Artikel Penelitian

FLOOD DISASTER, DIARRHEA AND COMMUNITY RESILIENCE IN WATER PROVISION: A CASE STUDY IN THE CITY OF BUKITTINGGI

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Abstract

Bukittinggi is a city in West Sumatra that become potential area for flooding. It is followed by increasing of diarrhea diseases. This also affects water quality. Bukittinggi is having problems with the provision of adequate clean water in accordance with the target of Sustainable Development Goals. This study aims to determine the relationship of floods to the incidence of diarrhea, water quality and community resilience in providing clean water for everyday life. The method used through a quantitative approach with cross-sectional design and conducted in December 2017 until January 2018. The results show the relationship between floods with diarrhea occurrence, water difficulty, water quality (smelly water, dirty water and the presence of insects and worms), as well as community resilience to help each other in water supply and water source storage to avoid contamination. It is advisable for the government to increase its social capacity in the provision of clean water because the city of Bukittinggi is vulnerable to floods that would damage water sources.

Kata Kunci: Banjir, diare, kualitas air, ketahanan masyarakat

BENCANA BANJIR, DIARE DAN KETAHANAN MASYARAKAT DALAM PENYEDIAAN AIR BERSIH: STUDI KASUS PADA KOTA BUKITTINGGI

Abstrak

Kota Bukittinggi merupakan kota yang berpotensi mengalami banjir dan bencana ini diikuti dengan meningkatnya kejadian diare. Hal ini juga mempengaruhi kualitas air karena pada saat ini, kota Bukittinggi mengalami masalah untuk penyediaan air bersih yang cukup dan sesuai dengan target Sustainable Development Goals. Penelitian ini bertujuan untuk mengetahui hubungan banjir terhadap kejadian diare, kualitas air dan ketahanan masyarakat dalam menyediakan air bersih bagi kehidupan sehari-hari. Metode yang digunakan dalam penelitian ini melalui pendekatan kuantitatif dengan desain cross sectional dan dilakukan pada bulan Desember 2017 sampai dengan Januari 2018. Hasil penelitian menunjukkan hubungan antara banjir dengan kejadian diare, kesulitan air, kualitas air (air yang berbau, kotor dan adanya serangga dan cacing), serta ketahanan masyarakat untuk saling membantu dalam penyediaan air dan penyimpanan sumber air untuk menghindari kontaminasi. Disarankan kepada pemerintah untuk lebih meningkatkan kapasitas sosial dalam penyediaan air bersih karena kota Bukittinggi rentan terhadap banjir yang akan merusak sumber air.

Keywords: Flood, diarrhea, water quality, community resilience

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Introduction

One of the causes of reduced water supply is climate changeand can affect water security. It can damage water infrastructure and disrupt clean water supply for community consumption. In addition, floods can carry dirt and disease pathogens that increase the health risks of the community.[1] Indonesia experiences of rainfall increasing about 2% to 3% per year so that the risk of flood increased significantly.[2] WHO predicts by 2020, the coverage of clean water services in Indonesia only 75%.[1] This can be compounded by a hydro-meteorological disaster such as flooding that can affect the quality and quantity of water.

Bukittinggi is a city in West Sumatra that become a potential area for flooding. It has occurred 20 times with total area 585 hectares or more than one-fifth of Bukittinggi area. This was followed by increasing of diarrhea diseases as many as 2,741 cases (previously only 965 cases).[3] It can be worsened by the fulfillment of clean water in Bukittinggi that are having problems. It will happen because of the growth of infrastructure in this city as tourism city has increased and the availability of clean water sources are inadequate. According to research conducted in the year of 2016, Bukittinggi will reach its optimal size when its population is 124,614.[4] However, by 2016, the total population of Bukittinggi municipality has reached 124,715 people.[5] This condition has exceeded the optimal capacity and can be a further problem in the next few years if the environmental carrying capacity is not quickly overcome.

Amount of groundwater in Bukittinggi city is small because the administrative area of Bukittinggi is composed by volcanic rock group consists of tuff, pumice, and andesite. These conditions make clean water supply came from outside the region of this city. Therefore, the availability of clean water is not sufficient for fulfilling all the needs of the Bukittinggi's community.[6] In terms of the use of clean water, the most used drinking water source of household is bottled drinking water, followed by well water and tap water.[3] This is not yet in line with the requirements of appropriate drinking water sources from the Sustainable Development Goals indicator that stated that bottled water is not a proper source of drinking water.[7]

In the framework of efforts to fulfill the public's access to safe drinking water according to SDGs, the target of drinking water service coverage of Bukittinggi City is 80% in 2019 and 100% in the year 2024. To support this program, Bukittinggi requires water distribution capacity of about 400 liters/sec.[8] At this time, Local Water Company of Bukittinggi only can meet the needs of the community with the capacity of water source installed about 209 liters/sec.[9] This condition has reduced by leakage problems and damage of pipes that are susceptible to water contamination and not maximal intakes. Public water supply still relies on the government and they do not have sufficient groundwater sources due to the decreasing water infiltration. Public also do not have knowledge of simple water treatment technology to meet water needs.

