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CAN MOBILE PHONES IMPROVE DISASTER PREPAREDNESS?

A survey-based analysis on the impact of AtmaGo

Centre for Innovation Policy and Governance
Jakarta
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Can Mobile Phones Improve Disaster Preparedness?
A Survey-Based Analysis on the Impact of AtmaGo

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Glossary

BPBD	*Badan Nasional Penanggulangan Bencana* (Indonesia National Board for Disaster Management)
BPJS	*Badan Penyelenggara Jaminan Sosial* (The Indonesia National Health Insurance System)
DALY	Disability-Adjusted Life Year
DRM	Disaster Risk Management (the implementation of disaster risk reduction; describing the actions that aim to achieve the objective of reducing risk)
DRR	Disaster Risk Reduction (concept and practice of reducing disaster risks through systematic efforts to analyze and reduce the causal factors of disasters)
EWS	Early Warning System (an integrated system of hazard monitoring, forecasting and prediction, disaster risk assessment, communication and preparedness activities systems and processes that enables individuals, communities, governments, businesses and others to take timely action to reduce disaster risk in advance of hazardous events)
ICT	Information and Communication Technology
IHME	Institute for Health Metrics and Evaluation
SFDRR	Sendai Framework for Disaster Risk Reduction
Puskesmas	*Pusat Kesehatan Masyarakat* (community health center)
YLD	Years Lost due to Disability
YLL	Years of Life Lost

Executive summary

Indonesia faces a serious risk from natural disasters. However, a growing body of research details how Information Communication Technology (ICT), social media, and mobile apps can all be important tools in reducing damage as well as decreasing morbidity and mortality from floods and other disasters.

The goal of this study is to understand the potential benefits and drawbacks of using ICT system to communicate emergency reports and disaster risk reduction (DRR) information. We focus on a particular application, AtmaGo, which was launched in Indonesia in 2015. Developed with the concept of crowd-sourcing, AtmaGo enables their users to share real-time disaster-related information such as reports of fires and floods, as well as to spread DRR information such as how to prepare for and prevent disaster. Particularly in Jakarta area, AtmaGo also provides alerts from government sources directly to users via mobile app.

This research aims to better estimate the potential impact of AtmaGo in improving disaster preparedness and response in Indonesia. We surveyed users and non-users of AtmaGo in five neighborhoods in the Greater Jakarta area: Penjaringan, Halim, Bekasi, Bojong Gede and Kampung Melayu. Specifically, this research seeks to improve our understanding of: 1) how people get emergency warnings and DRR information, 2) whether AtmaGo can provide these warnings in an actionable way, and 3) the potential benefits of successful warning systems in terms of avoided damages as well as prevention of mortality and morbidity.

This research resulted in **nine main findings**:

1. There is a growing usage of **social media platforms** like AtmaGo as a source of disaster information and alert.
2. Emergency alerts and related DRR information can help users **take effective preventive actions**: 30% of AtmaGo users who receive warnings take preventative action such as moving valuables, warning neighbors or evacuating.
3. Based on our survey, AtmaGo emergency alerts can reduce property damage caused by floods and other disasters by **$324 per household per year** for residents of the Jakarta region, assuming that effective action can reduce damages by about 50%.
4. If AtmaGo reaches a scale of 5% to 10% of households in the Jakarta area, this would equate to an avoided damage benefit of **$53 million to $106 million per year** assuming that 30% of users take effective action that reduces damages by about 50%.
5. By improving community response to floods and other emergencies, AtmaGo can also reduce healthcare cost by an average of **$14 per household per year** for residents of the Jakarta region.
6. If AtmaGo reaches a scale equivalent to 5% to 10% percent of Jakarta's population, then we estimate that this could reduce healthcare spending by **$2.3 million to $4.6 million** per year assuming that 30% of users take effective action that reduces damages by about 50%.
7. AtmaGo can also reduce morbidity and mortality caused by floods and other disasters by **643 years of healthy life lost per 100,000 population** as measured using Disability Adjusted Life Years (DALYs) and assuming that effective action can reduce impacts by about 50%.
8. AtmaGo also contributes to the improvement of social cohesion, which has been linked to an improved community response to disasters. According to our survey, **79% of users found AtmaGo helpful or very helpful in connecting them with the community**. Additionally, 67% of respondents found AtmaGo **helpful or very helpful** in assisting them to prepare for disasters.
9. Although we know that not all people who receive an alert will take action, **68% of users reported sharing information from AtmaGo** and 13% of those who shared information, shared disaster reports. Each user, on average, **shared AtmaGo posts with over 28 other people**.

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1 Introduction

1.1 Background and rationale

Over 2017, there were 2,341 natural disasters of different kinds across Indonesia's 1.9 million square kilometer (Badan Nasional Penanggulangan Bencana, 2017). The incidents in 2017 led to a total of 3.49 million evacuations, 47,442 damaged houses, 2,083 units of damaged public facilities and 377 deaths. Floods and landslides are generally the two deadliest natural disasters for Indonesians and, in 2017, caused 156 and 135 fatalities respectively. Economic losses from disasters are also substantial with floods causing an average annual loss of over $2.3 billion (UN Office for Disaster Risk Reduction, 2014).

Given this context, there is an urgent need to reduce the risk of disaster and improve preparedness across Indonesia. These priorities are echoed by global institutions (e.g. Sendai Framework for Disaster Risk Reduction[1]), who have been incorporated into national planning efforts and laws[2]. Based on in-country analysis, Indonesia supports the use of technology as one of the key resources to improve disaster management[3]. In particular, Information and Communication Technologies (ICT) have been highlighted as an important route to improve disaster management in Indonesia. Using ICT to reduce disaster risks holds much promise due to the broad availability of mobile phones, internet access and social media[4].

Realizing the potential of ICT in improving disaster management in Indonesia, AtmaGo was launched in 2015 by Atma Connect[5] as a neighborhood-level social network that can be accessed via website or Android app. Developed with the concept of crowd-sourcing reports and information, AtmaGo enables their users to share real-time disaster-related information, such as reports of fires, floods and other disasters. In addition, AtmaGo users can offer advice and solutions on Disaster Risk Reduction (DRR) topics, find information about jobs and education events and discuss a broad range of topics. Dedicated to the idea of "neighbors helping neighbors" (*warga bantu warga*), Atma Connect has a vision to help "create a world where neighbors help neighbors prepare for disasters, improve access to basic needs and overcome chronic challenges" (Atma Connect, n.d.).

AtmaGo has been growing rapidly since its introduction in 2015. As per December 2017, AtmaGo has more than 300,000 users in Indonesia who have taken more than 600,000 actions on various issues such as water, food, jobs, education, shelter, flooding, crime and fires (Atma Connect, 2017). An initial study

[1]The Sendai Framework for Disaster Risk Reduction 2015-2030 (SFDRR) consists of seven targets and four priorities for action to prevent new and reduce existing disaster risk. More information is available on https://www.unisdr.org/we/coordinate/sendai-framework.

[2]The implementation of SFDRR in Indonesia is incorporated into *Nawacita*, or Nine Priorities of National Development Program under Jokowi's Presidency. Furthermore, the National Medium Term Development Plan for 2015-2019 also indicates that disaster management and risk reduction is one of the priority agendas for the Government of Indonesia.

[3] According to Law No. 24/2007, science and technology are one of the key principles of disaster management in Indonesia.

[4] As per 2017, there are 143.26 million internet users and 371.4 million mobile subscribers in Indonesia.

[5] More information about AtmaGo and Atma Connect are available on https://www.atmago.com/ and https://atmaconnect.org.

by Atma Connect (Cain, 2017) that uses a cost-benefit framework, estimated that at a broad scale, AtmaGo could save low income residents of Jakarta by $6.2 million to $12.4 million per flood. And, if AtmaGo can reduce damage across the city by 5% to 10%, this would equate to benefits of between "$28 million in avoided damage (5% reduction of a moderately severe flood event) to up to $85 million (10% reduction for a severe flood event) for the city."

These estimates point to the possibility that ICT in general, and apps such as AtmaGo can be important tools to reduce damage and decrease morbidity and mortality from floods and other disasters. To better calculate the potential benefits, Centre for Innovation Policy and Governance (CIPG)[6], at the request of Atma Connect and with funding from Qualcomm Wireless Reach[7] has conducted an independent evaluation and analysis with the goal of improving our understanding of 1) how people get emergency warnings, 2) whether AtmaGo can provide these warnings in an actionable way, and 3) the potential benefits of successful warning systems in terms of avoided damages and prevention of mortality and morbidity. This research will ultimately be beneficial for the use of ICT in DRR and emergency communication.

1.2 Research design and objectives

The main purpose of this research is to assess how AtmaGo influences the behavior and understanding of its users. To be precise, this research seeks to examine the impacts and potential impacts of AtmaGo as a tool that helps people prevent and respond to disasters, such as urban flooding. Looking at a wider perspective, this research ultimately also aims to improve our understanding of how ICT can be used for DRR and emergency response.

