

The Impact of Floods on Safe Drinking Water Supply and Sanitation in Southeast Asia: A health Priority – Review

¹Qasim, B*, ²Abdul Syukor A.R

¹ Faculty of Civil Engineering and Earth Resources, Universiti Malaysia Pahang (UMP),
Lebuhraya Tun Razak, 26300 Gambang, Kuantan, Pahang, Malaysia

² Faculty of Civil Engineering and Earth Resources, Universiti Malaysia Pahang (UMP),
Lebuhraya Tun Razak, 26300 Gambang, Kuantan, Pahang, Malaysia

*Qasim, B (Phone: +601-66538046; banqasim@gmail.com), Abdul Syukor A.R (abdsyukor@gmail.com)

Abstract Floods are the most common natural disasters in developing countries, approximately 40% of all natural disasters. The floods has a sever implications on a human health during a flood. Southeast Asia is a region that is prone to a frequent floods. The Association of Southeast Asian Nations is involved Cambodia, Laos, Thailand, Vietnam, Brunei, Malaysia, Indonesia, Philippines, Singapore and Myanmar. The frequency of flooding in Southeast Asia has increased over the past several decades. Flooding is a projecting issue that is currently affecting many regions in Southeast Asia. United Nations Office statistics studies estimated that about 9.6 million people are currently affected by the flooding in Southeast Asia, and only 5.3 million in Thailand alone. The National Committee for Disaster Management and the Department of Hydrology announced that the flood are so sever in Southeast Asia and labeled the worst floods in over 60 years. These floods could raise many concerns for the health and well-being issues especially regarding providing safe drinking water through the disasters for all people. The consequences of flooding on human health can be extremely danger as during the actual onset of the flood there is potential for direct cause of spreading disease and pathogeneses to drinking water supplies and there is a very high risk for diseases breakout through flooding such as Cholera, coliform and salmonella that can pass into drinking water systems. Also lack of clean water supply through the disaster and access to safe drinking water and consumption of contaminated drinking water all these factors are having highly risk and impact on human health and can cause a certain death especially among infants, children and elderly people. Therefore a special attention and action should be taken through floods disasters to prepare for providing safe drinking water through this impact, and how to improve the sanitation system of water supply and how to be prepared to face health issues and to be ensure that every

individual person can have safe access to clean and safe drinking water and how to facilitate to people during these conditions.

Keywords: Floods, Safe drinking water supply, Sanitation of drinking water through flood, Southeast Asia region.

- 1. Introduction** Through the last ten years earlier to 2011, flooding has been the most common type of the natural global disaster in developing and developed countries, and approximately about 40% of all natural disasters [1, 2]. Floods have severe impact on human's health during and after the onset of a flood. The region of Southeast Asia is a region that is especially prone to sever frequent natural disasters, and the most effective one are floods [3]. In The last decade, floods have affected nearly one billion people worldwide [4]. The consequences of floods on human health remain rarely investigated and few studies suggested that increased short term of mortality, health impact and diseases that is caused by floods through the contamination of drinking water supplies which can spread certain deadly diseases especially among the elderly people and children in the society [5, 6]. Southeast Asia association is comprised of Malaysia, Indonesia, Cambodia, Laos, Thailand, Vietnam, Brunei, the Philippines, Singapore and Myanmar [7]. Through 2006-2007 Southeast Asian floods were a sequences of floods mostly affected Malaysia. The main cause of floods was above rainfall average and also had hit Philippines and Vietnam [8]. Johor, Singapore and specific parts of Indonesia were affected by floods and on December 18 of 2066 a series of floods hit Johor, Malacca, Pahang and Negeri Sembilan [9]. Singapore also experienced abnormally high rainfall which resulted in massive floods [10]. Other countries have also faced and experienced flood disasters as China, Cambodia, India and Bangladesh [11]. It is thought that floods will increase the global burden of diseases mortality and will counting stress on health condition of people and society especially in low resources countries [12]. Figure 1 shows the Southeast Asia Region map of vulnerability to climate change, taking into account exposure to climate hazards [13].