Diarrhea disease was the commonest morbidity in the flood-prone population. During the flood, there is an increase of endemic incidence of gastrointestinal symptoms and one of them is diarrhea.[10] Community resilience is needed to minimize the occurrence of larger problems due to an inadequate water supply. Community resilience is an ability to cope and rise from some challenge come from economic and social concept.[11] In term of water provision, economic is stated as an ability to provide some money saving in order to fulfill water for the difficult time and also ability to choose options to design safe water storage[12] and although water resource indicators have been social concept is a willingness to help others to provide safe water and it will be mutually cooperative behaviors. It has the same concept of social capital which has three elements i.e social support, social participation and community bonds[13]

Method

This study used cross-sectional approach and was conducted in the city of Bukittinggi in December 2017 until January 2018. Flood incident is used as dependent variable, and the independent variables are diarrhea, water difficul-

Table 1 Frequency distribution of respondents

Variable		Frequency	Percentage
Flood occurrence	Yes	50	17
	No	244	83
Diarrhea in last six months	Yes	28	9.5
	No	266	90.5
Water Quality			
Water difficulty	Yes	93	31.6
	No	201	68.4
Smells water	Yes	91	31
	No	203	69
Dirty water	Yes	68	23.1
	No	226	76.9
There are insects or worms in water	Yes	52	17.7
	No	242	82.3
Community Resilience			
Allocation of funds for water difficulties	No	110	37.4
	Yes	184	62.6
Families help each other in case of water difficulty	No	42	14.3
	Yes	252	85.7
Neighbors help each other in case of water difficulty	No	40	13.6
	Yes	254	86.4
Designing a safe water supply system	No	92	31.3
	Yes	202	68.7
Storing reservoir water to anticipate water contamination	No	143	48.6
	Yes	151	51.4

ty, water quality and community resilience. The sample in this study was 294 family heads taken with Proportional Stratified Random Sampling technique.

In this study, the instrument used was questionnaires that consist of some questions about the variable being studied. All of the data checked for its completeness before being processed using statistical software. Univariate analysis was performed for each variable and bivariate analysis was done to know the relation of flood incident (independence variable) to diarrhea occurrence, water difficulty, water quality and community resilience (dependence variables).

Table 2. Relationship of flood disaster (independence variable) with dependence variables

Variable	p-value
Diarrhea in last six months*	0.0001
Water Quality	
Water difficulty*	0.0001
Smells water*	0.0001
Dirty water*	0.001
There are insects or worms in water*	0.0001
Community Resilience	
Allocation of funds for water difficulties	0.370
Designing a safe water supply system	0.714
Storing reservoir water to anticipate water contamination*	0.022
Families help each other in case of water difficulty*	0.0001
Neighbors help each other in case of water difficulty*	0.0001

*variable which have p-value <0.05

Result

Based on table 1 frequency distribution of respondents who have experienced floods is 17% or 50 respondents. 9.5% or 28 respondents had difficulties in meeting the needs of clean water. 31.6% or 93 respondents stated the water they consumed smelled, 23.1% or 68 respondents had a dirty water source and 17.7% or 52 respondents found insects or worms in their water sources.

In terms of community resilience in meeting the provision of clean water, 37.4% or 110 respondents did not allocate funds in case of water shortage. 14.3% or 42 respondents did not help each other with family members to meet water needs. Likewise, with the neighbors, there are still 13.6% or 40 respondents who do not want to help each other in case of water difficulty. 31.3%

or 92 respondents did not design water supply systems to provide sufficient and safe water. 48.6% or 143 respondents did not save water if the water channel was contaminated by the flood.

The incidence of floods was significantly associated with diarrhea occurrence in the last six months (p-value = 0.0001). For water quality, the incidence of diarrhea was significantly correlated with the respondents having water difficulty (p-value = 0.0001), smells water (p-value = 0.0001), dirty water (p-value = 0.001), and found insects or worms in their water (p-value = 0.0001).

In terms of community resilience, there is no significant relationship between flood events and the allocation of funds for water difficulties (p-value = 0.37) and designing a safe water supply system (p-value = 0.714). Flooding is significantly associated with community resilience to help each other with family members (p-value = 0.0001) and neighbors (p-value = 0.0001) in case of water shortage and there is a significant relationship with water storage as a supply if the waterways are contaminated during floods (p-value = 0.022).

