

Evaluation of flood preparedness in public health facilities in Eastern Province, Sri Lanka

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A thesis

submitted in partial fulfillment of the
requirements for the degree of

Master of Public Health

University of Washington

2016

Committee:

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Program Authorized to Offer Degree:

Global Health

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Abstract

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Background

Sri Lanka, a lower-middle income country with universal healthcare, is vulnerable to floods and other hydro-meteorological disasters. Climate change is projected to increase the intensity of these events. This study aimed to assess the functional flood preparedness in Trincomalee District, Eastern Province, within a health system framework, to understand how government guidelines on disaster preparedness and management are translated and disseminated within rural health facilities, and to assess climate change awareness among physicians in the study area.

Methods

This was a cross-sectional, descriptive, mixed methods study conducted in Trincomalee District in Eastern Province. Face-to-face surveys were conducted in 31 of the district's 34 public healthcare facilities, using a pre-tested, structured questionnaire. Among these 31 facilities, 7

were selected using a simple random sample for an additional in-depth interview, and 3 interviews were also conducted with Medical Offices of Health, which provide public health support during floods. Respondents were Medical Officers in Charge or their equivalent. Descriptive statistics from the survey results were generated using Stata13, and interviews were analyzed in Atlas.ti.

Results

Two Ministry of Health hospitals, three base hospitals, 11 divisional hospitals, and 15 primary care units (PMcus) were included in this study. Six respondents (19.4%) reported flooding in their facility in the last five years, and 19 (61.3%) reported flooding in their catchment area in the same time period. For health workforce, 77.4% of respondents reported not enough staff to perform normal service delivery during disasters, and 25.5% reported staff absenteeism due to flooding in the last five years. Several respondents expressed a desire for more disaster-specific and general clinical training opportunities for themselves and their staff. Most respondents (80.7%) reported no delays in supply procurement during weather emergencies, but 61.3% reported they did not have enough supplies to maintain normal service delivery during disasters. Four facilities (12.9%) had disaster preparedness plans, and 4 (12.9%) had any staff trained on disaster preparedness or management within the last year. One quarter (25.8%) of respondents had received any written guidance on disaster preparedness from the regional, provincial, or national level in the last year.

Discussion

While there is a strong universal health system operating in Sri Lanka, improvements are needed in localized and appropriate disaster-related training, resources for continuing clinical education,

and investments in workforce to strengthen flood and other disaster resilience within the public healthcare system in Trincomalee District.

Background

Climate change is a reality that is uncontested in the scientific community. These changes in climate are projected to have dramatic consequences for the environment and human health, from more extreme weather events to changes in the distribution and incidence of vector-borne infectious diseases and increases in heat-related illnesses. All of these will put pressure on health systems.

The Intergovernmental Panel on Climate Change (IPCC) cites robust evidence that warming during the 21st century will put more people at risk of being affected by floods, and high confidence that urban areas without proper infrastructure will be at particular risk for risks including storms and extreme precipitation, sea level rise and storm surges, and inland and coastal flooding (1). The Lancet Commission on climate change posits that “the ability of health systems to respond effectively to the direct and indirect health effects of climate change is a challenge worldwide, especially in many low-income and middle-income countries, which suffer from disorganised, inefficient, and under-resourced health systems” (2). Reflective of this, building resilience and adaptive capacity to climate-related hazards and natural disasters is part of the United Nations Sustainable Development Goals (3). Health facilities, as a central aspect of health infrastructure and often the first line of contact for disaster victims, are a major component of disaster preparedness and response. It is therefore imperative to understand the functional capacity of health facilities to prepare for and respond to hydro-meteorological hazards.

Disaster risk can be divided into: intensive, characterized by high mortality and direct economic loss, and extensive, characterized by “large number of affected people and damage to housing and local infrastructure, but not to major mortality or destruction of economic assets” (4). Flooding is a global issue, and is not always unpredictable or disaster-magnitude. However,

“floods become disasters when they are of unusual proportion, occur in unusual places, or occur unexpectedly” (5). Risk management theory often posits that there is no such thing as a natural disaster; “what makes a hazard into a disaster depends primarily on the way a society is ordered” (6). There are no disasters without human components, and it is essential to understand the human systems in place in high-risk areas and the resilience and adaptation capacity of these systems.

Sri Lanka, as a small island nation, is at risk for numerous types of disasters, including floods, droughts, tsunamis, cyclones, coastal erosion, sea level rise, and landslides. The 2004 tsunami, which killed over 30,000 people and left over 5,000 missing in Sri Lanka alone (7), was one of the deadliest natural disasters in recorded history. Other less intensive climate-related disasters, however, form the bulk of natural disasters in Sri Lanka. Among these, floods are the most common natural disaster in the country, and the third most common type of recorded disaster overall between 1974 to 2007, behind epidemics and animal attacks (8). For average annual flood exposure in proportion to population, Sri Lanka ranks eleventh in the world (9). Although mortality is low, floods annually displace hundreds of thousands of people across the country and have widespread effects.

