# Prevention of Infectious Diseases in Natural Disasters

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## ABSTRACT

**Natural disasters extract a huge toll in terms of human life and economic cost. And as the actual calamitous events may cause immediate and extensive devastation, these may also generate circumstances that promote the spread of infectious diseases, which further aggravates the resulting distress. It is important, therefore, to limit the occurrence and spread of infectious diseases in times of disasters. To effectively do so requires an understanding of the interplay of the nature and magnitude of the catastrophe, the prevailing conditions at different periods of time after the disaster, and the primary characteristics of the affected population, among other factors.**

**The paper qualifies the circumstances that would most likely prevail following various disaster scenarios (i.e., floods, earthquake, and drought). From the described situations, specific disease-predisposing conditions are identified. Based on these, appropriate sets of interventions to better reduce the risks of infectious diseases are drawn.**

**An application of the prescribed approach in designing an infectious disease mitigation agenda for natural disasters is presented for the Philippines. The key country recommendations are; the enhancement of community-level preparedness, the incorporation of disaster and phase-specific contingency and other vital features into the operations of the main health response unit, and the improvement of coordination with related agencies.**

***Key Words: natural disasters, infectious diseases, Philippines***

Natural disasters inflict a heavy toll in terms of human suffering as well as environmental and economic costs. It has also become apparent that such situations are occurring more frequently and the magnitude of their impact likewise continues to increase. From 1994 to 2003, natural disasters were estimated to have affected 1 in 25 people worldwide – translating to an average of 255 million people directly affected, of which 58,000 died, annually.[1] The resulting economic cost has reportedly increased fourteen times from the 1950s and recently reached an average of US$67 billion a year.[1]

Increasing population, urbanization, and growing encroachment into more hazardous areas, among other factors, expose more people to higher disaster risks. The same man-made conditions can also have significant effects on the environment, such as global warming. These dynamics contribute to the increased incidence and heightened intensity of the interaction between violent natural phenomena and vulnerable populations. The likelihood of exposure to, and the capacities to withstand, the resulting calamities would expectedly be dissimilar among diverse populations. Thus, countries or populations with higher incomes, or geographically situated in areas with lower occurrence odds, or have stronger public institutions, are less adversely affected by disasters.[2] The converse of these features characterizes many developing countries, especially in Asia. Thus, many Asian countries have been the most deleteriously affected by natural disasters.[3]

The possible effect of any given disaster on the health status of the affected population is of paramount concern. Either as a direct result of the disaster itself (e.g., immediate physical trauma) or as a secondary offshoot of the resulting destruction and displacement, people's health may be compromised. The ensuing devastation can give rise to conditions – such as the disruption of water supply and sewerage systems – that can presumably be conducive to the spread of infectious diseases. The actual risks from contagious diseases during natural disasters are said to be often exaggerated.[4] Nonetheless, the potential for infectious outbreaks cannot be neglected.[5] The threat of such epidemics can be expected to vary depending on the type of disaster, the enormity of the resultant damage, the prior population health status, as well as the degree of the resulting deprivation and displacement, among other factors.[4-6] It is therefore apparent that any measures undertaken to lessen the risks of infectious disease outbreaks should be tailored to the specific circumstances surrounding a given natural disaster.[7]

To illustrate the importance of adopting the appropriate means for minimizing the risks of infectious diseases in times of natural disasters, the scenario in a calamity-prone Asian country – such as the Philippines – is subsequently considered. In the succeeding discussion, the categorization of disasters will follow mainly that which is utilized by the Center for Research on the Epidemiology of Disasters.[1] Based on the latter, natural disasters are broadly categorized as either hydrometeorological or geological. While droughts are included in the former category, such calamities will be discussed in separate detail in this study, due to the distinctness of their health impact. And though epidemics (particularly when these occur as primary events) can be considered as natural disasters on their own, these will not be so included for purposes of this study.

