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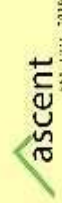
CAPACITY BUILDING IN RESEARCH AND INNOVATION IN DISASTER RISK REDUCTION



# CAPACITY BUILDING FOR RESEARCH AND INNOVATION IN DISASTER RESILIENCE

Selected papers from the  
 International Conference on  
**CAPACITY BUILDING FOR RESEARCH AND INNOVATION IN DISASTER RESILIENCE**

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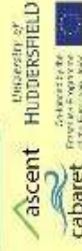


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## **Developing herbal based liquid sanitizer to maintain personal and environmental hygiene as a disaster resilience**

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### ***Abstract***

It is common to experience an outbreak of infectious disease caused by common pathogens due to the prevalence of a poor hygienic environment after natural disasters. Development of an organic based herbal sanitizer is a viable option to overcome such outbreaks. Sri Lanka is rich in plant species comprised with secondary metabolites proved to consist of *in vitro* antimicrobial properties. Acmella, Turmeric, Cinnamon and Lemon are some of the potential medicinal plants with antimicrobial, antiviral and antifungal constituents which could be used to develop liquid sanitizer against common pathogens. Thus this liquid sanitizer can be used in the occasions of washing hands, cleaning food processing areas, in preparation and consumption of food etc. Herbal extract based sanitizing liquid which is highly safe, efficient, convenient and cost effective could be used to mitigate disasters by ensuring personal and environmental hygiene.

### ***Keywords***

*Disease Spread; Environmental Hygiene; Herbal Extract; Personal Hygiene; Liquid Sanitizer*

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## 1. Introduction

All regions of the world experience different kind of disasters caused by natural and man-made factors. Floods, storms, Tsunamis and droughts are frequently recorded disasters in the South Asian region. Management of such disasters include mitigation of hazards within our control, increasing the community resilience capacity and disseminating knowledge of risk reduction. Risk assessment is essential in after-effects of disasters and in the immediate enactment of control measures through resettlement and improvement of basic health care provision is very crucial. Even though there is a lack of pre-disaster surveillance data in any type of unexpected disaster, managing personal and environmental hygiene should be given high priority.

It is common to experience public health and hygiene issues following natural disasters due to outbreaks of infectious diseases caused by common pathogens like *E. coli*, *Shigella* and *Hepatitis* (Akbari et al., 2004; WHO, 2005). This is caused by the destruction of sanitation systems and displacement of the population which leads to poor hygienic surroundings. Recent studies have shown that it is essential to maintain safe hygienic conditions of people and the environment of the public, which implies the necessity of cleanliness after disasters (Kouadio et al., 2012). An organic based herbal sanitizer is high in demand to overcome issues such as the spread of after-effect diseases including skin irritations. Plants are rich in a wide variety of secondary metabolites, such as tannins, terpenes, and alkaloids (Yadav & Agarwala, 2011; Vaghasiya et al., 2011; Rao & Gan, 2004) which have been proved to consist of *in vitro* antimicrobial properties (Ahmad & Beg, 2001; Uthpala et al., 2018). Sri Lanka is a gifted country rich in plant species with high bioactive compounds (Gunatilaka et al., 1980). Among them Acmella, Turmeric, Cinnamon and Lemon (Rao & Gan, 2004; Uthpala et al., 2018; Nelson et al., 2017; Ikpeama et al., 2014; Rauf et al., 2014) are some of the potential medicinal plants high in antimicrobial, antiviral and antifungal constituents which could be used in developing an effective organic liquid sanitizer against common pathogens responsible for causing diseases. This liquid sanitizer can be utilized in occasions such as washing hands, cleaning skin, cleaning food processing areas, in the preparation and consumption of food etc. Therefore, herbal extract-based sanitizing liquid which is highly safe,