Despite the less intensive nature of flood risk, mortality from weather-related disasters¹ increased in Sri Lanka from 1974 to 2007 by 1.70%, while damage to houses increased by 5.68% (4). Projections suggest that one-day heavy rainfall events will increase, which can lead to rapid flooding. A spatio-temporal analysis of rainfall in the Eastern Province of Sri Lanka from 1980-2010 showed that while the number of rainy days decreased, rainfall itself increased, suggesting increased intensity of rainfall events (10). The study states that “the apparent increased incidence

¹ Floods, flash floods, urban floods, rains, fires, forest fires, mudslides, avalanches, landslides, tropical cyclones, storms, gales, strong winds, hailstorms, tornados, electric storms, lightning, thunderstorms, droughts, heat waves, cold waves, frost, snowstorms

of flooding and droughts in the recent past could probably be attributed to such changes in the temporal pattern of rainfall distribution” (10).

Studies have found correlations between the proportion of households living below the poverty line and damage to houses due to flooding (4). Trincomalee District, the site of this study, has a mean monthly household income of USD\$240 (Rs 34,577), lower than the national average of \$318 but higher than the Eastern Province average of \$213 (11). The percentage of the population below the poverty line is 9.0% in Trincomalee District and 11.0% in Eastern Province, compared with 6.7% nationally (11), suggesting increased risk and decreased resilience for disasters.

The 2004 tsunami was an intensive disaster that catalyzed the creation of disaster response mechanisms within the government. Since the 2004 tsunami, the lead agency for disaster management has been the Disaster Management Centre (DMC). The DMC coordinates with the Disaster Preparedness and Response Division in the Ministry of Health, which acts as a focal point on the healthcare aspects of all emergencies. The focal point for climate change in Sri Lanka is the Climate Change Secretariat, housed in the Ministry of Mahaweli Development and Environment and Renewable Energy, and the Directorate of Environmental and Occupational Health functions as the focal point for climate change in the health sector.

The health services in Sri Lanka function under a Central Ministry of Health. Since the implementation of the Provincial Councils Act in 1989, health services were decentralized, with separate provincial-level Ministers of Health in the nine provinces. The Central Ministry of Health is responsible primarily for the protection and promotion of health among the population, and for providing technical support to the Provincial Ministries. In addition, the Central Ministry manages the network of teaching hospitals in the country. The key functions of the Central

Ministry include the setting of policy guidelines, medical and paramedical education, management of teaching and specialized institutions, and bulk purchasing of medical requisites. The Sri Lankan health system is overseen by the Ministry of Health, Nutrition and Indigenous Medicine at the national level, and decentralized to nine Provincial Directors of Health Services (PDHS) which in turn oversee the Regional Directors of Health Services (RDHS) for each district. Curative public facility types include the National Hospital in Colombo, teaching and specialized hospitals, provincial and district general hospitals, base hospitals, divisional hospitals and primary medical care units (PMCU), which are the smallest type of facility responsible for providing first-line care. In addition, there are Medical Offices of Health, which are responsible for preventive health measures, including surveillance, nutrition interventions, and other public health efforts. They also serve as an organizing mechanism, in collaboration with the divisional secretary, for flood response, while RDHS offices coordinate with the District Secretariats. Their duties in this area include setting up camps and providing aid for displaced people, monitoring water and sanitation, and mosquito control during and post-flood.

Disaster preparedness and response falls under the purview of the Ministry of Disaster Management, with relevant coordinating units in other ministries. In the Ministry of Health, the coordinating body is the Disaster Preparedness and Response Division, which is responsible for disseminating guidance to the PDHS through a focal point in each province.

Methods

Study type:

This is a cross-sectional, descriptive, mixed methods study using a structured questionnaire and in-depth interviews.

Study/target population:

The population was public health facilities (curative) and Medical Offices of Health (preventive) in Trincomalee District, Eastern Province, Sri Lanka. The city of Trincomalee is the location of both the Trincomalee District RDHS and Eastern Province PDHS offices. The units were individual public hospitals and primary medical care units within this population.

Study scope:

This study assessed the functional preparedness of public healthcare facilities at all levels in Trincomalee District for flood events, as well as their general preparedness for disasters.

Study area:

Trincomalee District, one of four districts in Eastern Province, was selected for this study. The district covers 2,727 kilometers, and the population in 2012 was 378,182. The district has 34 curative health facilities and 11 Medical Offices of Health (preventive health). In 2016 the Trincomalee District healthcare organization included three base hospitals, 11 divisional hospitals, 18 primary medical care units (PMcus) overseen by the PDHS, and two general hospitals overseen directly by the Ministry of Health.

Study sample:

A list of all 34 public healthcare institutions in Trincomalee District was procured from the Eastern Province PDHS. Participants were Medical Officers in Charge (MOIC) or equivalents. A pre-tested, structured questionnaire (Appendix 1) adapted from the WHO Safe Hospitals checklist was administered face-to-face for 31 of the institutions. Among the three not included, the medical officers were on leave at two, and the third facility was not functioning. The questionnaire investigated flood history within the health facility and in the surrounding area, communication on disaster management with Provincial and Regional Director of Health

Services Offices, staff capacity, procurement procedures, and disaster preparedness. Among these 31 health facilities, seven were selected using a stratified random sample for additional in-depth interviews with the same individual who completed the survey on behalf of their institution. An additional three interviews were conducted with representatives from Medical Offices of Health, for a total of 10 in-depth interviews. Informed consent was obtained from all interview participants, and interviews were tape recorded and transcribed for analysis.

