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Health Burden of Extreme Weather in Thailand

Jiraphan Plongmak [a], Nathsuda Pumijumnong [a] and Kanitta Bundhamcharoen [b]

[a] *Faculty of Environment and Resource Studies, Mahidol University, Nakhonpathom 73170, Thailand*
[b] *International Health Policy Program, Ministry of Public Health, Nonthaburi 11000, Thailand*

Abstract

This study assessed and evaluated the variation of the health burden in response to extreme weather events that occurred in Thailand from 2006 to 2010. The health burden was assessed using disability-adjusted life years (DALYs) lost and deaths from injuries as its indicators. Thailand has a DALYs lost of over 16,274 from extreme weather events. Extreme weather events include floods, flash floods, and severe storms, and most of the DALYs in Thailand were lost from floods (approximately 12,872 DALYs). The second most impactful weather event was severe storms, with losses of approximately 2,019 DALYs, followed by flash floods, which caused losses of about 1,383 DALYs. Climate change is a cause of extreme weather events, and a relationship between climate and health has been found worldwide. Improved long-term, high-quality data sets are needed to better analyze and improve accuracy of the health burden.

Keywords: health burden; extreme weather; DALYs, Thailand

1. Introduction

Since the start of the twentieth century, the average temperature of the earth has increased 0.4 to 0.8°C. This trend is expected to continue, and by 2100 the average global temperature has been predicted to be 1.4 to 4.8°C warmer (IPCC, 2007a).

This temperature increase is caused by increasing amounts of greenhouse gas emission caused by human activities. The potential subsequent effects of climate change include an increase in both frequency and intensity of extreme weather events, such as hurricanes, floods, and droughts (Alderman *et al*., 2012). Climate change and the resulting potential extreme weather events have been a source of debate for decades. While the hypotheses surrounding this correlation cannot be directly tested, there is no doubt that dramatic increases in both economic losses and causalities and injuries have occurred as a result of natural catastrophes over recent years. In addition, most of these natural catastrophes have been weather-related, implying an increase in the occurrence of extreme weather.

The annual weather conditions of Thailand, which is located in Southeast Asia, are influenced by monsoons and the natural phenomena of El Niño-Southern Oscillation (ENSO) (Singhrattna *et al*., 2005; Limsakul and Goes, 2008). Chidthaisong (2010) presented future climate projections for mainland Southeast Asia for the 21st century, predicting slightly warmer regional trends, with expanding regions of high temperature and a much longer hot period of the year. The study reported an extension of summer into winter and an increase in the intensity of precipitation, with the rainy season becoming longer. This scenario was consistent with the IPCC AR4 report (IPCC, 2007b).

Increased availability for health resources and improving health conditions has been the justification for sustainable development (Kovats *et al*., 2005). However, due to the impact of extreme weather events, this anticipated increase in overall health status has not been observed in the United Nations Framework Convention on Climate Change (UNFCCC). Multiple research projects have been initiated in Thailand to determine the impact of climate change on various aspects, such as natural resources (e.g. Trisurat *et al*., 2009; Dore, 2005), agriculture e.g Bhaktikul *et al*. (2012). Most research related to health conditions in Thailand generally focus on a specific disease, such as dengue (Sriprom *et al*., 2010) and malaria (Tanser *et al*., 2003; Manguin *et al*., 2008), but very few studies have examined any effects due to extreme weather. In this preliminary research, we use disability-adjusted life years (DALYs) to assess the health burden in Thailand, as this region has been significantly impacted by extreme severe weather events.

2. Materials and Methods

2.1. Identification of extreme weather events

Extreme weather events in Thailand were evaluated using summarized data from the Department

of Disaster Prevention and Mitigation, Ministry of Interior of Thailand between 2006 and 2010 regarding natural disasters and extreme weather. We selected flooding, flash flood, drought, winter extreme, forest fires, severe storms, and hailstorms for analysis. Because we applied DALY data for comparison across events, only flooding, flash flood, and severe storms were ultimately described in this report, as these events were associated with reported injuries and deaths.

2.2. Identification of the health effects of extreme weather

Data were collected regarding the number of injuries and deaths as well as the gender and ages of people involved in cases related to extreme weather; the analysis also included causes and timing of extreme weather events that occurred between 2006 and 2010.