Discussion

The present study showed that 17% or 50 respondents in the city of Bukittinggi experienced flooding. Floods occur due to several things including increased CO_2, rock structure and construction of houses and building. According to data measurement from Global Atmosphere Watch Koto Tabang, located 17 km from Bukittinggi, CO_2 emission has increased significantly from January 2014 until July 2017. [14] Greenhouse gases such as CO_2 have interaction with atmosphere and hydrological system in complex way. It increases global mean precipitation and evapotranspiration that enhance water vapor and increase rainfall frequency.[15] The flow of rainwater cannot absorb into the soil and also increases flood risk. This is caused by the permeability of the soil and the growth of infrastructure. Structure of rocks and soil in this city made from volcanic material because it is located near from Mount Marapi and Mount Tandikek which are active volcanoes since the year of1900.[6] Volcanic rocks have slightly permeability capability to drain water particles and will increase flood occurrence. [16] Land cover in Bukittinggi city is dominated by residential and built area.[3] Most of them is affected by the increasing of tourism sector especially in the city center.[17] Houses and buildings located in this area are not followed by the construction of drainage in accordance with actual needs so that floods often occur in densely populated houses. [18] To resolve these problems, the government should evaluate the drainage system and improve it according condition required. The development of houses and buildings must be accompanied by the construction of biopori and absorption wells to increase rainwater absorption. It is necessary to cooperate with Meteorological, Climatological and Geophysical Agency to predict rainy month period to anticipate flood event and its following impact.

Flood disaster has relationship with diarrhea occurrence (p-value=0.0001). Crude rate of diarrhea is higher during the flood than other season. Severe diarrhea is more frequent in person in poor, fair and good health than who have very good health condition (10). Flood has impact on numerous outbreak infectious diseases and it increases gastrointestinal symptoms both during and after flood (10,19). In the flood water samples collected in Thailand in 2011, found norovirus, rotavirus and hepatitis-E genes (20) Enteric viral contamination is transmitted by fecal-oral route and has been attributed to food and drinking water contamination.

Thirty-one percent respondent experienced water difficulty and associated with flood disaster (p-value=0.0001). Flood also has relationship with the smells of water (p-value=0.0001), dirty water (p-value=0.001) and presence of insect and worm in water (p-value=0.0001). Flood will contaminate water supply systems and need to evaluate regularly to prevent clean water scarcity. Poor water quality can result in smell water, have sour taste, and dirty water. Pathogen contamination is also known to have been detected in groundwater, resulting in a clean water supply also contaminated by pathogens during floods (21). In other case that is experienced by Pakistan, the flood can damage clean water infrastructure

and sanity.[22] Some insect and worm found in water indicate low oxygen level in water.[23]

Some unforeseen changes such as water system failures, degradation of water infrastructure, and contamination from waste water can happen and threat community's health. Cities in developing countries, include Indonesia, need to make urban water management more resilient because they have potential shocks by climate change effects.[24] Disaster prevention management is a solution to support local authorities together with communities as a coping strategy to minimize water contamination from damage caused by natural disaster. Some solution are capacity building, technology transfer, and assistance from goverment to improve communities knowledge. This solution will be better if it grow with social-ecological resilience to enhance the sustainability of water management in the future.

"Resilience" in ecological term relates to the tolerance to environmental perturbation became stable states.[25] In water provision, it will be described in economic and social resilience. Economic resilience is an ability to provide some money saving and ability to design safe water storage[12] and while the social concept is a willingness to help others to provide safe water[13 In economic resilience, individual or household behavior can take place at the microeconomic level that is explained as the ability to allocate some resource to prevent the aftermath of a disaster[26]

This study showed that there was no significant relationship between flood disaster with allocation of funds for water difficulties (p-value=0.37) and provide safe water supply system (p-value=0.714). It means that community is more flexible to response disaster threat so they don't have to prepare funds or safe water supply and only deal with that when the disaster happens. It can be explained by the relationship of flood disaster experience with providing reservoir water to store water to anticipate water contamination with flood (p-value=0.022). They don't need to save extra money and design safe water supply system because they have saved their water in save reservoir. Nevertheless, an emergency plan will be better to minimize water scarcity caused by flood disaster. By allocating funds, other consequences that will occur if safe water is not available can be overcome by purchasing bottled water or purchasing water from private providers.

Social resilience concept is described with the ability to help each other to provide safe water in case of water difficulty. There was significant relationship between flood disaster with ability of family members (p-value=0.0001) and neighborhoods (p-value=0.0001) to help each other when water difficulty happen. By accustomed to helping each other in facing of adversity, will build strong social support to cope with the impact of disasters. Social capital needs to reduce vulnerability and enhance resilience of disaster hazard, including water security affected by flood. By this social resilience, the capacity of linked social-ecological with each community members system can build higher capacity for learning and adaptation to uncertainly that could happen.[27]

Conclution

The result show that there is a significant relationship between floods and diarrhea, water quality (water difficulty, smells water, dirty water, and the presence of insects and worms in water sources), and community resilience (mutual assistance in water supply between family and neighbors, and water storage that is safe from contamination). There is no significant relationship between flood events with the allocation of funds for water shortages and safe water supply design.

It is advisable to the Bukittinggi's city government to provide an understanding to communities in flood-prone areas in form of training and assistance to provide safe water storage systems to ensure water quality and avoid water-borne diseases such as diarrhea.

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