Ethical considerations:

This study received a determination of non-research from the University of Washington Human Subjects Division of the IRB. It was approved after full committee review by the Ethical Review Committee of Department at Trincomalee General Hospital in Eastern Province, Sri Lanka.

Analysis:

Stata13 was used to analyze quantitative data. Qualitative interview data were transcribed, de-identified, and analyzed in ATLAS.ti.

Results

Table 1: Characteristics of facilities surveyed (n=31)

Variable	n (%), mean (SD), or med (IQR)
Health facility characteristic	
Type of facility	
Line Ministry hospital*	2 (6.5%)
Base hospital	3 (9.7%)
Divisional hospital	11 (35.5%)
Primary medical care unit	15 (48.4%)
Mean bed capacity	
Line Ministry hospital	317.5 (SD=116.7)
Base hospital	124.7 (SD=90.7)
Divisional hospital	37.4 (SD=18.7)
Primary medical care unit**	0.3 (SD=0.9)
Mean patients per day (in- and out-patient)	

Line Ministry hospital	575.0
Base hospital	550.0
Divisional hospital	150.1
Primary medical care unit	105.2
Facility damaged in 2004 tsunami	5 (16.1%)
Generator	18 (58.1%)
Running water in facility	29 (93.6%)
Respondent characteristics	
Current position	
Registered Medical Officer or MOIC	26 (83.9%)
Chief Administrative Officer	1 (3.2%)
Other	4 (12.9%)
Mean years respondent worked in facility	3 (IQR=2–5)
Minimum	0.08
Maximum	17
Years respondent had practiced as physician	13 (IQR=3–23)
Have an existing disaster protocol or plan	4 (12.9%)
Disaster training for any facility staff within last 1 yr	4 (12.9%)
Flooding history	
Floods in facility (structure or premises)	6 (19.4%)
Floods in catchment area	19 (61.3%)

*Hospital controlled directly by the Ministry of Health

**With infrequent exceptions, PMCUs do not have inpatient capacity

Within the last five years, six facilities (19.4%) had directly experienced flooding (defined as standing water lasting more than one day in buildings or grounds), while 19 facilities (61.3%) had experienced flooding in their catchment area. Floods occur during the rainy season, which runs November through January in this area. Among facilities that had experienced flooding directly, the experiences were heterogeneous: mean number of floods was 4.7 (SD=3.2, min=1, max=10), while average length was 25.2 days (SD=33.2, min=3, max=90) and cleanup lasted an average of 4.3 days after the end of the event (SD=5.5, min=1, max=15). All reported impaired road access to and from their facility, while four reported power outages and two reported phone lines down.

Leadership/governance

Communication regarding disaster preparedness was rare with both the Provincial Director of Health Services (PDHS) and Regional Director of Health Services (RDHS) offices. Because the RDHS serves as the intermediary between health facilities and the PDHS, only two facilities (6.5%) reported any disaster communication directly with the PDHS in the last year. Twelve (38.7%) facilities reported communication on disaster preparedness with the RDHS in the last year; one facility reported communication ≥ 12 times, nine reported 1-5 times, and two reported 6–11 times. Ten of the 12 facilities reported they were somewhat or completely satisfied with both the frequency and quality of communication. Respondents were also asked if they had received any instructive documents on disaster preparedness of any sort from the PDHS, RDHS, or DMC (Disaster Management Centre) within the last year. Three facilities (9.7%) reported receiving documents from the PDHS, three (9.7%) from the RDHS office, and two (6.5%) from the DMC. Both facilities receiving documents from the DMC were larger hospitals.

Emergency preparedness

Four facilities (12.9%) had an emergency preparedness plan, all of which were in writing. One facility performed an exercise or drill of the plan in the last year. Four respondents (12.9%) reported anyone in their facility having attended a disaster training of any sort in the last year. Many respondents had never received training, or had received only one during their medical education. Topics of interest for a training included emergency coordination and management, injury treatment, and rescue and evacuation procedures. Among those who had received non-academic training, many attended International Committee of the Red Cross (ICRC) trainings conducted during the civil conflict. In interviews, PMCU and base/divisional hospital respondent assessment of emergency preparedness was mixed, suggesting a moderate level of infrastructure

and high personal willingness for disaster response, as well as recognition that knowledge specific to weather-related disasters and disaster coordination was not ideal. This sentiment regarding emergency preparedness was captured by one respondent:

We can handle it, because everybody is going to do their best, right, people will come to work, staff will come to work, and they will do as much as they can, but if you take like, are you trained? Do you have enough stuff? Then no. But we will do everything we can. Staff will do everything here; we will use every drug we have, everything we know we will do, but we are not trained to do it.

During interviews, older doctors also expressed greater confidence in handling disaster situations due to their greater work experience and practice during the conflict. One respondent completed most of his internship (American equivalent: residency) in a conflict area: “so that experience [in training hospital] and during the conflict, the ethnic conflict, that time also I think around three months, we worked in the surgical team managing these casualties brought by the ships, so around 4,000 people, wounded people, we managed.”