**Weighing the Burden of Natural Disasters in the Philippines**

The Philippines, being astride an area in the western Pacific frequented by storms and earthquakes and coupled with its high population growth and emergent economy, is particularly susceptible to natural disasters.

In contemporary times, the country has witnessed a series of natural catastrophes. The 90's was declared as the International Decade for Natural Disaster Reduction by the United Nations. Ironically, it became the "Decade of Natural Disasters" for the Philippines.[8] Mt. Pinatubo, a long dormant volcano in the main Philippine island of Luzon, erupted in June 1991. This has since been recognized as one of the most destructive volcanic disasters worldwide, particularly in economic terms.[1] The eruption had been preceded by a devastating earthquake in the surrounding regions. A few months after the Mt. Pinatubo eruption, a typhoon with resulting flash floods decimated 6,000 inhabitants of a city in another island.

The Philippines has recently been reported as having the fourth highest annual national incidence of disasters (following the United States, China, and India – countries with much larger land areas).[1] The relative frequencies and population incidence for the various types of disasters are presented in Table 1 (using data derived from the Center for Research on the Epidemiology of Disasters reports).[1]

The economic price of these calamities cannot be understated. In 2006, the Philippines was among the ten worst affected countries worldwide in terms of the economic costs of natural disasters (both in absolute and GDP relative terms).[3]

Understandably, there have been strong incentives in the Philippines for public sector initiatives to better deal with the very sizable adverse impact of natural disasters. Currently, the lead government body for addressing these calamity concerns is the National Disaster Coordinating Council (NDCC). Originally established in 1987, it was intended to harmonize the disaster response activities of more than twenty key government departments and agencies as well as the many corresponding regional and local councils.[8] The NDDC's focus has evolved from primarily being concerned with acute disaster response to the more encompassing area of "risk management". Thus, its present thrusts now include disaster rehabilitation, mitigation and preparedness.[9] Among its attached departments is the Department of Health (DOH), which is tasked with providing vital health services and advisories in times of disasters.

Within the DOH, the unit primarily concerned with disaster management is the Health Emergency Management Staff (HEMS).[10] The main responsibilities of the latter agency are to plan, develop capabilities, coordinate, and provide advice on the disaster preparedness and response of the DOH. As will be pointed later, there may be some gaps in the programs and initiatives of the DOH-HEMS. The areas for enhancement, particularly in terms of infectious disease control during natural disasters, will be considered in further detail in the succeeding sections.

**Assessing Infectious Disease Risks in Disasters**

As mentioned earlier, several factors may relate to the risks of initiation and spread of infectious diseases during natural disasters.[4-7] In general terms, the suddenness and enormity of the disaster event would have a great bearing on mortality risks as well as the degree of population displacement. An unanticipated and massive incident, such as a high-intensity earthquake, or a sudden flooding from a burst dam, can inflict a significant number of deaths outright. While unfortunate, the communicable disease risks immediately following such acutely violent events are often small.[11-13] The presence of exposed dead bodies, while presumably enabling the spread of contagion, has been determined – with few notable exceptions – to pose but a minimal risk for initiating epidemics.[13,14]

Should the disaster event be of only low to moderate intensity or its after-effects short-lived, the collateral threat of infectious disease outbreaks will be minimal.[5,15] A number of disaster victims, though, may have either sustained injuries, or – in case of sudden flooding – aspirated contaminated material, making them susceptible to developing wound infections or pneumonia in the coming days.[5,16] The latter, however, involve mostly sporadic cases and do not predispose to epidemics.

Though not inevitable, infectious diseases start to be of more consequence following the first few days of the event, particularly if the devastation is extensive and the population displacement is significant.