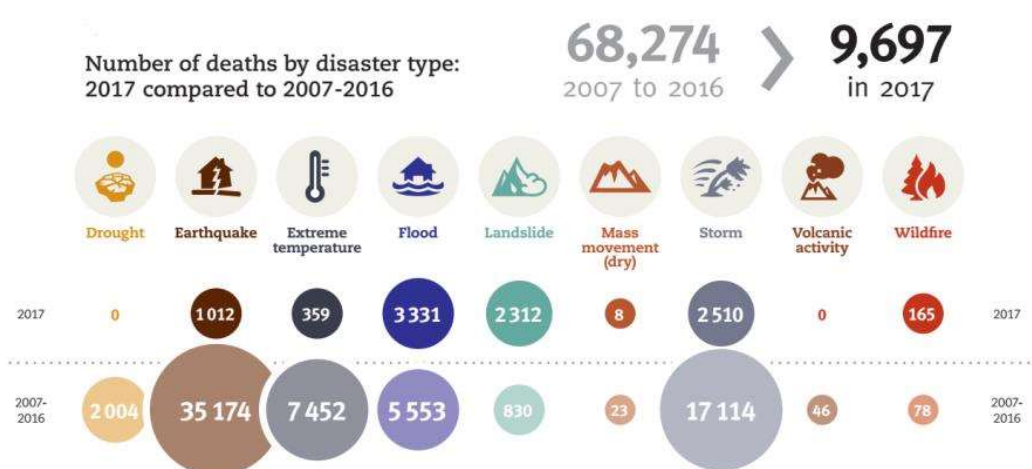
efficient, convenient and cost effective could be used to mitigate disaster related issues by managing ways of ensuring personal and environmental hygiene.

## 2. Objective of the study

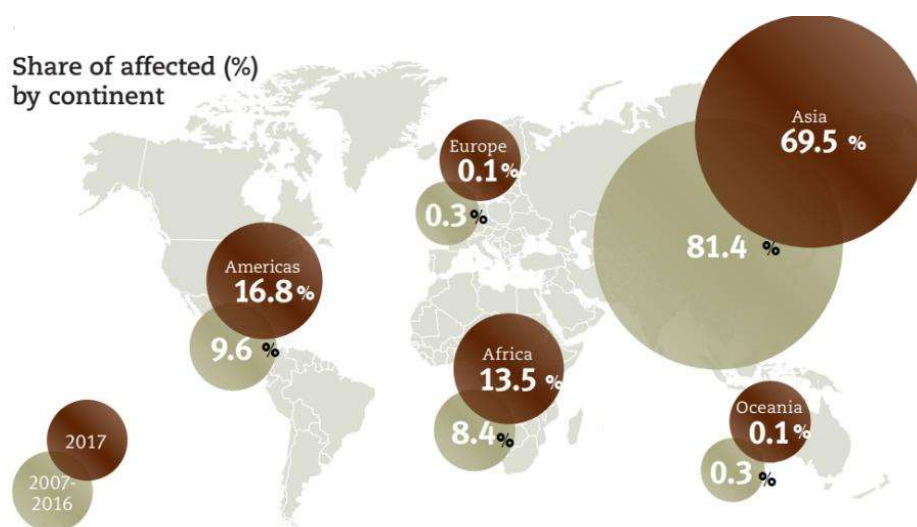
To identify the importance of developing an effective organic liquid sanitizer using phytochemical rich plants against common pathogens that are responsible for causing diseases.

## 3. Disaster occurrence

All regions of the world experience different kind of disasters (natural or man-made). Recent occurrences reveal that even the most developed countries are vulnerable to natural disasters. Floods, storms, Tsunami, droughts etc. are frequently recorded disasters in the South Asian region. Flood disasters are the most common (40%) natural disasters (Howard et al., 1996) in the world that occurs due to weather and climate changes. According to the Figure 1 shown below, Emergency Events Database (EM-DAT) reveals that floods, storms and earthquakes are the most common disasters that have occurred in 2017. Also 136 out of the 318 globally recorded natural disasters hit Asia, accounting for 58% loss of lives compared to other continents in 2017 (Below & Wallemacq, 2017; ESCAP, 2015).



**Figure 1.** Comparison of number of deaths by disaster type in year 2017 and average deaths in previous decade. Source: EM-DAT (Below & Wallemacq, 2017)



**Figure 2.** Comparison share of affected percentage by continent in year 2017 and average deaths in previous decade. Source: EM-DAT (Below & Wallemacq, 2017)

Among the disasters that have occurred around the world, 69.5% of people are affected in the Asian continent compared to other continents. EM-DAT data reveals that in 2017, Asia seemed to be the most vulnerable continent for floods and storms experiencing 44% of all disaster events, 58% of the total deaths and 70% of the total people affected inhabiting these regions. Therefore, it is highly essential to take measures to control these losses which are within our control. Management of such disasters include mitigation of hazards within our control, increasing the community resilience capacity and disseminating knowledge in risk reduction.

#### 4. Outbreak of Infectious Diseases

Figure 3 shows a disaster which occurred in Barbados, 2018. The image of this Caribbean natural disaster reveals that there is a significant number of property loss that have occurred due to such disasters and also in addition to damage and destruction of physical infrastructure, natural disasters can lead to the outbreak of infectious diseases. This is caused by the destruction of sanitation systems and displacement of the population (Watson et al., 2007) which leads to poor hygienic surroundings. Recent studies have shown that it is essential to safeguard hygienic conditions of people and the public environment, which implies the necessity of cleanliness after disasters.