Continuous training of any sort was infrequent. Up-to-date medical information is not disseminated in a way that many respondents found accessible, and their university medical education was the last that several had received. The rural nature of many facilities in this area amplified this, and there is a lower level of post-war infrastructure in Trincomalee District than other parts of the country. Self-driven knowledge acquisition was a theme cited frequently in interviews:

For the doctors in the periphery they are like just dumped, and they are not, there are sort of no updates; if we are interested in only we get ourselves by the internet, we don't get the proper protocol, even for the clinical management we don't get the protocols.

Workforce

Facilities reported their number of clinical staff (defined as doctors, nurses, midwives) and minor staff (attendants, drivers, dispensers, and cleaners). Primary medical care units had an

average of 1.2 clinical staff members, most frequently one physician and an average of 5.1 total staff members. Divisional hospitals reported 5.5 clinical and 17.5 total staff. Base hospitals reported 62.3 clinical staff and 115.0 total staff, with considerable variation (n=3, min/max 10–90 and 27–167, respectively). Ministry of Health hospitals also showed considerable variation, with an average of 438 clinical staff and 727 total staff (n=2, min/max 192–684 and 437–1017, respectively).

When asked if they had enough staff to perform normal service delivery during a flood or other weather emergency, 24 facilities (77.4%) reported that they did not; these were 12 PMCUs (80.0% of 15 total PMCUs), 10 divisional hospitals (90.9%), and 2 base hospitals (66.7%). Both Line Ministry hospitals reported enough staff. In interviews, several respondents in PMCUs and base or divisional hospitals remarked that they did not have enough staff for even non-emergency periods. Eight facilities (25.8%) reported staff absenteeism due to flooding in the past five years, while six said this had created a problem in service delivery. However, only three facilities (9.7%) reported that there were ever times when services were not available due to storms or floods, with the most commonly cited reason being impaired or blocked road access to the health facility. Many respondents described their staff doing “whatever it takes” to get to work during floods and working long hours to see all patients. As one physician in a facility that regularly experiences flooding explained, “they would somehow come, because they know that if one person doesn't come, there is no person to cover for them.”

Human resource shortages were present at many facilities. Most commonly, there were shortages of nursing officers, leaving physicians as the only or primary trained clinical staff in the facility. Because of this shortage, non-clinical staff often perform minor procedures (e.g., wound care, IV insertion) and dispense medications in place of a dispenser. The majority of

PMcUs had one doctor who saw an average of just over 100 patients per day. Many respondents described the encompassing nature of their work; they often live on hospital premises, and are left with little time to read circulars, seek additional training, or address long-term issues of resiliency and preparedness. Two respondents explained their experiences:

So such people, they don't want to get training here, they just want to run out from these stations, because there are no facilities, nothing. Only two doctors, 15 nights, you have to always be inside of the hospital, you have to attend the patient any time and it is really stressful to the patient, because when you are staying in the quarters it means you are inside of a hospital, that's a mentality that myself I know.

They usually send some circular or something, I don't know when it was sent, because here there are only doctors working with this station, no? So most of them won't have time to participate in that program, that's the problem. Most of the people here [minor staff] are uneducated; when we go for that program the patients create unnecessary problems, so most of the time we [doctors] like to be in the hospital. You can see all the roads are broken; the patients came here with difficulty, so we also like to be here in the hospital.

As minor staff made up the majority of the workforce at most smaller facilities (divisional hospitals and PMcUs), the strengths and weaknesses of these staff also emerged as a theme. Some respondents mentioned that they benefited greatly from the experience of minor staff; for example, some are skilled at small procedures, and most are from the local area and therefore have a better understanding of the community. Others thought better training of minor staff would reduce overload on clinical staff, and would better position facilities to perform everyday service delivery and be better prepared for disaster situations. As one respondent explained, many minor staff “can't even dress a wound. So they should have something like that, like generally they should teach everybody, if you are working in a hospital, how to manage small things.”

Supplies and facility infrastructure

Twenty-nine facilities (93.6%) had first-aid kits. The majority (80.7%) reported no delay in supply procurement during weather emergencies, while two (6.5%, both divisional) reported delays of less than a day and four (12.9%, 1 base, 3 divisional) reported delays of 1–6 days. Several respondents reported sharing supplies with other nearby facilities during emergency and non-emergency periods. Nineteen respondents (61.3%) reported they did not believe their facility had enough medical equipment and supplies to maintain normal service delivery during a weather emergency. Supplies listed as lacking included medical equipment (ECD monitors, oxygen cylinders, and other instruments) as well as general facility equipment such as fridges, beds, trolleys, and perimeter fencing or walls.

Overall preparedness

Respondents were asked how prepared they felt their health facility was overall for both a major flood event and a disaster of any sort using a five-point scale: Completely unprepared (1), Somewhat unprepared (2), Neither prepared nor unprepared (3) Somewhat prepared (4), and Completely prepared (5). Mean response was 3.3 for floods and 3.4 for any disaster.