Particularly following floods, those who were acutely injured may have their wounds contaminated. A specific pattern of injury called "cyclone syndrome" has been described among surge flood victims.[13] Wound contamination will not only predispose to wound infection but also the introduction of tetanus.[6] The risk of contracting leptospirosis in flooded areas where this is endemic is also significant[17]. Vectors for previously endemic infections may be prevalent in some areas. There may be a proliferation of these vectors, such as mosquitoes, especially after flooding recedes. Malaria and dengue epidemics happening one to two months following floods have been reported. Similarly, outbreaks of other vector borne infections, such as Japanese encephalitis and yellow fever, may occur.[6]

If a large number of people subsequently evacuate to common shelters or relocation centers, the potential for infectious disease problems is heightened. This would be particularly true if the prevailing circumstances remain rudimentary. The persistent contamination of the water supply, common with massive flooding, increases the

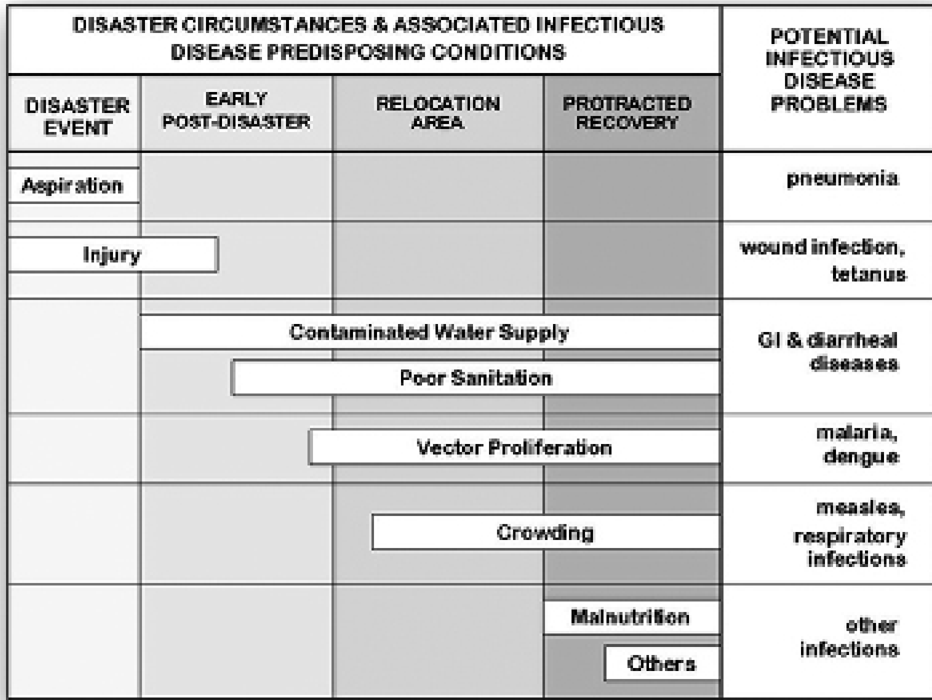


*Figure 1. Schema highlighting the conditions that predispose to specific infectious disease problems and their estimated relation to particular disaster circumstances*

likelihood of water-borne gastrointestinal diseases. Poor sanitary conditions in many of these congested shelters undoubtedly contribute to the propagation of pathogens. Thus, there may be outbreaks of cholera, hepatitis A and E, as well as *Salmonella* and *Shigella* infections in these areas.[6,17]

Crowding in evacuation facilities also facilitates the spread of air-borne diseases. Mild respiratory tract infections would be inconsequential. Much more problematic are measles outbreaks, which have been reported on several occasions.[4-7] Similar conditions may predispose to *Neisseria meningitidis* meningitis outbreaks – though these have been noted to have occurred in conflict rather than natural disaster related displaced populations.[4]

While uncommon following natural disasters, a long-drawn recovery phase – such as what may happen with a protracted drought and famine – leads to malnutrition for most of the survivors.[7] This makes them further prone to being afflicted with infections such as measles, diarrhea, respiratory infections and even tuberculosis.[5] Likewise, the possibility of the spread of sexually transmitted diseases may be heightened when the social situation becomes conducive to sexual promiscuity if not violence.[5] A few other infections, such as rabies and coccidiomycosis, may crop up particularly in relocation localities where such diseases were previously prevalent.[4,17]

Needless to say, the collapse of the local health system and structure in the epicenter of disasters lessens the population's capacity to address the immediate health problems of the affected populace.