2.3. Statistical analysis of the severity of the health burden of extreme weather

The DALY is a health gap measure that extends the concept of potential years of life lost due to premature death to include years of life of "full health" lost during states of compromised health, broadly termed as disability. Thus, one DALY is one lost year of healthy life (WHO definition). The DALY methodology has been described by Murray (1994), Murray and Lopez (1994) in the Global Burden of Disease (GBD) project using the following equation:

$$DALY = YLL + YLD$$

YLL, the number of years of life lost due to mortality and specific disease in a specified population, is calculated against the standard life table (West Level 26) as follows for a given cause, age, and sex:

$$YLL = \sum_{x=0}^{L} d_x e_x^*$$

e_x^*: ages expected to live in each age group.

d_x: number of deaths in each age group.

L: maximum age at death

YLD, the number of years lived with a disability, weighted with a factor between 0 (perfect health) and 1 (dead) (Murray, 1994) for the severity of the disability, is calculated as follows for a given cause, age, and sex:

$$YLD = I \times DW \times L$$

I: number of incident cases

DW: disability weights

L: average duration of the case until remission or death (years)

Because of the need to exclude all personal factors except age and sex, the standard expected years of life lost approach was adopted. Premature death was defined based on the world's longest-lived population (Murray, 1994). Additional refinements to the DALY included the disability weights. Disability (the impact on the performance of the individual) is evaluated rather than handicap (or overall impacts), which are dependent on the social environment.

Burden of diseases, which can be estimated from the numbers of DALYs calculated from diseases and injuries of the population, is a method of holistically measuring the population health.

3. Results and Discussion

Data analysis identified the major extreme weather events in Thailand between 2006 and 2010 that caused the highest burden on human health as flooding, severe storms, and flash floods. The number of DALYs lost in the each region are described in more detail in the following sections.

3.1. Impact of floods as assessed by DALYs lost

The data outlined in Fig. 1 show that floods in 2006 and 2010 had the greatest impact on the central region in Thailand, as shown by the markedly high numbers of lost DALYs. The northeast suffered the highest number of lost DALYs in 2007 and 2008, while floods in 2009 had the highest effect on the south.

Analysis of the DALYs lost due to floods from extreme weather events between 2006 and 2010 in each province in Thailand showed that the majority of the provinces suffered overall losses of DALYs that could be categorized as less severe (<460 DALYs), moderately severe (460-920 DALYs), and very severe (>920 DALYs). Both Nakhon Sawan and Phra Nakhon Si Ayutthaya suffered very severe losses of DALYs due to floods (Fig. 2).

Moreover, 48 provinces of Thailand, which represents 63.16% of the country, had a loss of DALYs from floods, underscoring the severe impact of floods in Thailand.

3.2. Impact of severe storms as assessed by DALYs lost

Severe storms in 2006 and 2010 in the north caused the highest number of DALYs lost in this region, while the northeast suffered most in the storms of 2007, and the central region in 2008 and 2009 (Fig. 3).

Analysis of the DALYs lost due to severe storms between 2006 and 2010 showed that the majority of the provinces suffered overall losses of DALYs that could be categorized as less severe (<60 DALYs), moderately severe (60-120 DALYs), and very severe

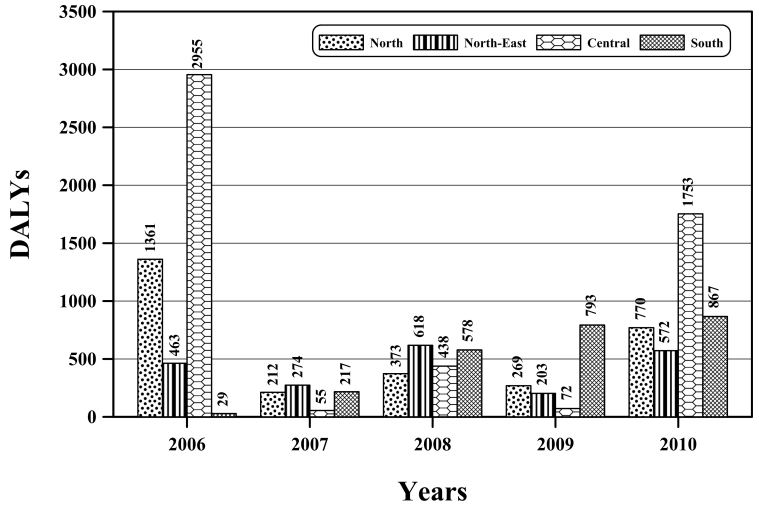

Figure 1. The DALYs lost from floods in regions in Thailand between 2006 and 2010.