Based on the above elaboration, the following research questions were formulated:

1. What are the impacts created by disasters on our survey respondents?
2. What are the potential benefits of DRR and EWS (Early Warning System) messages on AtmaGo for the respondents in our survey in terms of avoided damages, prevention of mortality and morbidity, and improved sense of safety and community cohesion?
3. What is the estimated potential benefit of AtmaGo at broad scale for a large city, such as Jakarta?

1.3 Scope of the study

As AtmaGo is still relatively new, it may not be possible to empirically measure its impacts at broad scale. Therefore, we begin by estimating the benefits for our survey respondents, which includes 358 users and non-users in five locations in the Greater Jakarta area: Penjaringan, Halim, Bekasi, Bojong Gede and Kampung Melayu. We then use these survey results and a cost-benefit analysis (CBA)

[6] http://cipg.or.id/

[7] https://www.qualcomm.com/company/wireless-reach

framework to estimate the benefits of improved EWS and DRR communication for users and for the entire city.

1.4 Report structure

This report consists of five chapters and three appendices. In chapter one, we discuss the context of disaster in Indonesia and how AtmaGo can play a role in improving disaster preparedness and response. Chapter two discusses our methodology, research strategy, and limitations. Then, we outline the profile of our respondents in chapter three and summarize their responses to ICT-related questions and experience with disasters. These data served as a basis to estimate the potential impact of AtmaGo in terms of avoided damages and prevention of mortality and morbidity, which are presented in chapter four. We conclude our research in chapter five by highlighting our key findings.

2 Methodology

This research aims to generate insights into how AtmaGo is being used and how it creates, or will create, impact on society during disaster situations. To better understand the impact of AtmaGo on users, and society at large, we carried out a survey to collect primary data. The survey examines how natural disasters affect people in select neighborhoods within the Greater Jakarta Area of Indonesia, what actions users and non-users take in the face of warnings, and what potential benefits accrue to users from the provision of emergency alerts and DRR messages provided by AtmaGo. We then use this data, as we detail in subsequent sections, to create quantitative estimates of the impact of AtmaGo on respondents and the possible impact at scale.

2.1 The cases

The survey was conducted in five urban locations in the Greater Jakarta Area: Penjaringan, Halim, Bekasi, Bojong Gede and Kampung Melayu. The selection of these locations was determined in concert with AtmaGo based on the vulnerability of the neighborhoods to disaster. To conduct the survey, we worked with AtmaGo to find local gatekeepers to help us connect with respondents in each community.

Table 1 Profile of selected locations (compiled by Authors)

	Penjaringan	**Halim**	**Bekasi**[8]	**Bojong Gede**	**Kampung Melayu**
Population	298,700 (2017)	34,456 (2016)	6,174,974 (2016)	140,261 (2016)	30,828 (2016)
Area	45.4 km^2	13.07 km^2	1,484.37 km^2	28.2469 km^2	0.46 km^2
Recent disaster	Flood (2017) Fire (2017)	Flood (2017)	Flood (2018) Fire (2018) Typhoon (2017)	Flood (2016) Drought (2015)	Flood (2018) Fire (2017)

2.2 Survey

Since the main objective of this research is to understand how AtmaGo creates impact on society, we developed a questionnaire to assess user experience with disasters and how they use ICT to prepare for and respond to emergencies. After asking demographic questions, we surveyed both users and non-users on how they receive emergency alerts and DRR information, what actions they take in response,

[8] Bekasi consists of two areas, city and regency. This data represents the sum of these two areas.

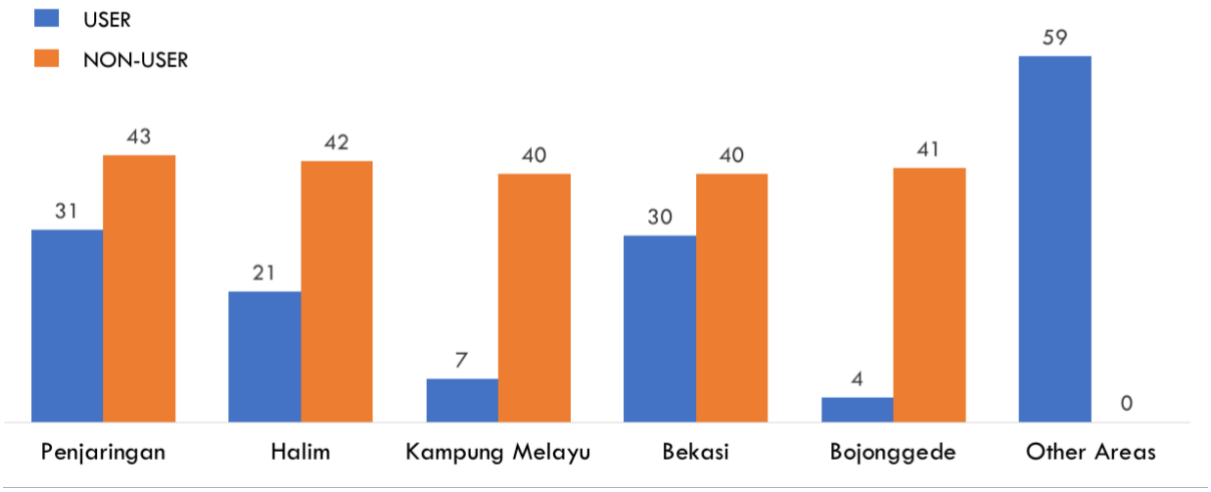
and what kind of impact the disasters created on their lives. The complete version of the questionnaire is available in the appendix.

Figure 1 An interviewer carrying out field survey in Bekasi, West Java

We used quota sampling method for this research (Moser, 1952), which allow us to focus only on certain subgroups in order to understand their characteristics. We divided the samples into two categories (users and non-users) and set a target of at least one hundred responses for each subgroup. To achieve this target, we conducted a face-to-face field survey using a purposive sampling approach (Guarte & Barrios, 2006; Tongco, 2007). This means that we relied on the knowledge of the gatekeepers to assist us in reaching both users and non-users in each location. We also used the snowball sampling method (Goodman, 1961) by asking the respondent about the next potential candidate to be interviewed. To boost the response rate, we also conducted phone interviews with existing users of AtmaGo.

After several rounds of field and phone sampling, we reached 358 respondents from October to December 2017 (152 users and 206 non-users). Figure 2 provides a count of the number of respondents in each location.

Figure 2 Overview of respondents in each location (n=358)



2.3 Quantitative estimation on the potential impact of AtmaGo

In order to get a better sense on the potential impact of AtmaGo, we made use of a cost-benefit analysis (CBA) framework to quantify and compare the costs of disasters and the potential benefits of AtmaGo. The CBA framework is a widely used approach to estimate the net benefit of a program by valuing the costs and benefits for various stakeholder groups over time and then subtracting the net present value of all costs from all benefits (Boardman, Greenberg, Vining, & Weimer, 2017). CBA has been used to examine a wide range of public policy questions and has been used to study the value of DRR programmes and EWS tools (Pappenberger et al., 2015; Priest, Parker, & Tapsell, 2011; Shreve & Kelman, 2014; Subbiah, Bildan, & Narasimhan, 2008; Teisberg & Weiher, 2009). Hence, this method is appropriate for this research given the nature of AtmaGo as a tool to improve citizen's response during disaster — however we do not perform a full cost-benefit analysis.

Our survey and estimation focus on four benefit pathways: avoided property damage, reduced healthcare cost, prevention of morbidity and mortality, and psychosocial benefits. The estimated value of AtmaGo's benefits for users is used as a basis for further analysis of AtmaGo's impact in different setting and as it reaches a larger user population.

2.4 Constraints and limitations

There are several challenges that we faced throughout this research, mainly during the data collection phase. In regard to the face-to-face interview, we found that few users met the ideal profile for respondent, which is the individuals who experienced disasters before and after becoming an AtmaGo users. Some of the users that we found had just started to use AtmaGo, and some of them have no experience in dealing with disasters. In these circumstances, we still interviewed these new users, but we focused more on capturing their motivation and experience in using AtmaGo.

Another challenge that we face is regarding the knowledge of gatekeepers. As we previously mentioned, gatekeepers were important to case selection. However, knowledge of the local area and connections to users within a neighborhood varied by gatekeeper. Thus, our initial set of field interviews was supplemented by phone interviews.

Given that we used a mix of quote sampling, purposive sampling, and snowball sampling, in addition to the data limitations discussed above, sample bias is a risk (Greene, 2003). To guard against this risk, we compare the demographics of users and non-users in the next chapter and highlight any discrepancies between the groups.