In interviews, preparedness was perceived as important both within the health facility and for the community at large. As one Medical Officer in Charge described: “so we have to educate...we have to assess the people and educate them about the disaster. So, to reduce their panic, that is important.”

Three in-depth interviews were conducted with Medical Officers of Health. Their responses suggested their ability to respond to floods was mostly satisfactory, with enough resources (sometimes from outside the district) to manage. Improvements suggested echoed the responses from curative facilities listed in these results: staff shortages and lack of qualified

dispensers during emergencies, and a desire for more training to strengthen preparedness.

Community trainings were also suggested. A respondent from a Medical Office of Health in a flood-prone area characterized the public’s response in their catchment area: “there is a lack of social mobilization. People are not aware how to act during a disaster; they are concerned about food and aid, but not about sanitation or mosquito-borne illnesses.”

Figure 1: Perceptions of overall preparedness for a major flood

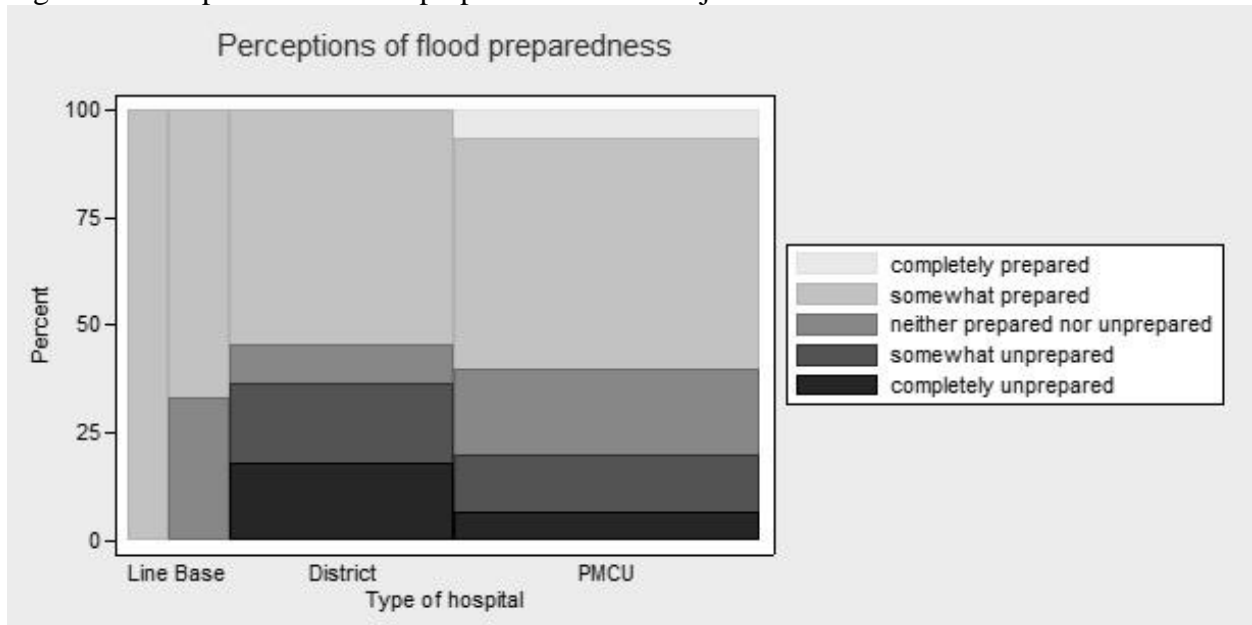
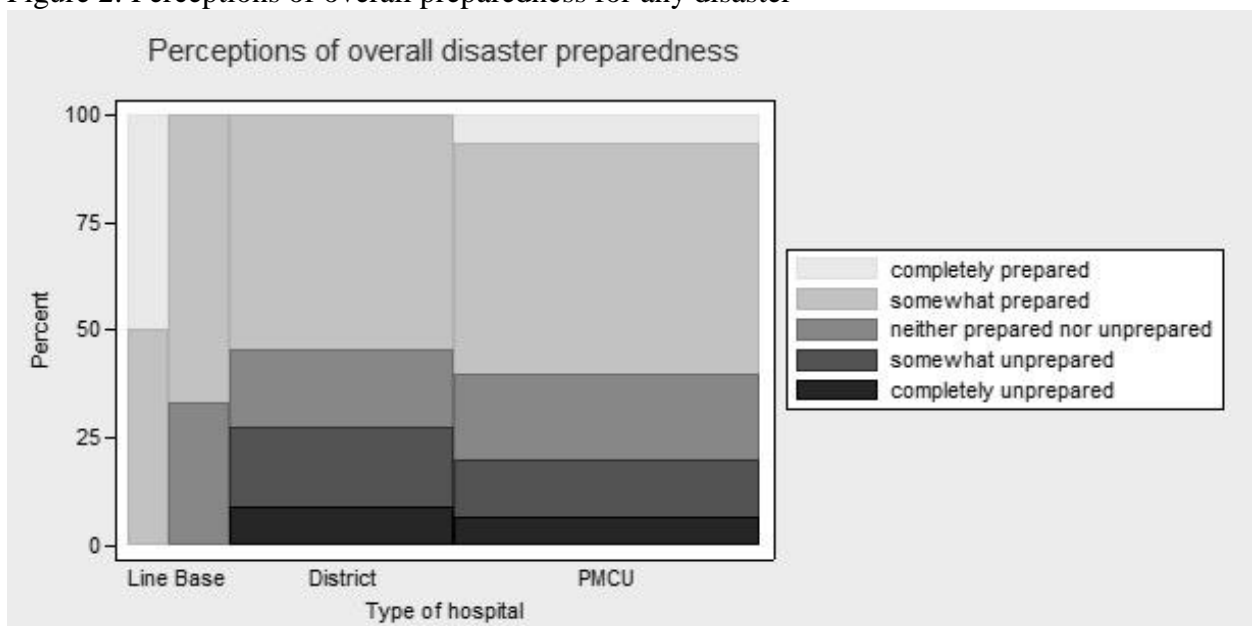