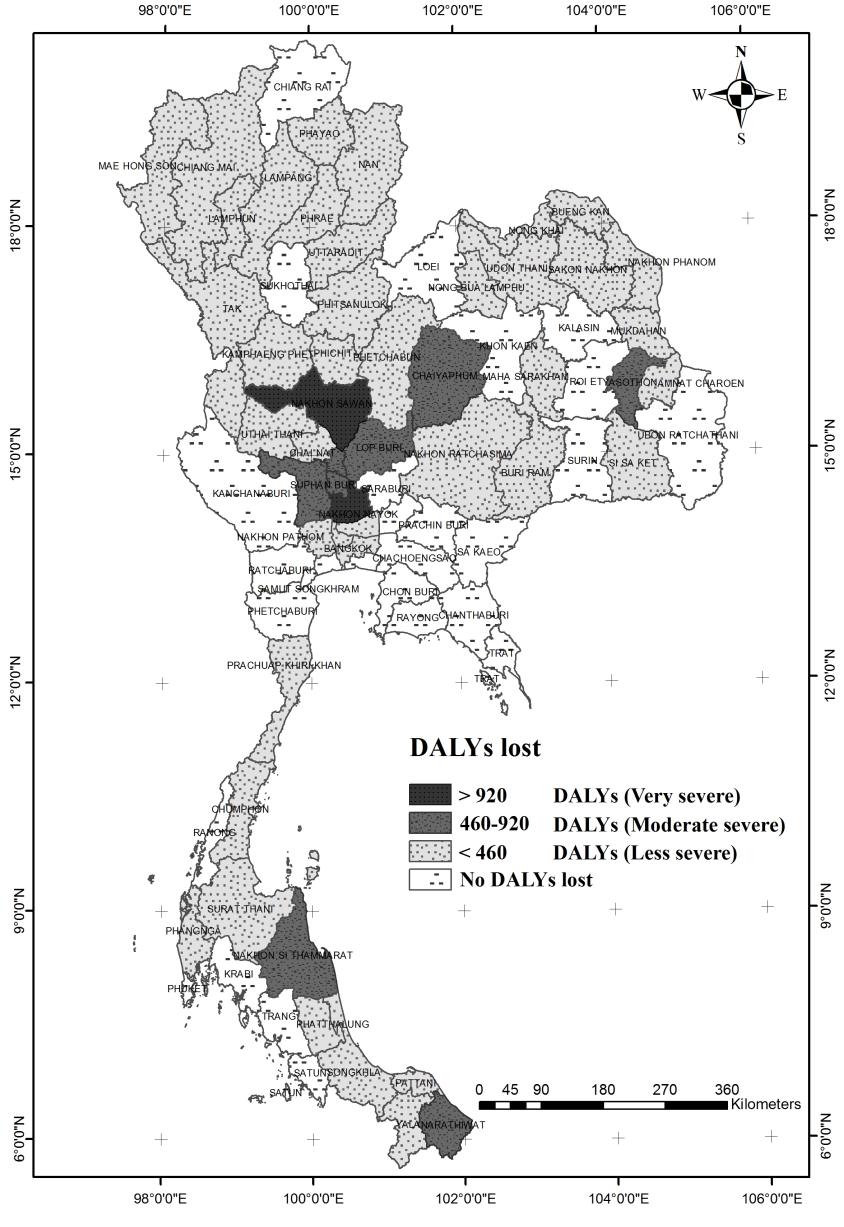

Figure 2. The DALYs lost from floods in each province of Thailand between 2006 and 2010.