3 Profile of respondents

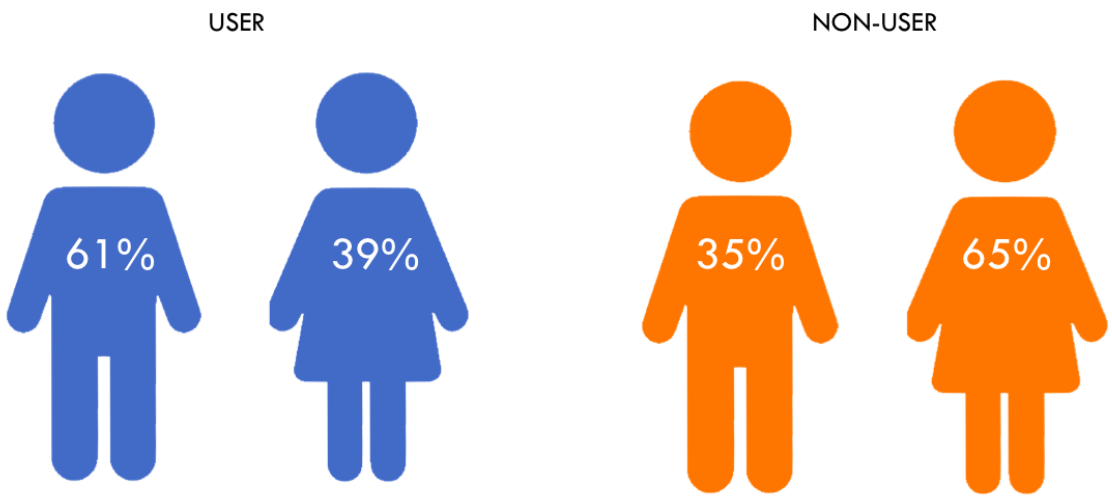
As AtmaGo aims to create impact for society especially during disaster situations, it is necessary to understand the characteristics of citizens who are at the risk of experiencing disaster. Hence, we conducted surveys with both users and non-users in select locations in the Greater Jakarta area. We define a user as an individual who has experience in using AtmaGo and/or is currently registered as a user. Non-users are individuals who have never used AtmaGo.

Figure 3 An interviewer carrying out field survey in Penjaringan, North Jakarta

3.1 Demography of respondents

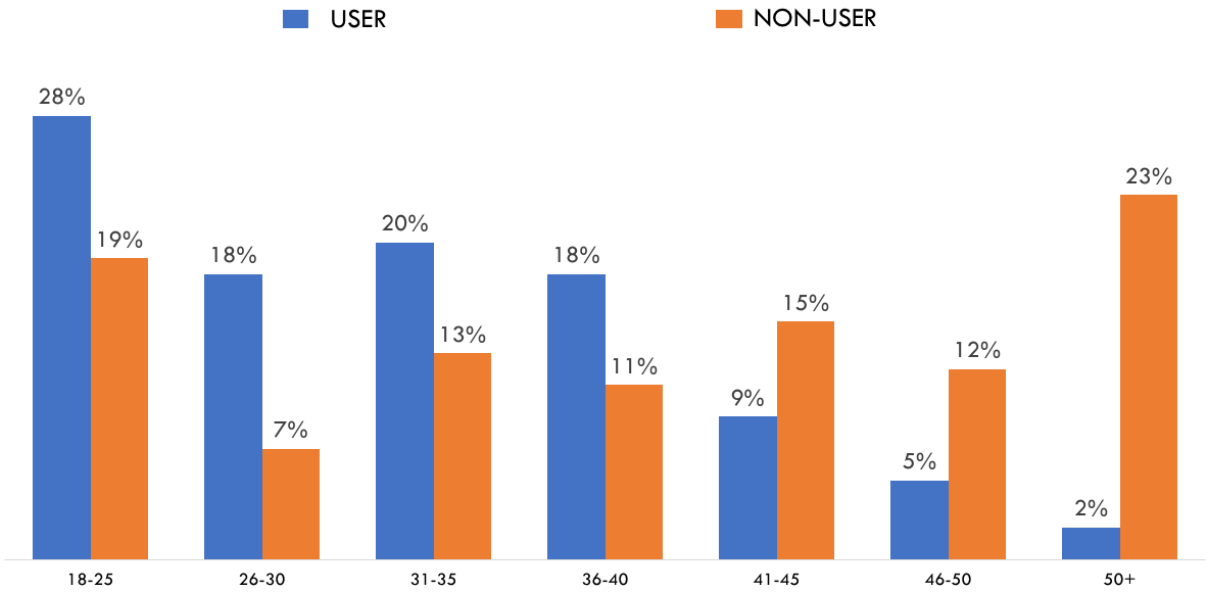
Our survey revealed that there are some demographic differences between users and non-users such as gender, marital status, educational background and monthly expenses. As we can see from Figure 4, 61% of users surveyed were male and 39% were female. For non-users in our survey, 35% were male and 65% were female.

Figure 4 Gender proportion of users (n=152) and non-users (n=206)



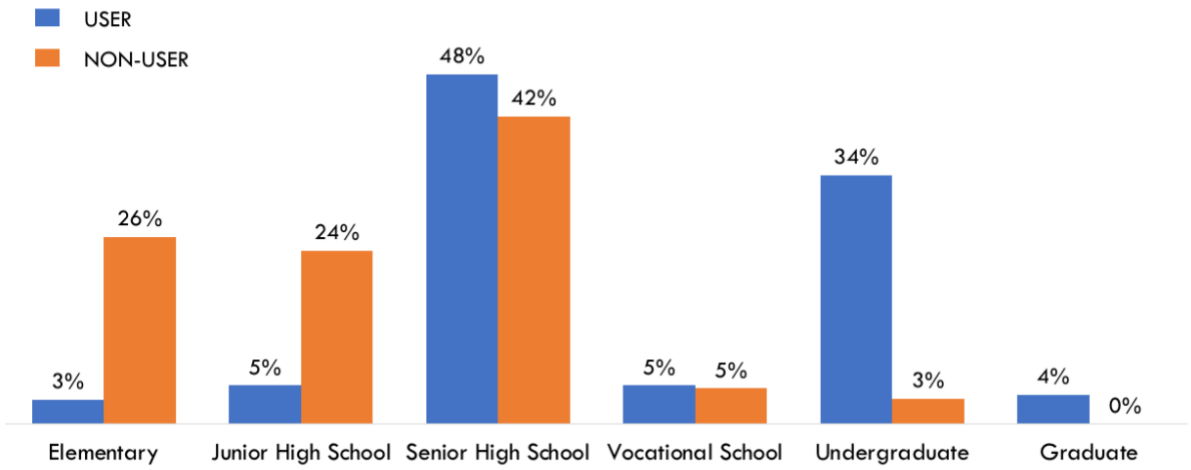
There are also differences in the proportion of age group between users and non-users as shown in Figure 5. The two categories share a similarly high proportion of young adults between 18-25 years old with percentages no less than 19%. However, the number of people older than 50 years old is significantly higher in our non-user group (23%) as compared to those who are AtmaGo users (2%).

Figure 5 Age ranges of users (n=152) and non-users (n=206)



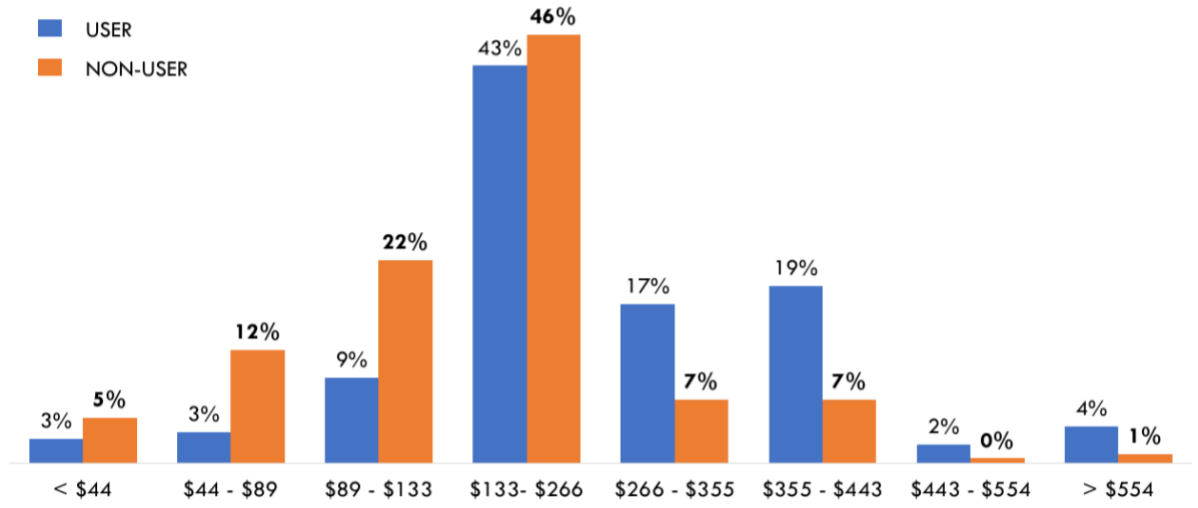
As can be seen in Figure 6, the majority of the respondents from both groups have at least a senior high school education, however 34% of AtmaGo users have completed education up to the equivalent of a 4-year college degree as compared to only 3% of non-users. Given that large pluralities of both groups have at least a high school education, the ability to read and write should not be a barrier to ICT use.