As a summary, an illustration of the association of disaster circumstances and the risks for infectious diseases is shown in Figure 1.

**Matching Measures and Likely Infectious Disease Risks**

While calamities, by their very nature, are associated with a high degree of uncertainty – particularly in the confusion that may ensue soon after a disastrous event – preparations and initial relief efforts may be made more efficient if the more likely scenarios are taken into consideration. It is evident from the preceding discussion that while there may be commonalities in the outcomes of various disasters, some of the consequences are also specific – molded not only by the type of the disaster itself but also by several of the stated circumstances. Determining the most probable infectious disease risk, given a particular set of circumstances, can therefore make both disaster preparations and response more appropriate and effective.

The effect of the type of calamity on infectious disease risk is most felt in the immediate post-disaster phase. To wit, violent earthquakes, while capable of causing widespread destruction and even high fatality rates, do not pose an imminent threat for the spread of infectious disease. Infectious problems relate more to the risks of secondary infections to sustained injuries and burns and would not necessarily be communicable.[13] Proper wound care as well as tetanus prophylaxis would be needed by the injured. Floods, whether or not in conjunction with storms, have an earlier penchant for the initiation and spread of communicable diseases. As ingestion or skin penetration pathogens from contaminated water are highly possible, then there is a substantial likelihood of consequent illnesses. Early institution of preventive measures would be needed.[20] Potable water should be provided, either from a safe external source, or by disinfecting local water stocks (most efficiently done by chlorination).[21] Appropriate antimicrobial and supportive treatment, if not outright transport to better-equipped medical facilities, should be instituted at the earliest sign that a disaster victim has a potentially severe infection (e.g., secondary bacterial pneumonia following aspiration of flood waters, leptospirosis, etc.).

Should the disaster event cause extensive devastation, a significant proportion of the populace may be expected to be displaced from their homes and communities. Providing temporary shelter in make-shift or predetermined evacuation sites can bring about a new set of infectious disease problems.

Following floods, access to potable water as well as assurance of proper sanitation may be made more difficult as more people congregate in the relocation sites. The crowding together of a large number of people also facilitates the spread of air and vector-transmitted diseases. Thus, public health measures meant to either prevent or treat the possible diseases should be put in place in these areas. Ensuring the availability of safe water supply is crucial in relocation sites. Site sanitation and proper waste disposal should be observed. While it has been shown that there seems to be a lesser need for quake victims to go to such evacuation sites – or, if they do, to not stay there long – preparations for, if not the actual implementation, of the same health measures should be similarly undertaken.

Where the immunization status of the population is poor, or even unknown, measles immunization as well as vitamin A supplementation should be considered particularly for the vulnerable pediatric population.[20,22] Implementing such an immunization campaign in the midst of disaster area may be technically challenging – and may even divert resources from more urgent needs. An alternative option would be for close population health surveillance, with immunization provided at the earliest sign of measles occurrence.[6] Should the locale be endemic for vector-transmitted diseases such as malaria, then vector-control measures – such as controlled insecticide application and use of insecticide treated nets – should be implemented.[6,20,21]

The scenario brought about by drought and resulting famine is somewhat different. As the affected people may eventually flock to relief or refugee sites, problems attendant to such areas may similarly crop up. Thus, nearly a similar set of public health measures need to be implemented in the relief centers. The disaster itself, however, is not at all sudden, but happens on a protracted scale. A significant problem is mass starvation. The resulting malnutrition has as one of its consequences an increasing population vulnerability to infectious diseases. In addition to the other relief measures therefore, the provision of nutritional support should be given priority.[19,20]