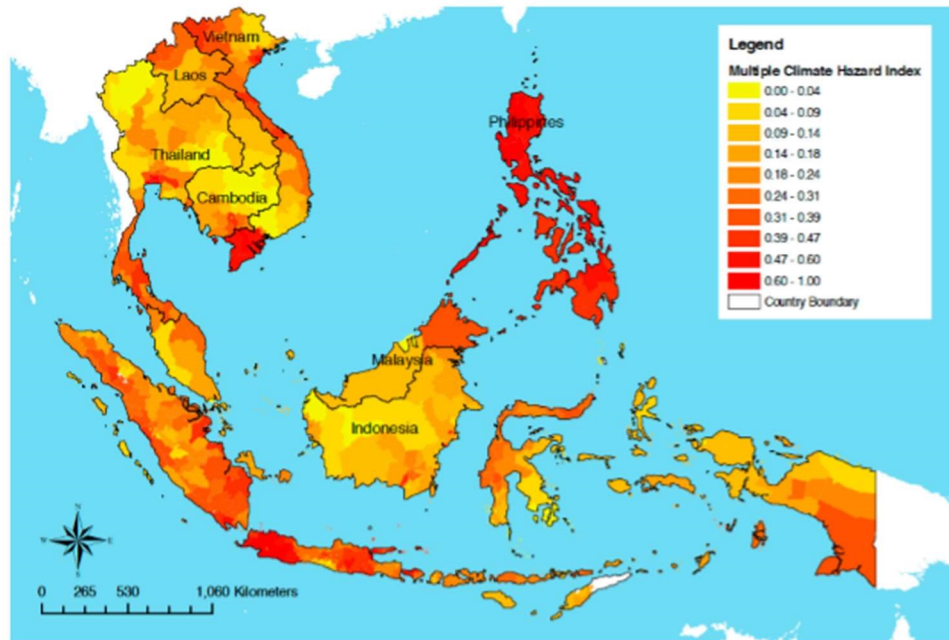


Figure 1 shows the Southeast Asia region map of vulnerability to climate change in, taking into account exposure to climate hazards Resource [13]

2. The Problem Importance The severity and frequency of flooding in Southeast Asia has increased over the past several years. Flooding is a major issue that is currently affecting many countries and regions in Southeast Asia, especially in Malaysia, Cambodia, Thailand, Vietnam and The Philippines. According to the United Nations office for the coordination of Humanitarian Affairs [14], it is estimated that about 9.6 million people are affected currently by the flooding in Southeast Asia only 5.3 million in Thailand alone [15]. The following figure 2 shows the major floods and affected countries by floods in Southeast Asia Region.

COUNTRY	AFFECTED PEOPLE	Evacuees	Year	Reference
Thailand	115,853	10,000	2014	[16,17]
Malaysia	200,000	237,037	2014-2015	[18]
Indonesia	94,500	120,000	2014	[19]
Siri Lanka	1.100,000	50,832	2014	[20]
Philippines	25,000	107,000	2013	[21]
Cambodia	2592	144,044	2013	[22]

Figure 2 Shows the major floods in Southeast Asia Region

3. The Impact and Main Risks of Floods on Human Health The flooding consequences on human health can occur during and after a flooding event. There is an increased rate of injuries onset of a flood when people are advised to move their families to a safe place [23]. During the onset of a flood, there is potential increase in communicable disease and waterborne diseases, particularly fecal oral diseases in flooded areas [24,25]. These diseases spread when fecal is passed through the mouth in areas struck by floods due to sanitation decline, lack of access to safe drinking water sources consuming contaminated water with pathogens, also other fecal-oral diseases that are increased and relevant to a flood including typhoid fever, paratyphoid, hepatitis A, hepatitis E and poliomyelitis [26,27,28].