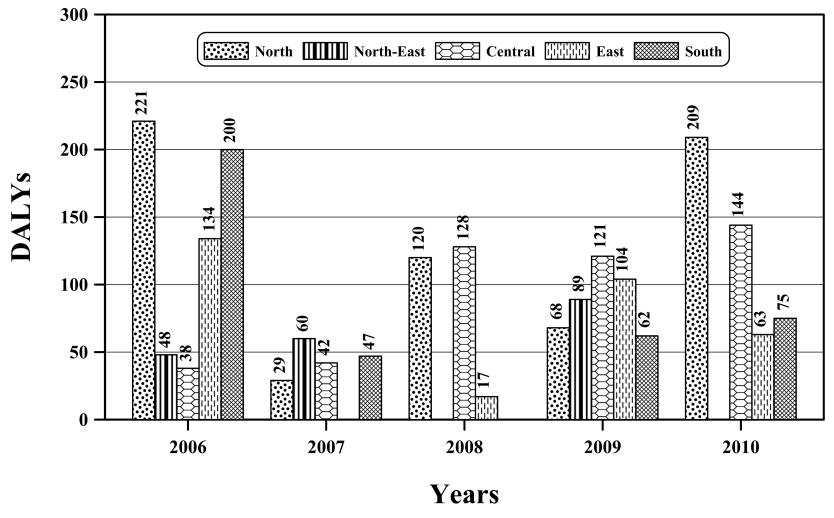

Figure 3. DALYs lost from severe storms in regions in Thailand between 2006 and 2010.

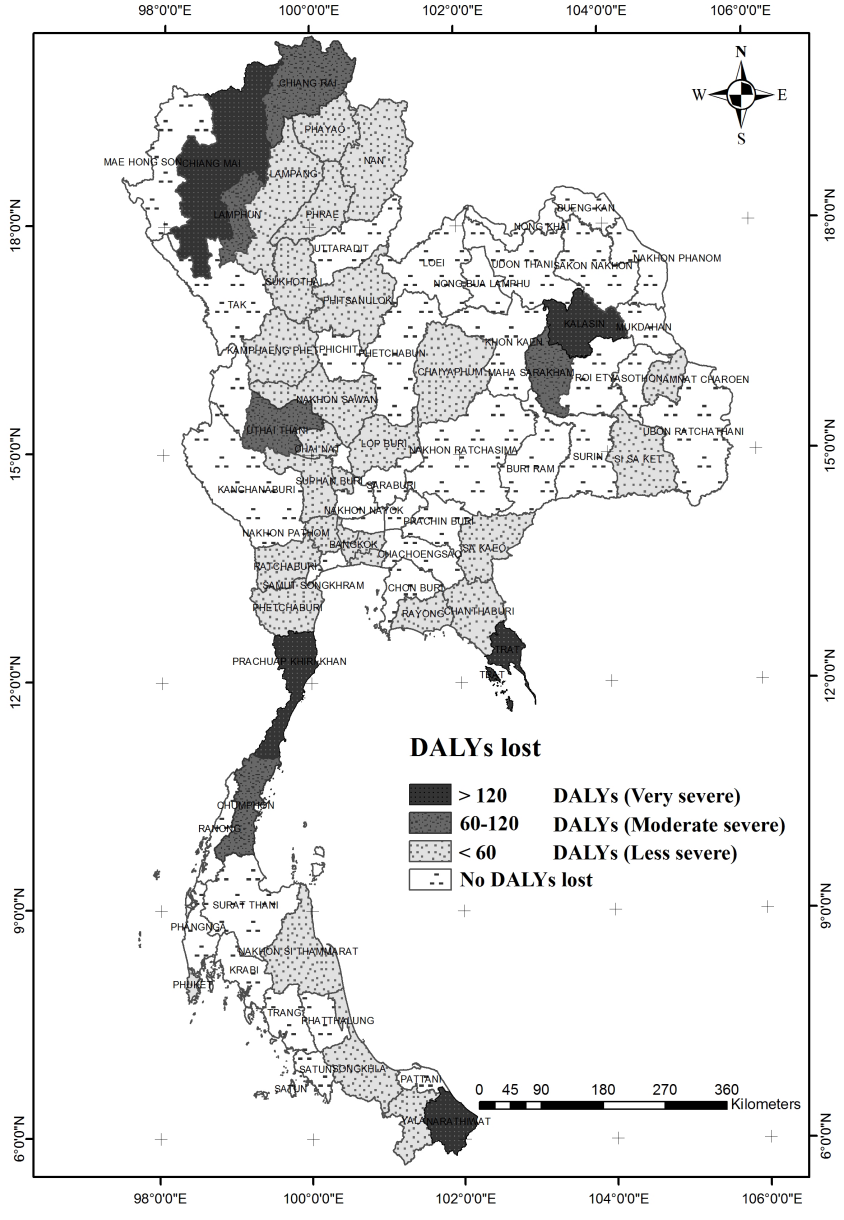

Figure 4. The DALYs lost from severe storms in each province of Thailand between 2006 and 2010.