While dead bodies do not pose as much of a threat for communicable diseases as popularly perceived, a few caveats that would need to be considered. Those that succumbed to cholera and highly communicable hemorrhagic diseases should be properly disposed of as early as possible.[4] Particular precaution should be exercised by those who handle the corpses, as they would be the most susceptible to getting infections from the process.[21] For most of the dead, however, there is no urgency in disposing of their bodies. Relatives should be given adequate opportunity to identify the deceased as well as undertake mourning rituals in accordance with their custom.[20]

In the event that preventive measures are not put in place or are not totally effective and people start to suffer from any of the possible illnesses, then first-line measures should also be at hand. This would include oral and intravenous rehydration solutions, as well as antibiotics for anticipated or endemic infections. Whenever possible, proper segregation if not isolation for those with frank infections should be done. Transport to higher tier medical facilities should be done for cases that cannot be adequately cared for in the locality.

The disaster scenarios presented presume several conditions. Foremost of these is that there will be an external response to the disaster area. Often, local health personnel or facilities are either rendered non-existent or inadequate by the calamity. Also, the response team or teams should coordinate with the local people or authorities, and situate themselves in the disaster vicinity or where the population has evacuated to. As such, the members of the acute response team have the additional responsibility of not only ensuring the adequacy and appropriateness of their subsequent interventions – they should also ensure that they do not become victims to the same afflictions that they came to address. They should therefore accept similar measures as those needed in the locale – such as, for example, prophylaxis against vector-borne diseases. The response team should also lead by example, particularly in such basics as proper hand-washing.

A concise algorithm of the infectious disease priorities with the given sets of disaster circumstances is shown in Figure 2. While the common patterns for particular disaster circumstances and anticipated infectious disease problems are provided, these are by no means universal or predictive. It remains crucial that the disaster response system or personnel maintain on-site surveillance at all phases of the disaster and regularly reevaluate needs and ensure the appropriateness of the relief measures.[6]

**Country-Specific Scenarios and Options**

For any country, the over-all disaster management approach should take into consideration the various circumstances that would have a bearing on the impact of the more probable disasters. The mitigation of the adverse effects of disasters is all the more important in developing countries as these may not have enough resources to remedy the after effects of such calamities. Thus, disaster management measures should be made more efficient and effective. Understanding the dynamics of disasters and thereby arriving at the most appropriate remedial policies is important for developing countries such as the Philippines.