Figure 6 Educational background of users (n=152) and non-users (n=206)



Overall, both users and non-users share common economic characteristics. We asked respondents about their monthly expenses as an indicator of income. As shown in Figure 7, similar percentages of users (43%) and non-users (46%) have a monthly spending range between 1.8 to 3.6 million Rupiah (US$ 133 – US$ 266). However, AtmaGo users, on average, are more likely to have a higher level of spending as compared to non-users. For context, the average monthly expenses for residents of Jakarta is approximately 7.5 million Rupiah (US$ 532) per month (Suryowati, 2014).

Figure 7 Monthly expenses of users (n=152) and non-users (n=206) in US Dollars

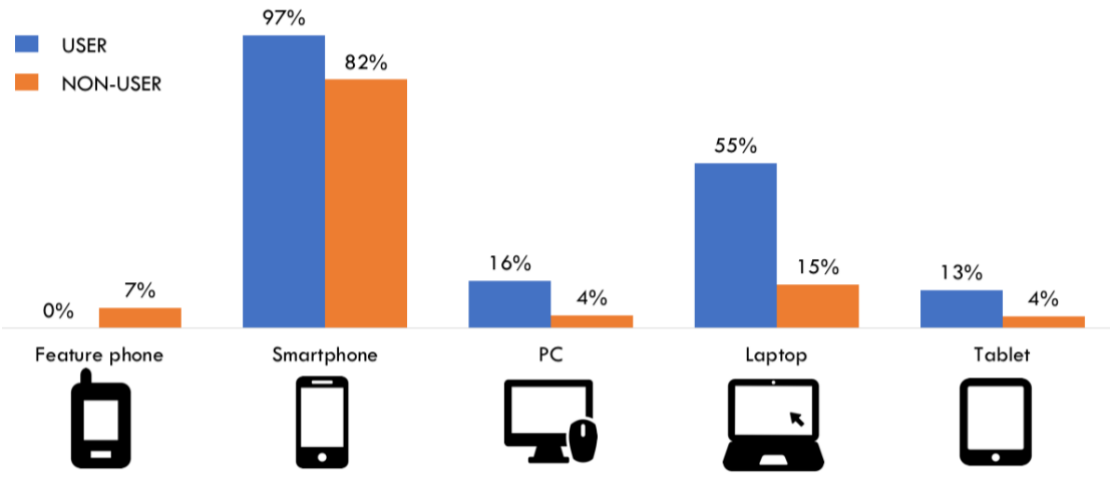


Note: US$1 = Rp13,600.

3.2 ICT-related activities among users and non-users

Almost all respondents can access the internet by some means. Figure 8 shows that 97% of users and 82% of non-users in our survey use a smartphone to access internet. Smaller percentages use other devices, such as feature phones, personal computers, laptops, and tablets — however, the key point for this study is that almost all respondents have at least one and, in many cases, more than one device that can access the internet.

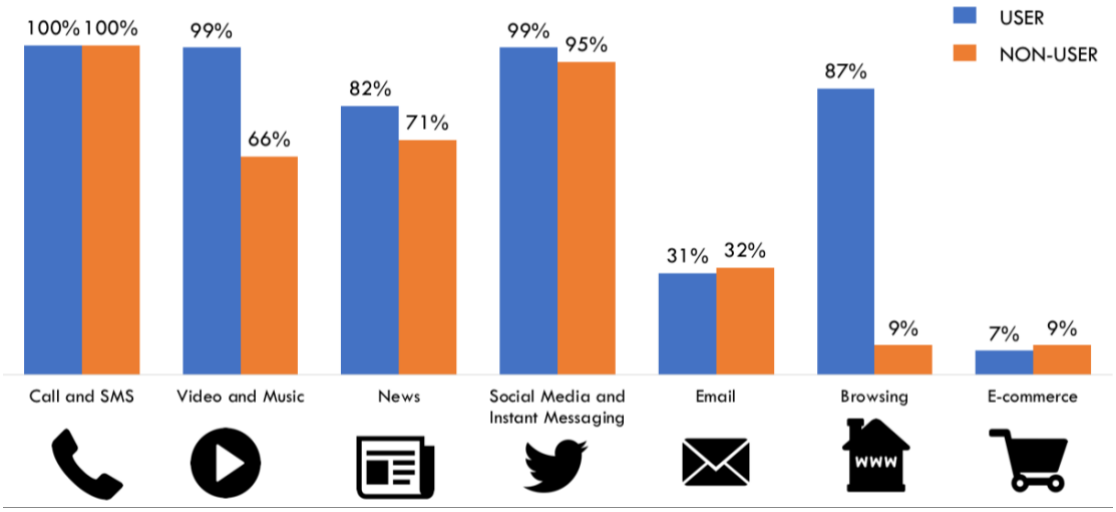
Figure 8 How respondents access the internet (users n=152; non-users n=206)



Note: Multiple answers possible.

All respondents (100% of both groups) use mobile phones for calls and messaging. Also, more than 90% of users and non-users us their mobile phones to access social media and instant messaging applications.

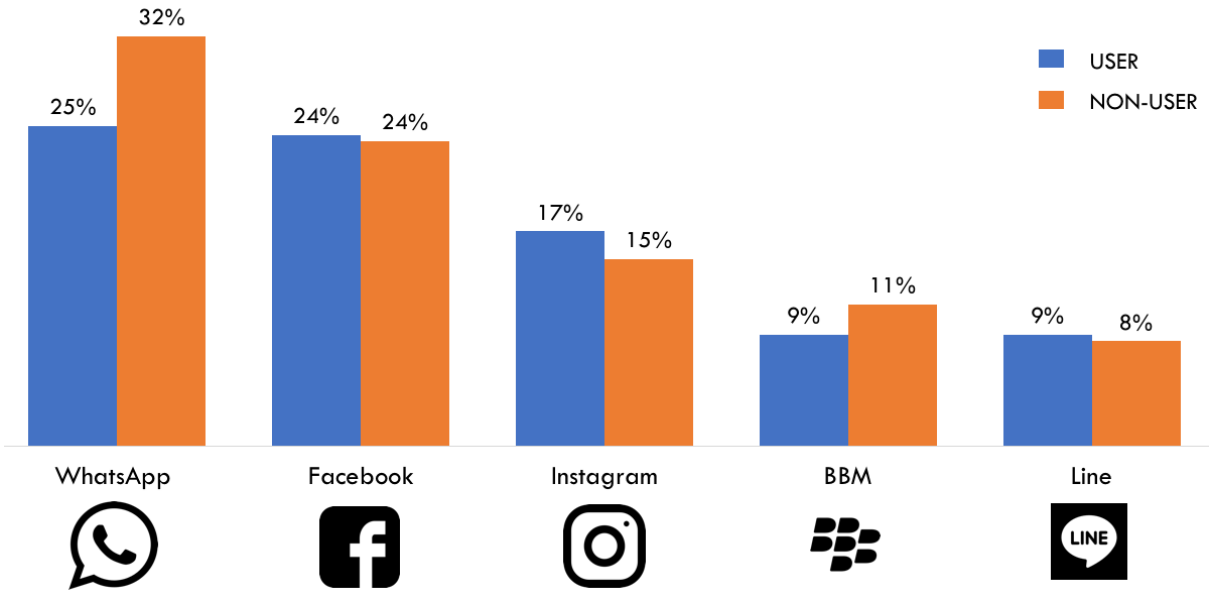
Figure 9 Mobile phone usage of users (n=152) and non-users (n=206) by activity



Note: Multiple answers possible.

Both users and non-users also have similar preference when it comes to social media. As is evident from Figure 10, WhatsApp, Facebook and Instagram are the top three most frequently used sites for both groups.

Figure 10 Social media preferences of users (n=152) and non-users (n=206)



Note: Multiple answers possible.

