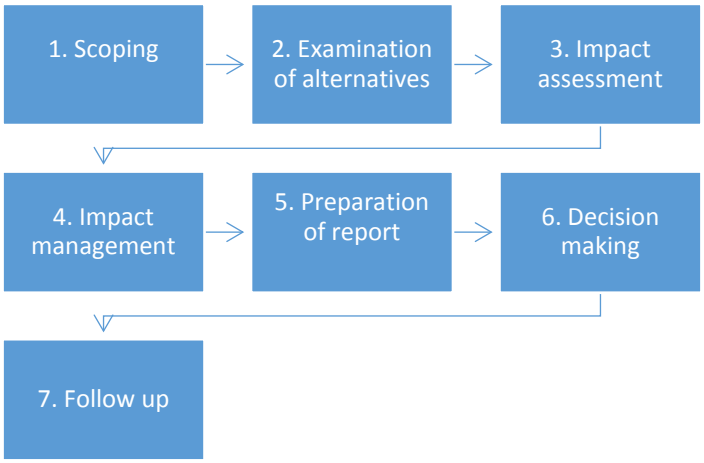
Table 1. Existing IA methodologies (adapted from Arnold et al., 2009)

Type of IA	Process	References
EIA / SEA	1. Screening 2. Scoping 3. Examination of alternatives 4. Impact analysis 5. Mitigation / impact management 6. Evaluation of significance 7. Preparation of EIA report 8. Decision making 9. Follow up	IAIA, 1999
HIA	1. Screening 2. Scoping 3. Identification 4. Assessment 5. Decision making / recommendations 6. Evaluation / follow up	University of New South Wales Centre for Health Equity Training, Research, and Evaluation, 2007
SIA	1. Screening 2. Community profiling 3. Scoping 4. Assessing impacts 5. Developing alternatives 6. Mitigation 7. Monitoring 8. Management / evaluation	Arce-Gomez et al., 2015

Table 2. NDIA indicators

Origin	Impacts	Indicators
EIA / SEA	1. Air quality 2. Water quality 3. Flora / fauna destruction	1. Monitor PM 10 concentration 2. Number of bacteria 3. Number of trees damaged / destroyed
HIA	1. Morbidity 2. Mortality 3. Infectious disease prevalence	1. Number of injuries 2. Number of deaths 3. Number of cases (e.g. diarrhea)
SIA	1. Displacement 2. Housing damage 3. Financial cost of damage	1. Number of individuals displaced 2. Number of dwellings damaged 3. Overall cost of damage across sectors

Figure 1. Integrated NDIA framework: 7-step process



Methods of integration
1. Stakeholder engagement: start early and maintain contact. • Assess needs of stakeholders • Use findings from needs assessment to plan & implement NDIA
2. Develop policy for routine meetings / consultations to exchange feedback.
3. Develop online platform for sharing knowledge and communicating progress; utilize social media.
4. Ensure that someone is personally responsible for development of integrated NDIA report.

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