(>120 DALYs). Chiang Mai, Kalasin, Trat, and Prachuap Khiri Khan suffered very severe losses of DALYs due to severe storms (Fig. 4).

In addition, 38 provinces in Thailand, accounting for approximately 50% of the country, lost DALYs from severe storms. This demonstrates the extensive impact of severe storms in Thailand.

3.3. Impact of flash floods as assessed by DALYs lost

The south suffered the most DALYs lost from flash floods in 2007 and 2009, while the flash floods of 2008 had the biggest impact on the north. Evaluation of the DALYs lost due to flash floods from extreme weather events between 2006 and 2010 of each province in Thailand showed that provinces Nan, Surat Thani, Yala, and Narathiwat had losses in DALYs that were less severe (<250 DALYs), and the Trang province had losses of DALYs that were very severe (>500 DALYs), as shown in Fig. 6.

Moreover, while only five provinces had DALYs lost from flash floods, which accounts for 6.58% of the country, the actual number of DALYs lost was approximately 1,383, underscoring the serious impact of the flash floods.

The World Health Organization has concluded that the climatic changes that have occurred since the mid-1970s could already be causing over 150,000 deaths and five million DALYs annually, mainly in developing countries. Ironically, it is the less developed countries that are the least responsible for global warming (Patz and Olson, 2006). Thailand is classified as a developing country, and a loss of 16,274 DALYs from extreme weather events has generated a major health burden.

The Department of Meteorological, Ministry of Information, and Communication Technology of Thailand recorded a total number of 186 storms that have hit Thailand over the last 61 years (1951-2010). These storms mainly occurred around the transition between the end of the rainy season and the beginning of the dry season (September through November). Severe storms bring intensive heavy rain, and recently deforestation has been discovered in the mountain range, which causes more dangerous situations for local people who settled in the mountain valley. In regions distant from mountain ranges, intense rain in short periods of time can cause flash flooding, as the capacity of the ground to absorb water quickly maximizes. Historical data were used in Bangladesh to calculate approximately 299 DALYs per 1000 people for a storm event, including both deaths and injuries (Nelson, 2003). This result is higher than data reported in our study. Patz *et al*. (2005) demonstrated that the relation between climate and health pose increasing health risks already contributed to increased morbidity and mortality in many regions. In Thailand, Ditsuwan *et al*. (2011) used DALYS as a measure to quantify the burden of road traffic injuries in Thailand in 2004, incorporating new data on mortality and the frequency of long-term disability. Bundhamchareon *et al*. (2011) assessed the national level of burden of disease in Thailand in 1999 and 2004. This technique became widely known in 1993 when the World Bank introduced DALYS for investing in health (Mont and Loeb, 2008). However, one limitation of applying this method and analysis in Thailand is the lack of reliable data. Further health policy strategy should support the use of a database to improve the quality of data.

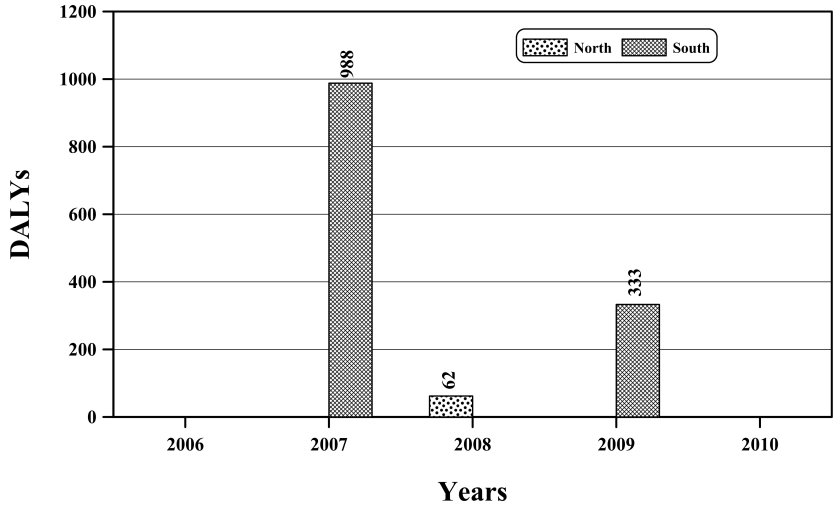

Figure 5. The DALYs lost from flash floods in regions in Thailand between 2006 and 2010.