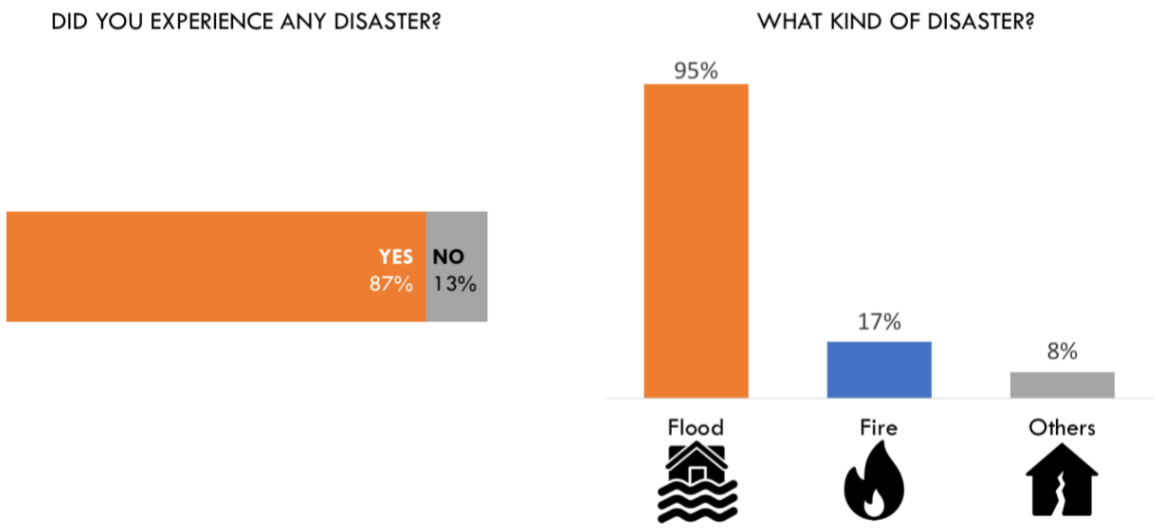
In comparing AtmaGo users to non-users, we can see that although there are differences in demographic characteristics, income and education, these groups are very similar in terms of access to the internet, use of mobile phones and social media preferences. The next section looks at respondents' experience with disasters.

3.3 Respondents' disaster experiences

In this section, we discuss findings on disaster-related experiences of all respondents. We briefly explain the types of disasters that commonly happens in the urban areas where our respondents lived. We also outline the behavior of respondents in dealing with the primary threat they face, which is urban floods, as well as the media that respondents use as sources of information.

The left side of Figure 11 shows that 87% of respondents have experienced some kind of disaster at least once between 1997 and 2017. The right side of the graph shows that 95% have experienced a flood, 17% a fire, and 8% some other kind of disaster such as earthquake or landslide. Totals exceed 100% because multiple answers are possible.

Figure 11 Disaster experiences of all respondents (n=358)



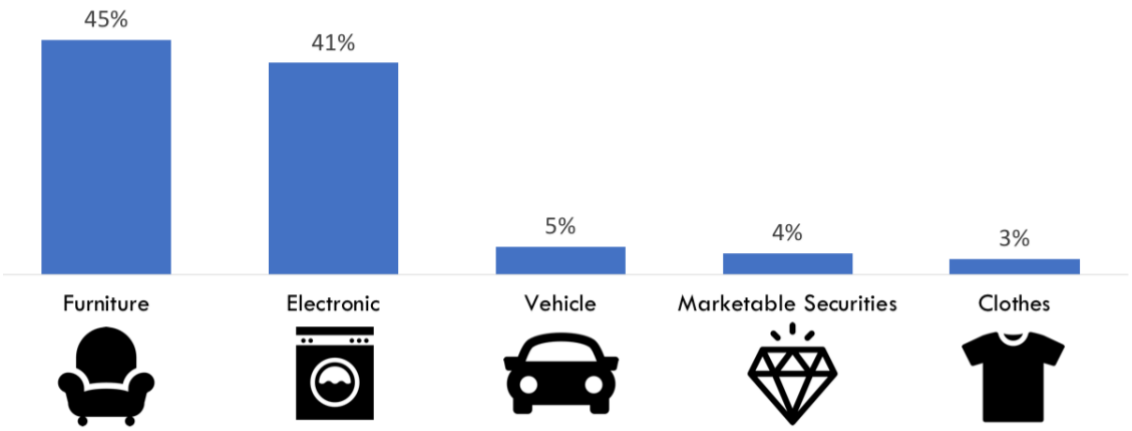
Note: Multiple answers possible.

These results are not surprising because these two disasters commonly occurred in the neighborhoods we surveyed. Although the risk of various kinds of natural disasters varies by neighborhood, city and region, as set out in the introduction, disaster risk is generally quite high across Indonesia with flooding being a common problem (Badan Nasional Penanggulangan Bencana, 2017).

We then asked respondents to "list the properties damaged" in the last disaster they recalled. We used a form with a checklist that allowed respondents to indicate what possessions were damaged. Although we asked individuals to assess their property damage, due to the context of the survey and how questions were asked, responses are considered as per household. We focused on assessing the direct cost of damage from floods to household items and did not survey users about structural damage or indirect costs.

As shown in Figure 12, the two most common kinds of damage reported by respondents were impacts to furniture (storage, sofa, bed) and electronic devices (TV, AC, refrigerator, rice cooker, fan). Other reported sources of damage include vehicles (car, motorcycle, bicycle), important documents (diplomas, housing lease or ownership documents), and clothes. Appendix B contains detailed count data on property damage.

Figure 12 Estimated property damage from disasters (n=358)

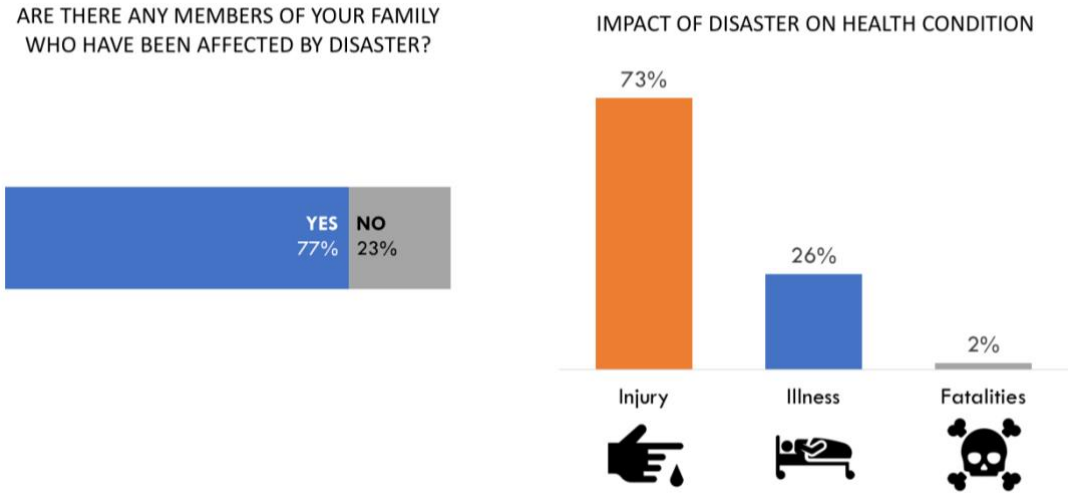


Notes: multiple answers possible.

Next, we surveyed individuals regarding any injuries, illnesses or fatalities that they or their families had suffered as a result of a disaster. Looking at

Figure 13, we can see that a substantial percentage (23%) suffered some kind of health impact from a recent disaster. The right side of Figure 13 shows that injuries were the most commonly reported health impact (73%). Examples of common injuries include strained ankle due to tripping or falling when trying to cross inundates areas and stepping on broken glass during the evacuation process. A smaller, but still substantively large group of respondents (26%) suffered an illness, such as diarrheal disease, influenza, fever, headache, or dengue infection. A very small percentage (2%) reported a family member that had died in a recent disaster.

Figure 13 Percentage of respondents' families who were affected by disasters (for the first question, n=312; for the second question, n=81)



Note: multiple answers possible.

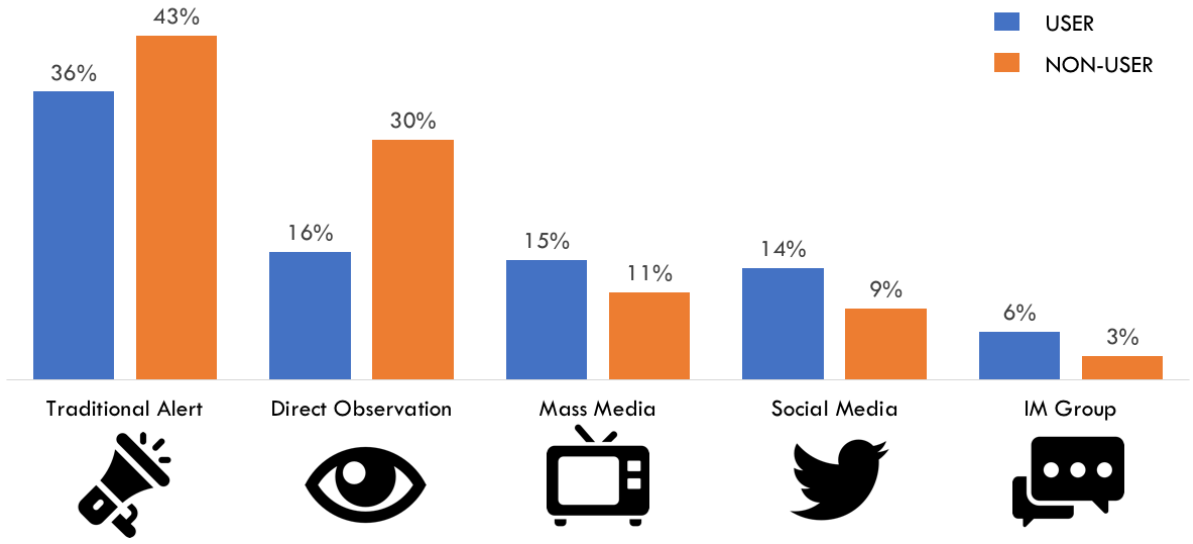
To verify their answers, we asked respondents in Questions 4.5 and 4.7 to list the family members who suffered from an illness, injury or death and to provide estimated dates, costs and durations. Please see Appendix D to see more details on this. In keeping with the approach above, we only surveyed respondents about their direct costs and did not include indirect damages such as loss of productivity.