Figure 2: Perceptions of overall preparedness for any disaster



Climate change awareness

Table 2: Climate change perceptions

Climate change questions	n (%)
Do you think flood and storm events happen more frequently than they used to?	
Yes	10 (32.3%)
No	18 (58.1%)
Don't know	3 (9.9%)
Do you think flood and storm events are stronger or more intense than they used to be?	
Yes	9 (29.0%)
No	16 (51.6%)
Don't know	6 (19.5%)
Do you think that climate change is occurring in Sri Lanka?	
Yes	20 (64.5%)
No	7 (22.6%)
Don't know	4 (12.9%)
Do you think changes in climate can affect human health?	
Yes	28 (90.3%)
No	1 (3.2%)
Don't know	2 (6.5%)

Respondents were asked questions on their perceptions of climate change (Table 2). In addition to the responses above, two reported that they had received information from any governing body on climate change and health issues. Awareness about climate change was mixed among respondents. While just under two-thirds responded that climate change was occurring in Sri Lanka, over 90% of respondents acknowledged that changes in climate (seasonal or systematic) can affect human health. During the rainy season, respiratory tract infections, viral fever, diarrhea, conjunctivitis, and asthma were cited as frequent problems, while the hot season brings rashes and other skin problems, chicken pox, and allergies. Some respondents only saw it as a problem in other parts of the country, such as the west coast, or in the mountains where landslides occur after heavy rains.

Discussion

The WHO outlines ten components for a climate resilient health system, rooted in the six WHO health systems building blocks: financing, service delivery, essential medical products and technologies, health information systems, health workforce, and leadership and governance. This study focuses primarily on service delivery and health workforce. The framework calls for an adequate baseline level of qualified staff to create a climate-resilient system. Many respondents felt they were understaffed and that staff in their facilities were overworked, leaving time only for direct clinical care. Getting qualified nurses to Trincomalee District appears to be a major challenge. Possible reasons for this include the rural location of many peripheral hospitals and the lack of a nursing college in the district.

Lack of continuing professional education was a common thread throughout this study. Respondents cited the Internet or private courses as their options for obtaining additional training or certifications. The literature suggests that efforts to improve clinical information (CI) among physicians usually takes place at the tertiary level in more populated areas, and rarely focus on the primary or district level of healthcare (12). The urban/rural dynamic is also an important consideration. Trincomalee District is far from the capital, and many facilities are geographical isolated. Physicians in rural areas are frequently at a disadvantage when it comes to information access due to professional and geographic isolation, less internet and other information and communication technology infrastructure, and limited professional development opportunities (12-14).

The lack of training on disaster preparedness and management is one facet of this information shortage. A minority of respondents, in either preventive or curative settings, had ever received training on preparedness or response for any sort of disaster situation, and plans

and protocols were unclear. Similar situations were found in hospitals experiencing floods in rural India (15), rural Vietnam (16), and Thailand (17). The lack of continued education opportunities and disaster-specific information and training is a barrier to creating a climate change-resilient health system in Trincomalee District, and creates a situation where some health professionals are not confident or up-to-date in their knowledge of procedures or protocols. Successful strategies for flood preparedness in other settings in Asia include local meetings to promote national flood policies (18), flood trainings and plans, and human resource management including regularly updated staff contact lists and adequate staff for shift rotations (19).

The context of the three-decade civil conflict that ended in 2009 and its implications for health systems is also important. Distribution of health-related human resources has been historically uneven, with shortages in the North and East due to extended conflict (20). These provinces have worse health indicators than other parts of the country (21). Interview respondents indicated that infrastructure is still being rebuilt in the Eastern Province, and camps for internal displaced persons (IDPs) still operate in Trincomalee District. It is important to evaluate and create future disaster-preparedness programs within the context of continued post-conflict recovery in these regions.

Overall, disaster resiliency in the Sri Lankan primary health system has both strong points and areas that need strengthening. The government provides universal healthcare, with wide geographic coverage. Sri Lanka has some of the best health indicators in the SE Asia region (22). Ninety-three percent of women attend four or more antenatal care visits (compared to an average of 54% in the 11-country WHO SEARO region²), and births attended by skilled health personnel and measles immunizations are both at 99% (compared to 67% and 78%, respectively, in the WHO region) (23). Climate change adaptation across sectors is increasingly prioritized by

² Bangladesh, Bhutan, DPR Korea, India, Indonesia, Maldives, Myanmar, Nepal, Sri Lanka, Thailand, Timor-Leste

the government, and the link between climate change and health is acknowledged in the National Climate Change Adaptation Strategy and other national policies (24).