3.1 The Risk of Communicable Diseases Following a Flood Floods as a natural disaster that have are associated with onset and impact that can produce many factors that work synergistically to increase the risk of mortality resulting from water and vector-borne diseases [29]. Communicable transmission diseases, outbreaks have been noticed immediately following floods and the risk increases when infrastructure of safe drinking water supply system is heavily impacted and damaged, leading to the contamination of drinking water facilities [30]. Commonly, diseases resulting from water contamination including cholera, diarrheal disease, hepatitis type A and E, leptospirosis, rotavirus and typhoid fever [31]. The following table 1 shows the communicable and water-borne diseases in Southeast Asia Region.

Table 1 Shows the Communicable and Water-Borne disease in Southeast Asia Region

Year and location of the flood	Design of the study	References
Bangladesh, rural floods of 1998 and 2004	Qualitative surveying study with 120 households most affected in previous floods	[32]
Jakarta, Indonesia, 2001– 2003	Community-based case control study. 93 patients presenting with Salmonella related fever	[33]
Thailand, 2006	Descriptive study. 38 males and 58 females flood-affected patients complaining of skin problems were clinically evaluated	[34]

3.2 Water-Borne Diseases The risk of gastrointestinal diseases that following floods is higher in the poor hygiene and inadequate sanitation provision of clean safe drinking water [35], therefore the countries with low-income are the greatest with water-borne diseases during the floods times and may increase the risk of these diseases [36]. In the last decade diarrheal disease that is related to floods following mortality has been observed in Bangladesh and Indonesia [37]. Compromising the water quality contributed to a high incidence of diarrheal diseases and it has been found that 70 million people in Bangladesh are exposed and consumed drinking water that does not meet the World Health Organization WHO standards and floods caused shortage of clean water for half of the year [38]. Most of the badly affected villages in Bangladesh and Indonesia suffered inundation of two thirds of drinking water source which led to diarrheal disease

and fever for the affected population [39]. The risk is lower in highly income countries of gastrointestinal diseases; however, it increases with the depth of flooding [40].

3.3 Vector borne Diseases The risk of acquiring a vector borne diseases, such as malaria and dengue fever is usually higher following a disaster like a flood. The insects return shortly after waters begin to recede. The dynamic changing of vector breeding, coupled with the displacement of large numbers of people into temporary crowded shelters and the vector borne outbreaks even where normal transmission risk is low there is a lag time up to eight weeks before the onset of vector borne disease [41].

4. Water Supply Cycle in Southeast Asia, many countries like Singapore, Malaysia and Indonesia have shown the way in water resources management and development. The external forces like dependency for some water supply on Malaysia and internal forces like very limited land for water catchment purposes made Singapore heading to desalination, recycling of wastewater to make NEWWATER (recycled potable water), and the combining responsibilities for water and sanitation [42]. Of the 14 utilities in six Southeast Asian countries, only three included sanitations under the same agency as water and there must be integrated water supply system under one responsible agency [43]. The following figure 3 shows the water supply cycle in urban areas.