**Figure 3.** Image of people affected by flood in Bridgetown, Barbados, 2018

As an after-effect of disasters, it is common to experience public health and hygiene issues due to outbreaks of infectious diseases caused by common pathogens like *E. coli*, *Shigella*, and Hepatitis. Table 1 shows disasters that have occurred in the past few years around the world and the consequent disease outbreaks. It reveals that Diarrhea, Leptospirosis and hepatitis tend to occur after natural disasters. Among those disease outbreaks, diarrheal diseases are the most common potential secondary associated disease which causes over 40 % of deaths (WHO, 2009) in disaster and refugee camp settings. There are a number of pathogens (Table 2) that cause diarrheal disease which eventually leads to death.

Evidence of diarrheal deaths have been reported from several studies in low-income countries. Surveillance data reveals significant mortality rates associated with diarrhoea following floods in Khartoum, Sudan. Routine surveillance data and hospital admissions records also dictate diarrhoea as the most frequent (27 percentage) cause of death following severe floods in Bangladesh (Ahem et al., 2005).

**Table 1.** Natural disasters and potential associated infectious disease

Disaster Event	Year	Country	Infectious disease outbreak associated to disaster	Source
<b>Flood</b>	2018	India	Diarrhoea	(Below & Wallemacq, 2017).
<b>Earthquake</b>	2011	Japan	Diarrhoea, influenza	(Kouadio et al., 2012;Norio et al., 2011)
<b>Hurricane</b>	2005	USA	Diarrhoea,TB	(CDC, 2005)
<b>Earthquake</b>	2005	Pakistan	Diarrhoea, hepatitis E, Acute respiratory infection tetanus	(WHO,2005)
<b>Flood</b>	2004	Bangladesh	Diarrhoea	(Kouadio et al., 2012)
<b>Tsunami</b>	2004	Indonesia Sri Lanka	Diarrhoea, hepatitis A and E , Acute respiratory infection, measles, meningitis, tetanus	(WHO, 2005;EM-DAT, 2005)]
<b>Tsunami</b>	2004	Thailand	Diarrhea	(Kouadio et al., 2012)
<b>Earthquake</b>	2003	Iran	Diarrhea, Acute respiratory infection	(Kouadio et al., 2012)
<b>Flood</b>	2001	Indonesia	Diarrhoea	(Kouadio et al., 2012)
<b>Hurricane</b>	2001	USA	Diarrhoea	(WHO,2005)
<b>Typhoon</b>	2001	Taiwan	Leptospirosis	(WHO, 2005, 21-28)

**Table 2 .** Common pathogens involved in Diarrhoea (Kiser et al., 2011)

Pathogen	Fever
<i>Campylibacterspp</i>	Common
<i>Salmonella spp.</i>	Common
<i>Shigella spp.</i>	Common
<i>Escherichia coli</i>	Atypical
<i>Clostridium difficile</i>	Occurs
<i>Entamoeba histolytica</i>	Occurs
<i>Cryptosporidium spp</i>	Variable
<i>Cyclospora</i>	Variable
<i>Viruses</i>	Variable

## 5. Reasons for outbreak

Infectious disease transmission or outbreaks are common (months) after the onset of disasters and are caused by massive population displacement and aggravation of risk factors for disease spreading, such as increasing size and characteristics of the displaced population within the local disease ecology, lack of food, safe water and functioning

latrines, poor personal hygiene etc. Further, public health consequences of disease outbreaks are listed below;

- Shared water containers and cooking pots.
- Displacement of people into overcrowded camps/ unplanned and overcrowded shelters.
- Scarcity of cleaning material (soap).
- Limited access to safe food.
- Limited access to safe water (cross-contamination of water sources with fecal material and toxic chemicals).
- Pre-existing poor sanitary infrastructures, water supply and sewerage systems [High humidity and damped environment leading to rapid increment of micro flora (log phase)].

It is important to manage the outbreak of diseases due to the severity of losses caused by it. As an example, in the year 2004, Indonesia faced a Tsunami and 85 % of the survivors in the town of Calang experienced diarrheal illness as an after-effect of the disaster.

## **6. How to overcome disease outbreak as resilience?**

It is essential to maintain proper personal and environmental hygiene during disasters. Therefore, herbal extract-based sanitizing liquid can be used to mitigate the outbreak of infectious diseases by maintaining personal and environmental hygiene.