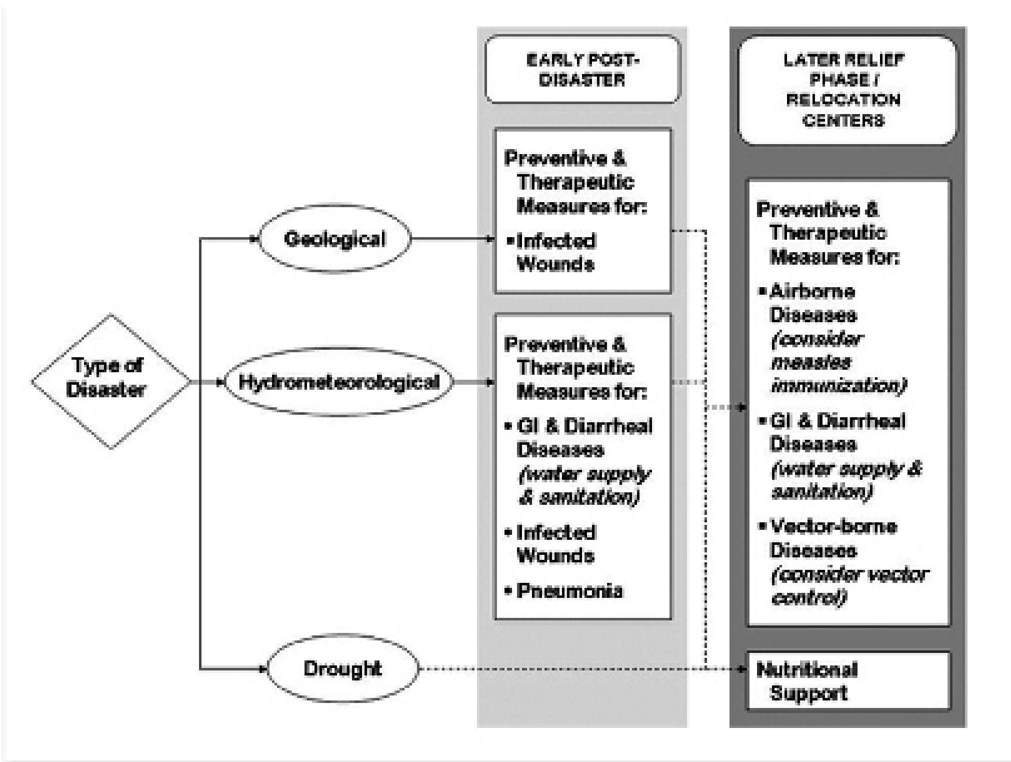


*Figure 2. Algorithm for the prioritization of infectious disease control measures during natural disasters*

As discussed earlier, the Philippines has established the NDCC to serve as the center of disaster management efforts in the country. Through the attached DOH-HEMS, there is a unit that focuses on health concerns, including infectious disease control in times of natural disasters.

But while these institutions are creditable, there remains some room for improvement. The DOH-HEMS, in particular, seems to be mostly reactive in its operations. One of its principal activities is the formulation of health teams for deployment to disaster areas. While meant to be able to respond to any calamitous situation, the HEMS does not have existing protocols or guidelines that are directed towards even the more probable disasters.[22] Likewise, little stress is placed on preventive and other pre-disaster community-level communicable disease mitigating measures.

A more integrated and contingent approach would make the DOH-HEMS, if not the nation-wide disaster management system, more efficient and effective. With infectious disease control as the focal point, there are several policy options that may be availed of to arrive at a more appropriate disaster management approach. The utility and relevance of these proposals are based on the details and concepts previously discussed. The framework integrating these recommendations is laid out in Table 2.

The foremost concern is to foster a greater degree of disaster preparation at the community level. This is not in reference to the local or regional response teams. Rather, the communities themselves should be made "disaster-ready", if not "disaster proof".

The lack of safe water is an almost universal occurrence following natural disasters. This leads to significant infectious disease morbidities, particularly following floods – still the most devastating disasters for the country. The availability of a clean water supply is most crucial in evacuation or relocation centers. In the Philippine setting, these centers are most often the local public schools. Stockpiling of sealed supplies of water in the latter – especially in the more flood and storm-prone areas of the country – will undoubtedly help avert communicable disease problems, particularly when there is a need for the people to relocate following a calamity. Dedicated supplementary toilet facilities should also be constructed in the anticipated evacuation areas. It goes without saying that the toilets should be weather-proof.

Immunizations, especially for measles, should be made more comprehensive. If public stocks of vaccines are short, immunizations for those living in disaster-prone areas may be prioritized. These would not only prevent outbreaks following disasters, but can also be done in better controlled and certainly more effective circumstances. Similarly, the control of endemic, particularly vector-borne communicable diseases should be pursued. In disaster-prone areas where access is restrictive and the reach of vector-control measures is hampered, the prior storage of an ample amount of insecticides in designated relief centers can facilitate later utilization.

The second recommendation is concerned with improving the actual response mechanisms of HEMS. While the HEMS has procedures in place for disaster response – including water decontamination, field immunization, and corpse disposal, among others – there are remaining gaps. HEMS needs to incorporate disaster and phase-specific contingency features into its response procedures. In essence, the HEMS response should not only be calculated but also graduated.