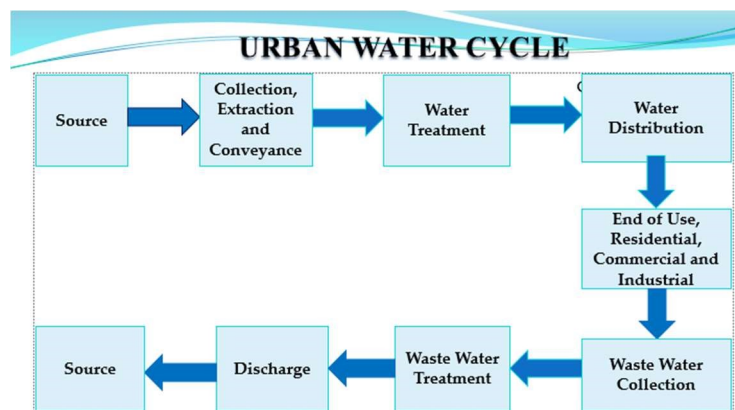


Figure 3 Water Supply Cycle in Urban Areas

5. Water and Sanitation Policies in Southeast Asia region Climate change will affect the future of water supply in Southeast Asia countries, thus the quality and quantity of water supply must meet the needs of an increasing population and there must be a protection and a solid plan to protect them during natural disasters such as floods and how to manage the facilities during and after the floods to prevent water from pollution over a great area and distance. Evidence shows that water supply and sanitation utilities, including all infrastructure elements of water abstraction, catchment areas, reservoirs, treatment plants, drinking-water pipelines and distribution systems, as well as sewerage networks are key environmental determinants in these critical conditions [44]. Improper management of the infrastructure may also have negative impacts on general water management and may in turn affect healthy water and wastewater services Internal vulnerabilities of these services comprise a wide range of science and information, in terms of existing networks, quality of performance in critical conditions, implementation of technology development and safe delivery of the services. Furthermore, the potential impacts of the individual “extreme events” can vary, as a different individual process exists within each system category of the complex water and wastewater services systems [45].

6. Water Security and the interconnected risks Water security is a global concern, and the top global risks that are facing water supply and sanitation as listed below [46].

- Geopolitical risk
- Economic risk
- Societal risk
- Environmental and climate changing risk

7. Water Supply Protection Actions should be taken to protect water supply during floods and Extreme weather conditions. The following steps to protect water supply system [47]:

- The design of water supply elevation should be higher than the risk level of floods.
- Flood walls and barriers should be considered in design.
- Prevention of back flow.

8. Emergency Management through Floods to provide Safe Drinking Water Precaution must be taken during the floods to protect people from water-borne diseases and water supply pollution because there will be increase health consequences especially if water treatment supply plants are flooded. The following steps must be taken to ensure drinking water safety [48]:

- The most practical form to keep free chlorine for a household water treatment as a liquid form (Sodium hypochlorite) solution or calcium hypochlorite to disinfect drinking water.
- The amount of chlorine needed depends on organic inside water but it should be between 0.2-0.5 mg/Liter.
- Drinking water should be stored in safe and clean storage container.
- Preparation for filtration System
- Preparation for bottled water
- Preparing for reservoirs
- Preparing for small reservoirs and small network system.

9. Conclusion and Discussion Without any doubt, water supply and sanitation system define the improvement of living conditions to human history. There is also a significant consensus on the importance of water supply and sanitation systems to health problems and environmental issues, services, management and drinking water security supply related to natural disasters such as floods. If there is extremely climate behavior, water supply, sewerage and waste water system treatment will lose much of their environment and health benefit and becoming a significant source of pollution to water during floods if there is no suitable protection. Preventive actions need to be strengthen in order to limit direct damage and ensure safe basic needs are met such as sanitation, water scarcity, chemical and biological contamination of water and water borne diseases. There is also a need to focus on safe drinking water supply to cope with disasters that are related to climate change such as floods. Assessment of vulnerabilities as well as risk management in extreme situation still need to be addressed, remembering that the performance of water supply and sanitation is the end point of pressure from extreme weather, climate related to disasters. On the Other hand, poor support and emergency services, along with lack of resources in Southeast Asia largely contribute to negative health impact of floods in the area. Climate change may be increasing the severity of floods in the region, so that many involvements must be set in place to prepare communities for floods and more studies should be taken place to focused on health impact of floods to human and more education to people and community about behaving during floods, preparing safe drinking water and diseases prevention.

References:

- [1] Coker RJ, Hunter BM, Rudge JW, Liverani M, Hanvoravongchai P. Emerging infectious diseases in southeast Asia: regional challenges control. *Lancet*. 2011; 377:599–609.
- [2] Ohl CA, Tapsell S. Flooding and human health: the dangers posed are not always obvious. *BMJ*. 2000;321:1167–8.
- [3] Ahern M, Kovats RS, Wilkinson P, Few R, Matthies F. Global health impacts of floods: epidemiological evidence. *Epidemiol Rev*. 2005; 27:36–46.
- [4] Acuin J, Firestone R, Htay TT, Khor GL, Thabrany H, Saphonn V, et al. Southeast Asia: an emerging focus for global health. *Lancet*. 2011; 377:534–5.
- [5] Bean J. 9.5 million people experience flooding in Southeast Asia. Pacific Disaster Centre Weather Wall: World's Weather and Disaster News, 18 November 2011. Available at: <http://weather.pdc.org/index.php/2011/11/18/9-5-million-people-experience-flooding-in-southeast-asia/> Accessed: 7 November 2012.
- [6] Few R, Ahern M, Matthies F, Kovats S. Floods, health and climate change: a strategic review. Norwich: Tyndall Centre for Climate Change Research 2004.
- [7] Meerburg BG, Singleton GR, Kijlstra A. Rodent-borne disease and their risk to public health. *Crit Rev Microbiol*. 2009; 35:221–70.
- [8] ReliefWeb. Cambodia: floods – Sep 2011. Available at: <http://reliefweb.int/disaster/fl-2011-000148-khm> Accessed: 7 November 2012.
- [9] Manzanilla DO, Paris TR, Vergara GV, Ismail AM, Pandey S, Labios RV, et al. Submergence risks and farmers' preferences: implications for breeding Sub1 rice in Southeast Asia. *Agric Syst*. 2011; 104:335–47.
- [10] United States Agency for International Development. Southeast Asia- Floods. US AID 2011; Fact Sheet #3, Fiscal Year [FY] 2012. Available at: http://transition.usaid.gov/our_work/humanitarian_assistance/disaster_assistance/countries/thailand/template/fs_sr/fy2012/southeast_asia_fl_fs03_11-08-2011.pdf Accessed: 7 November 2012.
- [11] Delgado JM, Merz B, Apel H. A climate-flood link for the lower Mekong River. *Hydrol Earth Syst Sci*. 2012; 16:1533–41.
- [12] Goswami B. The Asian monsoon: interdecadal variability. In: Wang B, ed. *The Asian monsoon*. Chichester (UK): Springer, 2006:295-327.
- [13] Yusuf, A.; Francisco, H. Hotspots! Mapping Climate Change Vulnerability in Southeast Asia; Economic and Environment Program for Southeast Asia: Singapore, 2010.
- [14] Sivakumar MV, Stefanski R. Climate change in South Asia. In: Lal R, Sivakumar MVK, Faiz SMA, Rahman AHMM, Islam KR, eds. *Climate change and food security in South Asia*. Chichester (UK): Springer, 2011:13-30.
- [15] Wilson E, Termeer C. Governance of climate change adaptation: introduction to the Special Issue. *Climate Law*. 2011; 2:149–57.

- [16] "Indonesia, Malaysia, Thailand, Sri Lanka Hit by Heavy Rains, Floods: AIR". AIR Worldwide. Insurance Journal. 30 December 2014. Retrieved 5 July 2016.
- [17] Malaysiakini. 30 December 2014. Retrieved 5 July 2016.
- [18] "Floods and storms kill dozens of people in Malaysia, Thailand and the Philippines". Reuters. ABC Online. 30 December 2014. Retrieved 5 July 2016.
- [19] storms". Reuters. Thanh Nien News. 30 December 2014. Retrieved 5 July 2016.
- [20] Arya Dipa (21 December 2014). "Thousands evacuate as floods inundate Bandung homes". The Jakarta Post. Retrieved 5 July 2016.
- [21] Philippine-floods-ease-but-typhoon-death-toll-hits- Online 21 October 2015. Retrieved 5 July 2016.
- [22] Relief Web. Disasters: Cambodia. Available online: <http://reliefweb.int/disasters>. Retrieved on 5 July 2016).
- [23] Bagchi S. Disease outbreaks in wake of Southeast Asia floods. CMAJ. 2007; 177:560.
- [24] Kassim YR. The 19th ASEAN Summit: tackling floods, food and stability RSIS Commentaries. 2011;166. Available at: <http://dr.ntu.edu.sg/bitstream/handle/10220/7894/RSIS1662011.pdf?sequence=1>. Retrieved 5 July 2016.
- [25] Chang CH. Preparedness and storm hazards in a global warming world: lessons from Southeast Asia. Nat Hazards. 2011; 56:667–9.
- [26] Whiteman G. Making sense of climate change: how to avoid the next big flood. ERIM Report Series 2011; Reference No. EIA-2011-045-ORG. Available at: http://www.eabis.org/fileadmin/eabis_uploads/Blackboard/Inaugural_Address_Professor_Gail_Whiteman_RSM.pdf Retrieved : 5 July 2016.
- [27] Watson J, Gayer M, Connolly M. Epidemic after natural disaster. Emerg Infect Dis 2007;13:1-5.
- [28] World Health Organization. Human leptospirosis: guides for diagnosis, surveillance and control Available at http://whqlibdoc.who.int/2003/WHO_CDS_CSR_EPH_200223.pdf.
- [29] World Health Organization. Global status report on communicable diseases 2011.
- [30] World Health Organization. Flooding and Communicable Diseases Fact Sheet. Retrieved on 5 July 2016 from http://www.who.int/hac/techguide/ems/flood_cds/en/.
- [31] World Health Organization. Floods-Technical Hazard Sheet- Natural Disaster Profile. Retrieved on 5 July 2016 from <http://www.who.int/mediacentre/factsheet>.
- [32] Schnitzler J, Benzler J, Altmann D, Mucke I, Krause G. Survey on the population needs and the public health response during floods in Germany 2002. JPHMP.2007;13:461-4.
- [33] Vollaard A, Ali S, van Asten H, Widjaja S, Visser I, Surjadi C, et al. Risk factors for typhoid and paratyphoid fever in Jakarta, Indonesia. JAMA 2004; 291:2607-15.