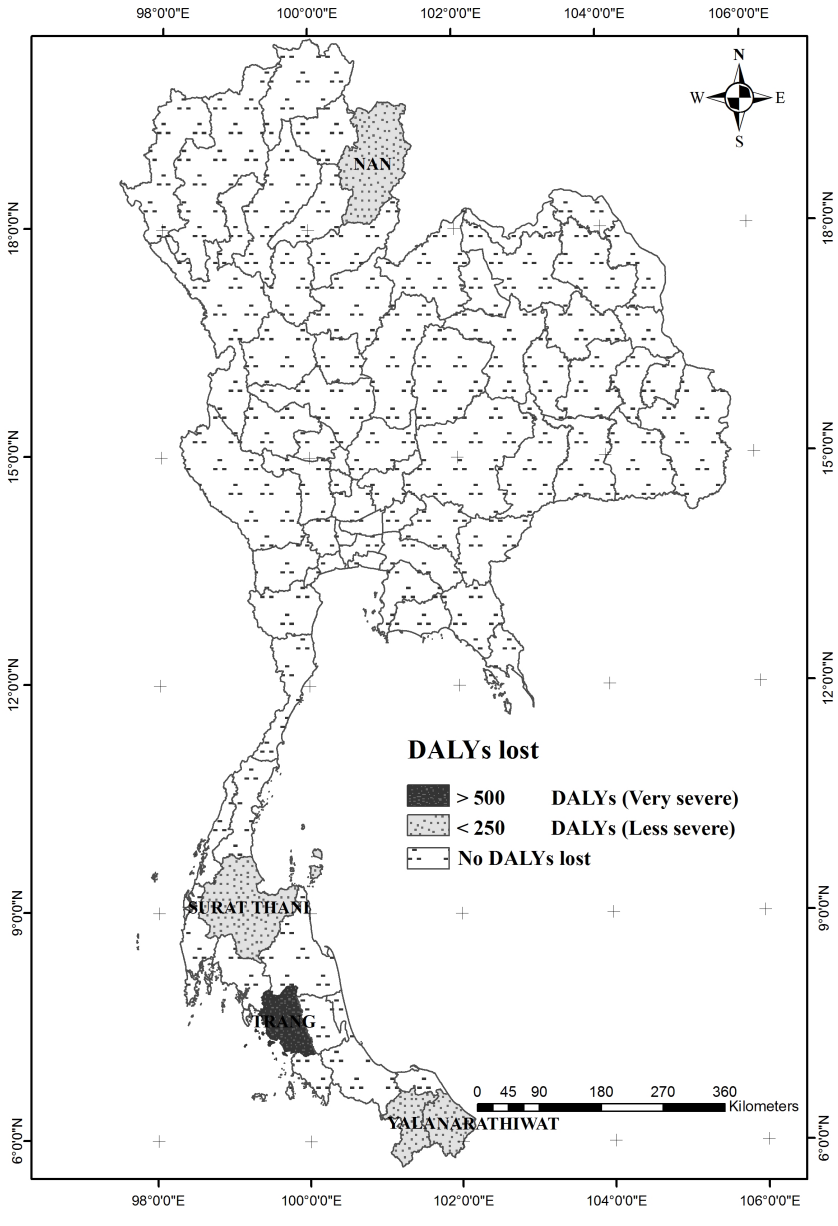

Figure 6. The DALYs lost from flash floods in each province of Thailand between 2006 and 2010.

4. Conclusions

Analysis of the overall health burden caused by extreme weather in Thailand between 2006 and 2010 showed that a total of 12,872 DALYs were lost in this region from floods alone; severe storms correlated with a loss of 2,019 DALYs, and flash floods with 1,383 DALYs. The other extreme weather events that occurred in Thailand were drought, extreme winters, forest fires, and hailstorms, though these events were not associated with any injuries and deaths, and therefore not classified as a health burden. Future studies should aim to improve and systematize the database systems of agencies that collect health data events occurring due to extreme weather in Thailand, because these databases currently do not cover all of the affected health conditions assessed in studies, such as cause of injury, feature of injuries, and duration of the disability.

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Correspondence to
Associate Professor Dr. Nathsuda Pumijumnong
Faculty of Environment and Resource Studies,
Mahidol University,
Salaya, Phutthamonthon,
Nakhon Pathom, 73170,
E-mail: nathsuda.pum@mahidol.ac.th,
nathsuda@gmail.com