However, climate change is happening now and projected to intensify. In Sri Lanka, average temperature is expected to rise between 1.1 and 2.4°C by 2100 (25), while the population, currently with a density of 300 people per km², continues to grow at a rate of 0.9% (26). These trends will amplify the impacts of disasters, like storms, floods, droughts, and sea level rise, in addition to health problems such as increased heat-related illnesses and changes in prevalence and distribution of vector-borne diseases. These added stresses to the health system could magnify small issues, including lack of knowledge about how to prepare for and respond to disasters, understanding of climate-sensitive health issues, and limited human resources at every level. Further, while climate change policies exist at the national level in Sri Lanka, information is not yet reaching the peripheral level of public healthcare. Current communication channels are not effective for disseminating information, and must be improved.

This research had some limitations. It only included one region of Sri Lanka. This limits the generalizability of the study, as type and intensity of hydro-meteorological hazards vary widely throughout the country. Preparedness among health facilities may also vary widely throughout the country. Subjective responses in the study questionnaire were left to the interpretation of the respondent, and may not reflect the experiences or opinions of other facility staff. Finally, this study only includes public health facilities, and did not include private health facilities or traditional medical providers (Ayurvedic or other) in either the public or private sector.

Conclusion

While there is a strong universal health system operating in Sri Lanka, there are still improvements to be made in disaster preparedness, particularly in the context of resilience to climate change. While some hazards-specific preparedness, such as flood early warning systems or disaster management training, may be necessary, it is important to also address system strains such as human resource shortages. Health system strengthening improves resilience to all hazards, but should be improved with disasters in mind. Investments in workforce, disaster training that ensures broad access, and better resources for continuing education are all adaptation strategies that would improve disaster response and climate change mitigation now and in the future.

Appendix 1: Questionnaire

Background

What is the name of this facility? _____

When was this health facility built? _____

What type of facility is it?

Medical Office of Health

Teaching hospital

Base hospital

District hospital

Peripheral hospital

Other (please specify) _____

What is the bed capacity? _____

Does this facility have a generator? _____

What is your current position? _____

How many years have you worked in your current position at this facility?

How many years have you practiced as a physician? _____

What is your contact information (phone number/email)? _____

Flood history

1. Has this facility experienced flooding in catchment area in last 5 years/

Yes

No

2. Has this facility experienced flooding on premises since in last 5 years?

Yes

No (*please proceed to question 8*)

3. If so, how many times has your facility experienced flooding since in last 5 years?

4. What was the date (month and year) of last flood? _____

5. How many days did it last? _____

6. Duration of hospital clean-up/renovation (days)? _____

7. During the last flood, did you facility experience:

Phone lines down

Internet down

Power outages

Road access to health facility impaired

Flood protocols and plans

8. Does the health facility have an overall emergency preparedness plan?

Yes

No (*please proceed to question 13*)

9. Is the health facility emergency plan documented in writing?

Yes

No

10. When was the plan last updated?

Within past year

Within last 1-3 years

More than 3 years ago

Don't know

11. Has your facility ever conducted an exercise or drill this emergency preparedness plan?

Yes

No (please proceed to question 13)

12. How often have you conducted an exercise or drill in the last year? _____

13. Does your hospital have an existing flood protocol?

Yes

No (please proceed to question 16)

14. Has your facility ever conducted an exercise or drill of flood protocol?

Yes

No (please proceed to question 16)

15. If yes, how often have you conducted a drill in the last year? _____

16. Have you or anyone in your health facility participated in a **disaster preparedness training** in the last year?

Yes

No (please proceed to question 20)

17. How many trainings have you or someone in your health facility participated in during the last five years? _____

18. On a scale of 1 to 5, how sufficient do you think the *frequency* of training is?

Completely insufficient	Somewhat insufficient	Neither sufficient nor insufficient	Somewhat sufficient	Completely sufficient
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

19. On a scale of 1 to 5, how sufficient do you think the *quality* of training is?

Completely insufficient	Somewhat insufficient	Neither sufficient nor insufficient	Somewhat sufficient	Completely sufficient
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Leadership/government

20. How often have you communicated with the **PDHS** about disaster preparedness and response within the last year?

At least one time per month

6-11 times

1-5 times

Have not communicated on this topic (*please proceed to question 23*)

21. How satisfied do you feel with the *frequency* of communication?

Completely dissatisfied	Somewhat dissatisfied	Neither satisfied nor dissatisfied	Somewhat satisfied	Completely satisfied
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

22. How satisfied do you feel with the *quality* of communication?

Completely dissatisfied	Somewhat dissatisfied	Neither satisfied nor dissatisfied	Somewhat satisfied	Completely satisfied
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

23. How often have you communicated with the **RDHS** about disaster preparedness and response within the last year?

At least one time per month

6-11 times

1-5 times

Have not communicated on this topic (*please proceed to question 26*)