- [34] Vachiramon V, Busaracome P, Chongtrakool P, Puavilai S. Skin diseases during floods in Thailand. *J Med Assoc Thai* 2008; 91:479-84.
- [35] Abaya SW, Mandere N, Ewald G. Floods and health in Gambella region: a qualitative assessment of the strength and weakness of coping mechanism. *Glob Health action* 2009;2.
- [36] Sidley P. Floods in Indonesia results in cholera and displacement. *BMI*. 2008; 336:471.
- [37] Reacher M, McKenzie K, Lane c, Nichols T, Kedge I, Iversen A, et al. Health impact of flooding in Lewes: a comparison of reported gastrointestinal and other illness and mental health in flooded and non-flooded household. *Common Dis Public Health* 2004; 7:39-46.
- [38] Casteel M, Sobsey M, Mueller J. Fecal contamination of agriculture soil before and after hurricane associated flooding in North Carolina. *J environ Sci Health A Tox Hazard Subst Environ Eng* 2006; 41:173-84.
- [39] Yee E, Palacio H, Atmar R, Shah U, Kilorn C, Faul M, et al. Widespread outbreak of norovirus gastroenteritis among evacuees of Hurricane Katrina residing in a large "megashelter" in Houston Texas: lesson learned for prevention. *Clin Infect Dis* 2007; 44:1032-9.
- [40] Aggarwal R, Krawczynski K. Hepatitis E: an overview and recent advances in clinical and laboratory research. *J Gastroenterol Hepatol* 200;15:9-20.
- [41] Ligon B. Infectious diseases that pose specific challenges after natural disaster a review. *J Urban Health* 2006.p.1-18.
- [42] Asian Development Bank and National University of Singapore. 2012. Good Practices in Urban Water Management. Manila and Singapore.
- [43] Coloma, Javier, and Graciano Carpes. 2013. Wastewater Management beyond Biogas Plants. Paper presented at the ADB Water Conference. Manila. March 2013.
- [44] Facon, Thierry, and Louise Whiting. 2013. Revitalizing Asia's Irrigation: An Action Agenda. Paper presented at the ADB Water Conference. Manila. March 2013.
- [45] International Water Association (IWA). 2000. Losses from Water Supply Systems: Standard Terminology and Recommended Performance Measures. Information document prepared by the IWA Task Force, London.
- [46] Postel, Sandra. 1997. Last Oasis: Facing Water Scarcity. The World Watch Environment Alert Series. New York and London. World Watch Institute and W.W. Norton and Company.
- [47] Foster, J. (2007), Water supply & sanitation after flooding, British Geological survey, NERC.
- [48] World Health Organization office of Southeast Asia region at www.searo.who.int/eha.