Overall, we can see that the vast majority of respondents have experienced a disaster in the past two decades, and that a substantial percentage have suffered recent property damage and health impacts from these incidents. We examine what kind of property damage and health effects respondents suffered in greater detail in Chapter 4. But first, to complete our descriptive analysis of the survey data, we discuss how respondents receive emergency information and what actions they take in response to warnings and DRR information.

3.4 Disaster alert and preventive action

When it comes to disaster warning and alert, a plurality of both users and non-users reported that they received disaster alert from traditional tools such as *kentongan* (traditional slit drum) or announcements from mosques. Direct observation was the next most popular source of information, then mass media. Users of AtmaGo are served emergency flood alerts generated by the PetaBencana system[9], which are vetted by the Indonesian National Board for Disaster Management (known as BPBD). For AtmaGo users, we can see that social media was almost as popular source of disaster information (14%) as mass media (15%).

Figure 14 Disaster information sources for users (n=202) and non-users (n=110)

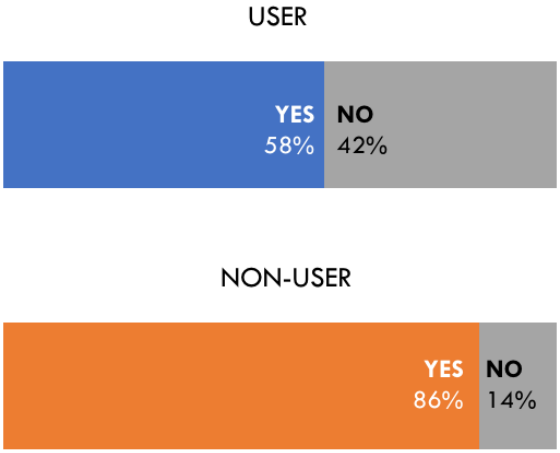


Note: Multiple answers possible.

[9] More information about PetaBencana is available from their website: https://petabencana.id/

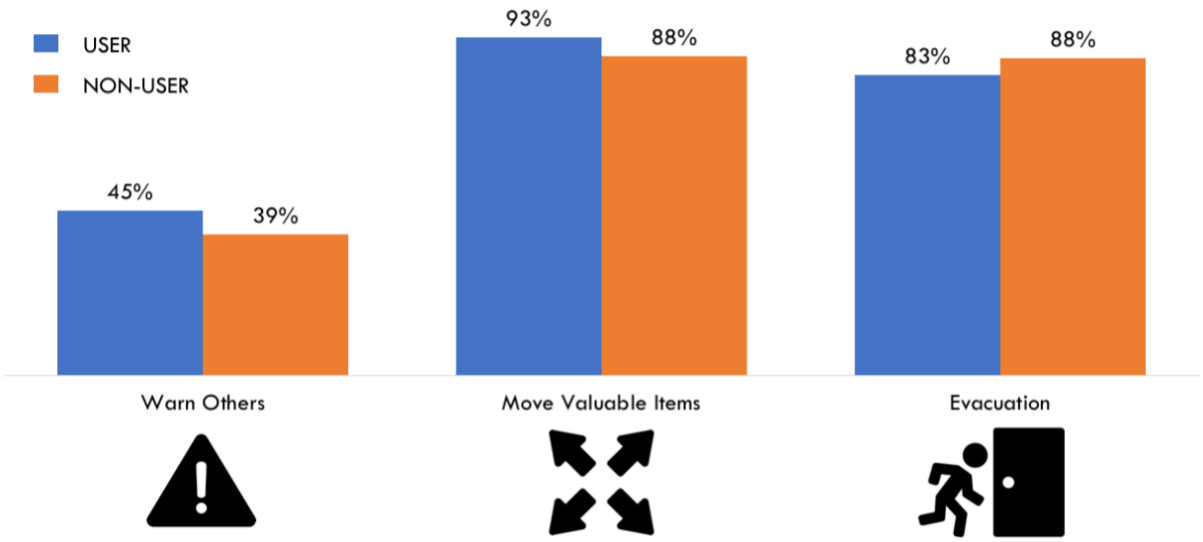
Upon receiving a disaster warning, a majority of users (58%) and a large majority of non-users (86%) took preventive action when facing disaster.

Figure 15 Percentage of users (n=110) and non-users (n=202) that take preventive action after a warning



Respondents were also asked what kind of preventive actions they took when a disaster occurred. Both groups appear to perform in some similar actions. Securing valuable items is on the first list for both users (92%) and non-users (77%), followed by evacuating themselves and their families (e.g. to a higher floor in the house), then providing warnings to other people.

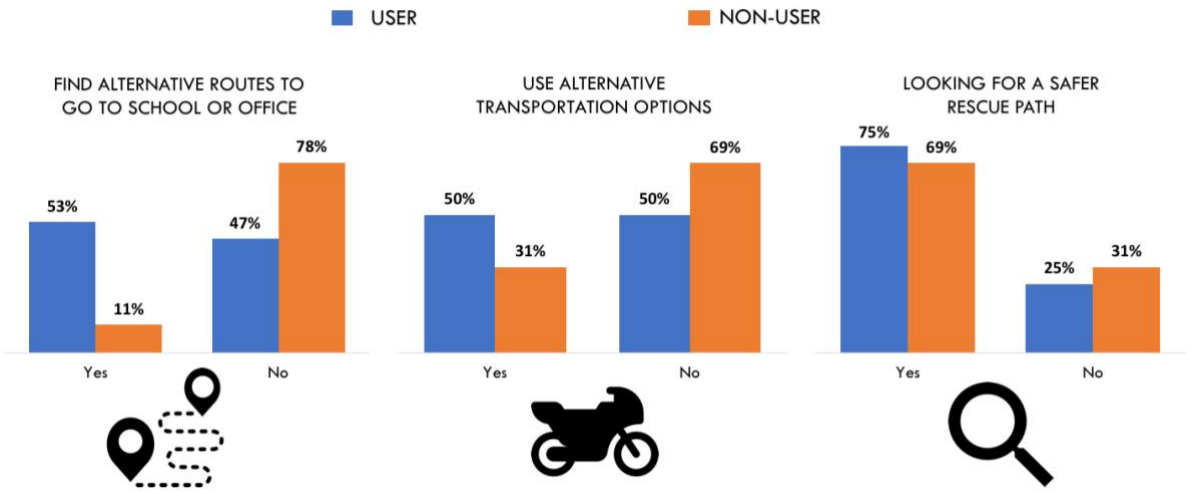
Figure 16 Type of preventive action performed by users (n=84) and non-users (n=178)



Note: Multiple answers possible.

Disaster warnings provide additional benefits to users and non-users. These include finding an alternative route to school or work, choosing an alternative transportation option (e.g., taking a cab or bus instead of motorcycle taxi) or choosing an alternative route to evacuate the neighborhood.

Figure 17 Benefits of disaster warning for users (n=84) and non-users (n=178)



In the next two sections of the survey (section 5 and 6), we asked only AtmaGo users specific questions about how they found out about AtmaGo and how they use the platform. Although most of these questions are not of use to a general audience, it is worth noting responses to two questions from within this set: 68% of users in our survey reported sharing information with other people and 13% of those users shared disaster-related information, with flood warnings being most commonly shared. We asked respondents to estimate how many people they shared information with and the average value was 28 people per AtmaGo user.

In section 7 of the survey, we asked only AtmaGo users how they use AtmaGo for disaster-related communication. Below, we present more information from this section of the survey.

This number is similar with several studies that examined evacuation rates for various disasters. Sorensen & Mileti (1988) found that 32% to 93% of people evacuate from floods, hurricanes, and mud flows after receiving a warning – depending on the severity and the credibility of the warning. Furthermore, Dow & Cutter (1998) found that the evacuation rates for hurricane warnings in the United States is between 10% to 81%. In addition, a study in 2000 found that 45% of people in a Tornado area responded to warning and took preventive action (Balluz, Schieve, Holmes, & Malilay, 2000). We can see that in only three years of operating, the early warning system provided by AtmaGo has shown the evacuation and preventive actions rate of 30%, which is similar to that of other early warning systems.