24. How satisfied do you feel with the *frequency* of communication?

Completely dissatisfied	Somewhat dissatisfied	Neither satisfied nor dissatisfied	Somewhat satisfied	Completely satisfied
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

25. How satisfied do you feel with the *quality* of communication?

Completely dissatisfied	Somewhat dissatisfied	Neither satisfied nor dissatisfied	Somewhat satisfied	Completely satisfied
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

26. Are instructive documents on disaster preparedness made available to your facility from **PDHS**?

Yes

No (please proceed to question 30)

27. If yes, how satisfied are you with the **frequency** with which you receive these documents?

Completely dissatisfied	Somewhat dissatisfied	Neither satisfied nor dissatisfied	Somewhat satisfied	Completely satisfied
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

28. How satisfied are you with the **quality** of these documents?

Completely dissatisfied	Somewhat dissatisfied	Neither satisfied nor dissatisfied	Somewhat satisfied	Completely satisfied
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

29. Are instructive documents on disaster preparedness made available to your facility from **RDHS**?

Yes

No (please proceed to question 32)

30. If yes, how satisfied are you with the **frequency** with which you receive these documents?

Completely dissatisfied	Somewhat dissatisfied	Neither satisfied nor dissatisfied	Somewhat satisfied	Completely satisfied
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

31. How satisfied are you with the **timeliness** with which you receive these documents?

Completely dissatisfied	Somewhat dissatisfied	Neither satisfied nor dissatisfied	Somewhat satisfied	Completely satisfied
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

32. Are instructive documents on disaster preparedness made available to your facility from the **Disaster Management Centre**?

Yes

No (please proceed to question 34)

33. If yes, how satisfied are you with the **frequency** with which you receive these documents?

Completely dissatisfied	Somewhat dissatisfied	Neither satisfied nor dissatisfied	Somewhat satisfied	Completely satisfied
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

34. How satisfied are you with the **timeliness** with which you receive these documents?

Completely dissatisfied	Somewhat dissatisfied	Neither satisfied nor dissatisfied	Somewhat satisfied	Completely satisfied
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Healthcare financing

35. How satisfied are you with the level of funding this health facility receives for flood and storm preparedness and response?

Completely dissatisfied	Somewhat dissatisfied	Neither satisfied nor dissatisfied	Somewhat satisfied	Completely satisfied
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

36. Do you have funds for weather emergencies of any sort in your annual operating budget?

Yes

No *(please proceed to question 38)*

37. If yes, are any of these emergency funds specifically for flood preparedness or response?

Yes

No

Information management

38. Do you report flood events?

Yes

No

39. If so, to whom? *(Please check all that apply)*

RDHS

PDHS

Disaster Management Centre

- Disaster Preparedness and Response Unit
- Other Ministry of Health entity
- Other entity (please specify) _____

Health workforce

40. On average, how many patients does your facility see per day? _____
41. Do you feel that you have enough staff to successfully perform normal service delivery during a weather emergency?
- Yes
 - No
42. If your facility has experienced past floods, were staff absent due to the flood?
- Yes
 - No
 - Not applicable (no prior floods)
43. If so, did this create problems in service delivery?
- Yes
 - No
 - Not applicable (no prior floods)
44. How many clinical staff (doctors, nurses, midwives) work at this facility? _____
45. How many total staff work at this facility? _____

Medical products, technologies

46. Are there first-aid kits available at your health facility?
- Yes
 - No
47. Does the health facility have a system in place for emergency procurement of supplies?
- Yes

No

48. How long does the procurement of supplies take under emergency conditions?

No delay in procurement

1-6 days longer than usual

1-2 weeks longer than usual

2 weeks or more longer than usual

Other (please specify) _____

49. Do you think that your health facility has enough medical equipment and supplies for normal service operation during a flood or storm?

Yes

No

Service delivery

50. Are there ever times when preventive or curative services are not available during storms or floods?

Yes

No (*please proceed to question 52*)

51. If so, what are the reasons? (please check all that apply)

Staff absent from facility

Lack of supplies

Damage to facility medical equipment

Damage to building infrastructure

Impaired or blocked road access to health facility

Power outages

Other (please specify) _____

Institutional safety score

52. How prepared do you feel your health facility is for an **extreme flood event**?

Completely unprepared	Somewhat unprepared	Neither prepared nor unprepared	Somewhat prepared	Completely prepared
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

53. How prepared do you feel your health facility is for **any type of disaster**?

Completely unprepared	Somewhat unprepared	Neither prepared nor unprepared	Somewhat prepared	Completely prepared
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Climate change

54. Do you think flood and storm events happen more frequently than they used to?

- Yes
- No
- Don't know

55. Do you think flood and storm events are stronger or more intense than they used to be?

- Yes
- No
- Don't know

56. Do you think that climate change is occurring in Sri Lanka?

- Yes
- No
- Don't know

57. Do you think changes in climate can affect human health?

- Yes
- No
- Don't know

58. Have you received any disaster management communication or documents from the PDHS or RDHS that includes information or guidance on climate change?

Yes

No

Don't know

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