As may be gleaned from previous discussions, the anticipated requirements following a flood are different from those following an earthquake. The intervention requirements are also much different in the first three days after a disaster as compared to those of two weeks and later. The present policy of HEMS is to deploy teams drawn from various public city hospitals on a rotation basis. The system of deployment may be made more effective if specific teams were organized or oriented to function in specific disaster scenarios.

In terms of infectious disease control, there should be greater participation of public health professionals immediately after the first two to three days of the calamity. At that point, people able to look primarily into ensuring water supply and sanitation conditions, among other concerns, would be more vital in stemming communicable diseases.

The ability of the members of the response team to avoid exposure to or be resistant to possible infections should be considered. For example, as malaria prophylaxis may not be feasible on an immediate basis, the members of the team should at least be supplied with repellants or insecticides for their personal use should they need to be deployed to malaria endemic areas.

Further impetus on site assessment and continuous surveillance should be given. This would be the best way to ensure the appropriateness of any intervention.

Finally, the coordination between the DOH-HEMS with other concerned agencies, including the local health authorities or personalities, has to be strengthened. While the HEMS structure is well-suited to address emergent medical cases following epidemics, there are factors outside of the defined medical or health domains that need to be just as importantly addressed. Basic utility, security, and shelter provision – even the suggested prior stockpiling of water supply – are crucial to health promotion (and effective infectious disease control) but these would be beyond HEMS' capacities. As these need to be made available if disease outbreaks are to be averted or suppressed, then the DOH if not HEMS should ensure that these equally important areas are competently dealt with by the concerned agencies.

**Table 1. Summary of the frequency, population incidence, and international rank by category of natural disasters affecting the Philippines from 1994 to 2003 (data based on the Center for Research on the Epidemiology of Disasters statistics1)**

| Natural Disaster Event | | **Total Frequency of Event for 1994 - 2003** | Average Annual Incidence of Event | Average Number of People Affected per Event Per 100,000 Population | International Rank Philippine total frequency of given disaster event compared to totals of 238 countries/ territories | Ranking Comments |
|---|---|---|---|---|---|---|
| Hydro-meteorological | Floods[a] | 80 | 13.33 | 404.19 | 5th | India, China, Indonesia, and the US have higher frequencies |
| | Windstorms[b] | 154 | 25.67 | 3,154.6 | 2nd | The U.S. has the highest frequency |
| | Droughts[c] | 8 | 1.33 | 194.4 | 17th | 33 countries have higher rankings and 9 countries share the 17th rank |
| Geological | Earthquakes & Tsunamis | 13 | 2.17 | 122.3 | 8th | 9 countries have higher rankings, topped by China, Iran, and Indonesia |
| | Volcanic eruptions | 13 | 2.17 | 72.46 | 2nd | Indonesia has the highest frequency |

*a – includes landslides, mudflows, avalanches, tidal waves; b – includes typhoons, cyclones, hurricanes, storms, winter storms, tropical storms, and tornadoes; c – includes extreme temperatures, wildfires and complex disasters associated with droughts*

**Table 2. Proposed DOH-HEMS (Philippines) Infectious Disease Mitigation Matrix for Natural Disasters**

| LEAD AGENCY | Health-Related Tasks by Disaster Phase | | | |
|---|---|---|---|---|
| | Pre-Event | Acute Event | Relief | Recovery |
| HEMS | Response System Readiness | Status Assessment | Triage & Treatment<br>Surveillance<br>Team Prophylaxis | Surveillance & Evaluation |
| **Joint** | Local Adequacy & Preparedness<br>• water supply<br>• sanitation capacity<br>• means of vector control | Rescue | Institute Appropriate Public Health Measures<br>• Safe water<br>• Sanitation<br>• Vector control<br>• Immunization<br>• Corpse disposal as indicated<br>Transport of Communication | Scalling Up of Health Services<br>Nutrition Programs |
| **Other Agencies** | Hazard Avoidance | Overall Assessment & Coordination | Adequate Shelter<br>Security | Rebuilding & Restoration |

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