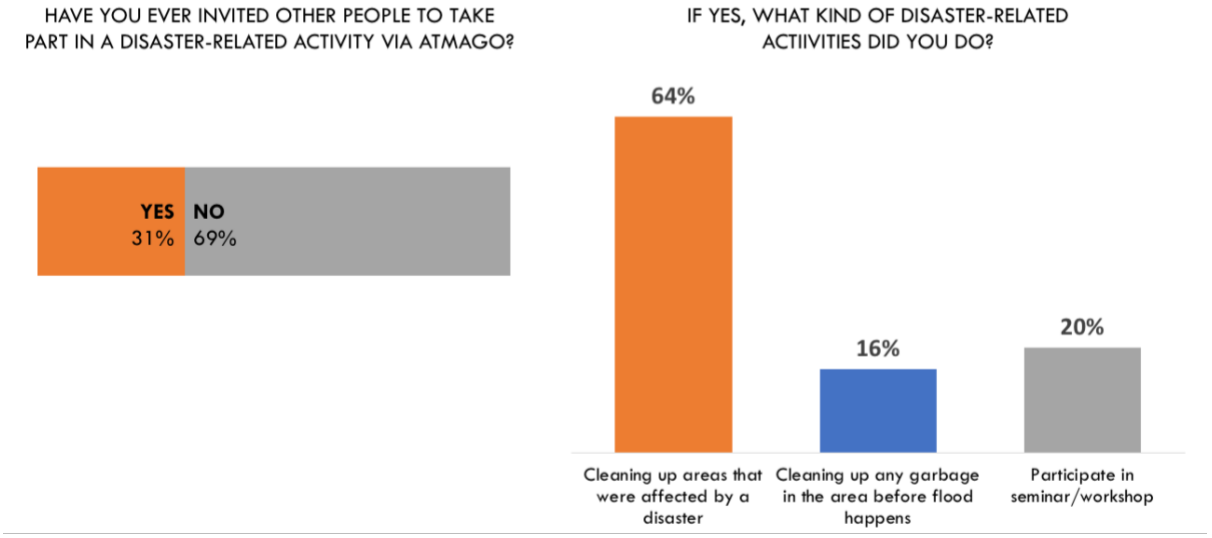
Figure 18 shows the number of respondents who received "disaster early warning information" from AtmaGo and took "preventive actions" as a result. We can see that 26% (40 respondents) of the total of 152 respondents reported that they have received early warning information from AtmaGo. This number is on par with other social media platforms; for instance 18% of respondents of the 2011 American Red Cross survey used Facebook to get information about emergencies (Haddow, Bullock, & Coppola, 2017).

Among 40 respondents who received early warning from AtmaGo, 30% of them took preventive actions after receiving the warning. This number is similar with several studies that examined evacuation rates for various disasters. Sorensen & Mileti (1988) found that 32% to 93% of people evacuate from floods, hurricanes, and mud flows after receiving a warning – depending on the severity and the credibility of the warning. Furthermore, Dow & Cutter (1998) found that the evacuation rates for hurricane warnings in the United States is between 10% to 81%. In addition, a study in 2000 found that 45% of people in a Tornado area responded to warning and took preventive action (Balluz, Schieve, Holmes, & Malilay, 2000). We can see that in only three years of operating, the early warning system provided by AtmaGo has shown the evacuation and preventive actions rate of 30%, which is similar to that of other early warning systems.

Figure 18 Users who received disaster early warning information from AtmaGo (n=152) and perform preventive action (n=40)

In addition to alerting others during disaster situation, AtmaGo is also useful in gathering people to conduct variety of disaster-related activities. As can be seen in Figure 19, around 31% of users reported that they use AtmaGo to invite their neighbors so that they can take part in pre- and post-disaster activities. The types of activities include clearing storm drains in the area, which reduces flooding, and post-event clean-ups after a flood. Another common activity is participating in a workshop that provides tips on how to respond to local hazards.

Figure 19 Users who use AtmaGo to invite others to take part in disaster-related activities (n=152) and type of activities conducted (n=47)



Note: multiple answers possible.

3.5 Synthesis

Based on the survey data, our analysis indicates that although there are differences between users and non-users in terms of respondents' demographic profile, the ability of both groups to access the internet via mobile phones is very high. Both groups are also avid social media users. This confirms various studies on Indonesia's digital profile, showing high usage of smartphone and social media in the country (DailySocial.id, 2017; We Are Social & Hootsuite, 2018). Thus, we can see that there are no *prima facie* barriers in Indonesia to the broad uptake of ICT-based DRR and emergency communication platforms such as AtmaGo. In the next chapter, we use the survey data discussed above to construct impact estimates.

4 Estimating the potential impact of AtmaGo at scale

To estimate the potential impacts of AtmaGo and similar ICT tools, we adopt a cost-benefit analysis (CBA) framework. CBA aims to estimate the potential costs and benefits of a program, such as providing flood warnings, using a comparable unit, such as money or lives saved. Although we do not perform a full CBA in this study, we use the CBA framework as it has been demonstrated to be a useful approach to assessing the net benefit of various kinds of disaster risk reduction (DRR) technologies, such as early warning systems (EWS) (Rogers & Tsirkunov, 2010).

Figure 20 An interviewer carrying out field survey in Tangerang, Banten

There are several approaches to calculate the benefits of EWS. A "cost-avoidance approach" is preferred in cases where contingent valuations are difficult to assess — as long as data are available to estimate benefits (Klafft & Meissen, 2011). Although estimating avoided costs can be challenging, there is "broad"

support in the cost-benefit literature for using a "benefit chain" methodology (Fritz, Scholes, Obersteiner, Bouma, & Reyers, 2008). This approach depends on showing that information provided by an EWS impacts an individual's decisions, and showing that the decisions that individuals make "improve well-being" (Klafft & Meissen, 2011). Although determining precise valuations for a broad range of benefits can be difficult, this approach can be combined with other tools, such as survey research, as we do here, to create useful estimates to inform policymaking and investment decisions (Fritz et al., 2008).

Based on valuation efforts in existing studies (Rogers & Tsirkunov, 2010), we evaluate four categories of benefits: property damage, healthcare costs, mortality and morbidity, and social cohesion.

4.1 Avoided property damage / loss

The first set of benefits is the direct cost of avoided property damage. With sufficient warning, users can move personal property to higher ground, protect their home or office by closing windows and doors, and take other actions, such as moving vehicles, that reduce the potential damage created by a flood (Rogers & Tsirkunov, 2010). In this part, the estimation adopts basic principle of estimating the benefits[10] (see Subbiah et al., 2008) based on the survey result. After calculating avoided damage per household, per incident, we also estimate avoided property damage assuming a higher proportion of AtmaGo users across the Greater Jakarta Area.

4.1.1 Estimating per household avoided property damage based on survey

In estimating total property damage, we asked respondents to recall recent disasters they had experienced over the past five years (2013-2017) and then to indicate what items across five different categories had been damaged: appliances, vehicles, furniture, important documents, jewelry (see question 4.2 and 4.3 in Appendix A). Users recalled what items had been damaged by year and indicated the type of disaster; in all cases over the past five years, damages were from urban floods that usually happen during the rainy months.

We then found 2017 average costs for appropriate proxy items using prices from Tokopedia[11], a popular Indonesian online shopping site (see Appendix B for details). Using prices and yearly counts of damage reports, we estimate the average per-household damage for each year from 2013 to 2017. Because the intensity of disasters varies from year to year, we present the average yearly per-household damage cost figure averaged over the past five years: $676.

[10] "*If loss due to a disaster without early warning is "A", and if the decreased loss that may be incurred after appropriate measures following early warning is "B", then the potential reduction in damages due to early warning is A - B. However, there may be a cost or investment required for providing the early warning services "C". Therefore, the actual benefit due to early warning is A-B-C.*" (Subbiah et al., 2008).

[11] https://www.tokopedia.com/

Table 2 Average yearly per household property damage estimates

Year	Number of respondents who experienced disaster	Property damage estimates (IDR)	Property damage estimates (USD)	Average yearly per household damage estimates (USD)
2017	42	Rp293,000,000	$21,544.12	$512.96
2016	52	Rp531,700,000	$39,095.59	$751.84
2015	30	Rp474,200,000	$34,867.65	$1,162.26
2014	18	Rp96,200,000	$7,073.53	$392.97
2013	51	Rp378,700,000	$27,845.59	$545.99
	193	**Rp1,773,800,000**	**$130,426.47**	**$675.78**

Note: US$ 1 = Rp13.600

The final step in estimating an avoided damage benefit is to consider the amount of annual damage that can be eliminated by improved flood warnings. A review of the empirical literature by Priest et al. (2011) finds that although "there is debate about the amount of flood damage that may be saved by flood warnings" there is substantial evidence that warnings do provide "some reduction in property damages from flooding" (p. 102). In surveying the literature, they highlight work by Smith (1981) who finds that residents of a city in Australia reduced residential river-caused flood damage by 48%. Thus, we discount the avoided damage benefit by 48% and estimate that improved warnings can save the average low-income family living in Jakarta by $324 per year.