This can be done in several ways;

- Sanitizing and washing hands and body.
- Sanitizing and cleaning food processing and serving surfaces.
- Sanitizing and cleaning food processing areas before preparing or eating food.
- Sanitizing and cleaning house hold floors.

## **7. Phytochemical rich plants**

An organic based herbal sanitizer is high in demand to overcome issues related to the after-effects of disasters due to cross contamination. Plants are rich in secondary metabolites, such as tannins, terpenes, and alkaloids which have been proved to consist of *in vitro* antimicrobial



properties (Uthpala et al., 2018). Sri Lanka is a gifted country rich in plant species with high bioactive compounds (Gunatilaka et al., 1980). An effective organic liquid sanitizer can be developed using herbs that can fight against common pathogens that are responsible for causing diseases. The general public tend to use natural herb-based products rather than artificial products because of its convenience.

Those potential medicinal plants are higher in antimicrobial, antiviral and antifungal constituents (Table 3, 4). Recent studies show evidence that plants which have a higher phytochemical profile are good in controlling harmful microbes (Uthpala et al., 2018; Gupta et al., 2012; Awan et al., 2013; Mauti et al., 2015; Racowski et al., 2017). Therefore, these properties can be used to develop hand sanitizer during disasters. Figure 4 shows images of selected herbs which have higher anti-microbial properties.

**Table 3.** Anti-microbial properties of plant compounds [MIC- Minimum Inhibitory Concentration which should be used to kill relevant pathogens]

Type of antimicrobial plant	MIC value	Target organism(s)	Reference
<b>Acmella- water extract</b>	20%	<i>E. coli</i> , <i>S. aureus</i>	(Uthpala et al., 2018; Gupta et al., 2012)
<b>Turmeric</b>	5.25%	<i>S. epidermidis</i> , <i>P. aeruginosa</i> <i>S. aureus</i>	(Awan et al., 2013)
<b>Cinnamon- bark ethanoic extract</b>	0.41µg/ml 0.63µg/ml 0.12µg/ml	<i>E. coli</i> , <i>P. aeruginosa</i> <i>S. aureus</i>	(Awan et al., 2013; Mauti et al., 2015)
<b>Lemon- peel ethanoic extract</b>	5% 20%	<i>E. coli</i> , <i>S. aureus</i>	(Racowski et al., 2017)

**Table 4.** Phytochemical availability of selected herbs (+ mark indicates the presence of relevant phytochemical, - mark represents the absence)

Selected Plant								References
	Tanin	Terpenoids	Alkaloids	Saponins	Flavonoids	Phenolics	Phlobatanins	
<b>Acmella</b>	+	+	+	+	-	+	-	(Uthpala et al., 2018; Lalthanpuii et al., 2018)
<b>Turmeric</b>	+	+	+	+	+	+	+	(Nelson et al., 2017; Ikpeama et al., 2007)
<b>Cinnamon</b>	+	+	+	+	-	+	+	(Watson et al., 2007; Hosseins et al., 2009)
<b>Lemon</b>	-	+	+	-	+	+	-	(Rauf et al., 2014; Nascimento, et al., 2000)



**Figure 4.** Potential herbs which are having phytochemicals and anti-microbial properties [ a- *Acmella (Acmella oleracea)*, b- *Lemon (Citrus limon)*, c- *Cinnamon (Cinnamomum verum)*, d- *Turmeric (Curcuma longa)*

## 8. Advantages of herbal sanitizer

Inventing herbal extract based sanitizing liquid is highly safe with minimum or no skin irritation. Generally Triclosan, Fragrance, Parabens, Formaldehyde and Phthalates (Squance et al., 2015) are used as commercial sanitizing liquids and have been labeled as possible carcinogens. Therefore this product is high in demand for all ages including children. Liquid sanitizer prevents the drying effect that solid soap can have on the skin. Solid soap generally has a higher pH (Nix, 2000) level causing drying (particularly of sensitive skin). Hence the use of liquid sanitizer minimizes the effect of skin irritations. It is efficient because it is in liquid state which is more active than soap. Moreover it is convenient because there are no cross contaminations

by users, ease of usage and is cost effective because the availability of raw materials are high. These sanitizers can be used to control the outbreak of infectious diseases by maintaining good personal and environmental hygiene.

## 9. Conclusion

Innovation of herbal based organic liquid sanitizer made from phytochemical rich selected plants of Acmella, Turmeric, Cinnamon and Lemon can be used to mitigate the after effects of disasters due to infectious disease outbreak as resilience for personal and environmental hygiene.

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