4.1.2 Estimating avoided property damage at broad scale

The same approach can be used to estimate the potential benefits of AtmaGo as it reaches a larger number of users in Jakarta. In estimating the impact of AtmaGo at a broad scale, we use a response rate of 30%, which is the percentage of AtmaGo users who took action after receiving an alert. We note that not all AtmaGo users may read alert, and not all users who read alerts may take effective preventative action. However, our survey indicated that 68% of users share posts from AtmaGo and 13% of those respondents share disaster alerts. On average, each AtmaGo user shares posts with 28 other people in their neighbourhood. We do not include the follow-on benefits of this additional set of users in order to compensate for the factors outlined above.

In the following equations, we estimate the annual avoided damage benefit if AtmaGo reaches 5% to 10% of residents in the city of Jakarta, which equals 10,855,000 people[12]. We assume that each AtmaGo user will warn their immediate family or household and thus use average per-household damage estimates from above.[13] We also assume that 30% of users will take effective action (based on our

[12] The population of Jakarta is estimated by World Population Review based on 2016 Indonesian Census and other data sources (http://worldpopulationreview.com/world-cities/jakarta-population/

[13] According to the United Nations report "Household Size and Composition Around the World 2017", the average household in Indonesia includes 4 people.

survey) that can protect their household from the annual average avoided damage estimate of $324 (48% of the average yearly damage caused by floods).

- 5% usage by Jakarta population (10,855,000 people) = 542,750 people. If 30% of those households take effective action that reduces the damage caused by the flood by $324 per year, that's a total annual avoided damage benefit of $52,755,300.
- 10% usage by Jakarta population (10,855,000 people) = 1,085,500 people. If 30% of those households take effective action that reduces the damage caused by the flood by $324 per year, then that's a total annual avoided damage benefit of $105,510,600.

4.2 Reduced healthcare cost

Disaster warnings, combined with post-incident information, can also create benefit to human health by reducing injuries, illness and fatalities associated with major disaster such as floods and fire. Using a similar approach as in section 4.1, we estimate the healthcare savings per individual across all respondents.

4.2.1 Estimating per household healthcare savings based on a survey

Following a similar approach to calculating the damage estimates, we asked respondents to estimate their annual spending on healthcare caused by disasters over the past five years (2013-2017). Based on our survey, respondents spent between $4 to $75 per household per year, on either hospitalization charges or the cost of outpatient care for illness or injuries linked to a specific recent disaster. Appendix C presents detailed data on estimated spending for care. Over five years, this averages to $30 per household per year in total healthcare costs stemming from disasters.

Table 3 Average yearly per household healthcare cost estimates

Year	Number of respondents who needed to pay for the healthcare cost	Healthcare cost estimates (IDR)	Healthcare cost estimates (USD)	Average healthcare cost yearly per household (USD)
2017	7	Rp2,751,000	$202	$29
2016	19	Rp7,484,000	$550	$29
2015	5	Rp950,000	$70	$14
2014	1	Rp50,000	$4	$4
2013	18	Rp18,303,000	$1,346	$75
Total	**50**	**Rp29,538,000**	**$2,172**	**$30**

Note: US$ 1 = Rp13.600

Although the discount factor above applies to household damages, the principle still holds: warnings are unlikely to reduce all the health spending associated with an urban flood. Therefore, we use the same 48% discount factor to estimate the avoided healthcare spending benefit and estimate the benefits of improved warnings at $14.40 per year. We note that healthcare costs are generally low in Indonesia because basic healthcare is provided to low-income residents for free; since 2014, the

government has been rolling out a national health insurance system *(BPJS Kesehatan[14])* to provide free healthcare services to all residents (Razavi, 2015). However, they cannot go directly to the hospital to receive treatment. Instead, they have to go to the community health center *(Puskesmas)* first, which is often very crowded and not reliable. Given this condition, our analysis focuses only on the out-of-pocket spending by respondents, who prefers to go to the hospital at their own cost or using private insurance. However, we can assume a follow-on benefit in a reduction in government healthcare spending.

4.2.2 Estimating total healthcare savings at broad scale

Using a similar approach as in section 4.1.2, we estimate the benefits for avoided health care costs at broad scale assuming 5% and 10% usage by the residents of Jakarta. We again assume a 30% response rate (based on our survey) and estimate the benefits of $14 per year on a household basis.

- 5% usage by Jakarta population (10,855,000 people) = 542,750 people. If 30% of those people take effective action that eliminates their average annual per-household healthcare spending linked to disasters, then that is a total avoided healthcare benefit of **$2,279,550 per year**.
- 10% usage by Jakarta population (10,855,000 people) = 1,085,500 people. If 30% of those households take effective action, then that's a total avoided damage benefit of **$4,559,100 per year**.

4.3 Disability Adjusted Life Years (DALYs) averted

Another approach to measuring the benefits of early warning systems is by looking at a reduction in mortality and morbidity that EWSs create (Rogers & Tsirkunov, 2010). EWSs reduce injuries, illness and death by providing sufficient warnings to allow people to flee prior to the incident, and by alerting them to dangerous areas to avoid during and after the disaster. In the low-lying areas where we surveyed residents, reports of injuries sustained from evacuating floodwaters were common, as were reports of illnesses that corresponded to floods and other local disasters.

In studies of disaster risk, Disability-Adjusted Life Years (DALYs) is often used to quantify the health burden caused by disasters. This measurement was developed to account for deaths, injuries and diseases that are disabling, but not deadly (World Health Organization, 2014). A single DALY represents the loss of the equivalent of one year of full health. Following best practices as set out in Fox-Rushby and Hanson (2001), we use life expectancies for Indonesia, and we use a straightforward approach that does not include age weights or a discount function.

[14] https://bpjs-kesehatan.go.id/bpjs/

In estimating DALYs, we use the following equation:

Disability Adjusted Life Years (DALYs) =

Years Lost due to Disability (YLD) + Years of Life Lost (YLL)

Years Lost due to Disability (YLD) = I x DW x L

Where:

- I = Number of cases
- DW = Disability Weight
- L = average duration of cases (in years)

Years of Life Lost (YLL) = N x L

Where:

- N = Number of deaths
- L = life expectancy at the age of death (in years). This is the number of additional years a person is expected to live beyond the age of death.

4.3.1 Estimating per household morbidity and mortality based on a survey

In this section, we use data from our field survey to estimate the benefits of AtmaGo warnings on reducing morbidity and mortality. As we discussed above, effective warnings can prevent potential injuries from when trying to flee the floodwaters and can reduce disease and death caused by the floodwaters.

From the reports we collected during our survey, we identified the most common diseases linked to floods and we then found their disability weights in World Health Organization reference materials. The disability weights we use are:

- Dengue & Chikungunya = 0.051
- Diarrheal diseases = 0.188
- Typhus and viruses = 0.051

Additionally, as life expectancy differs by nation and gender, we used the latest WHO data for Indonesia: 67.1 years for men and 71.2 years for women. In calculating DALYs averted by the intervention, we first sum YLL and YLD for each year as shown in Table 4. We then average these yearly tallies over the 12 years in our sample set and then divide by our sample (N = 358). Appendix D contains more detailed information on our DALYs calculations.

Table 4 Estimation of DALYs per year

Years	Years Lost due to Disability (YLD)	Years of Life Lost (YLL)	DALYs per year
2006	0.031	0	**0.031**
2007	0.047	29	**29.047**
2008	0	0	**0**
2009	0.047	0	**0.047**
2010	0.011	0	**0.011**
2011	0	0	**0**
2012	0.078	0	**0.078**
2013	0.105	28	**28.105**
2014	0	0	**0**
2015	0.031	0	**0.031**
2016	0.12	0	**0.12**
2017	0.078	0	**0.078**

From the above estimation of DALYs per year, we get the following calculations:

1. Average DALYs caused by disasters per year (over 12 years) = **4.79**
2. Average DALYs per household = 4.79 years / 358 people = **0.013393 years**
3. DALYs per 100,000 population = 0.013 x 100,000 = **1,339.3 years per 100,000 population**

To provide more context, we compare our findings with the data on DALYs per 100,000 people provided by Institute of Health Metrics and Evaluation (IHME)[15], which can be seen in Table 5. According to this source, Tuberculosis causes 1,361 DALYs, while Diarrheal Diseases and Chronic Obstructive Pulmonary Disease (COPD) causes 935.1 and 919.2 DALYs per 100,000 population respectively. We can see that this number is quite similar with our findings, which is around 1,339.3 DALYs from flood disasters.

Assuming messages from AtmaGo can reduce DALYs by 48%, this equals 643 DALYs per year. This means that emergency alert provided by this application can help in reducing morbidity and mortality caused by floods and other disaster by saving around **643 years of life lost per 100,000 population**.

Table 5 DALYs Comparison

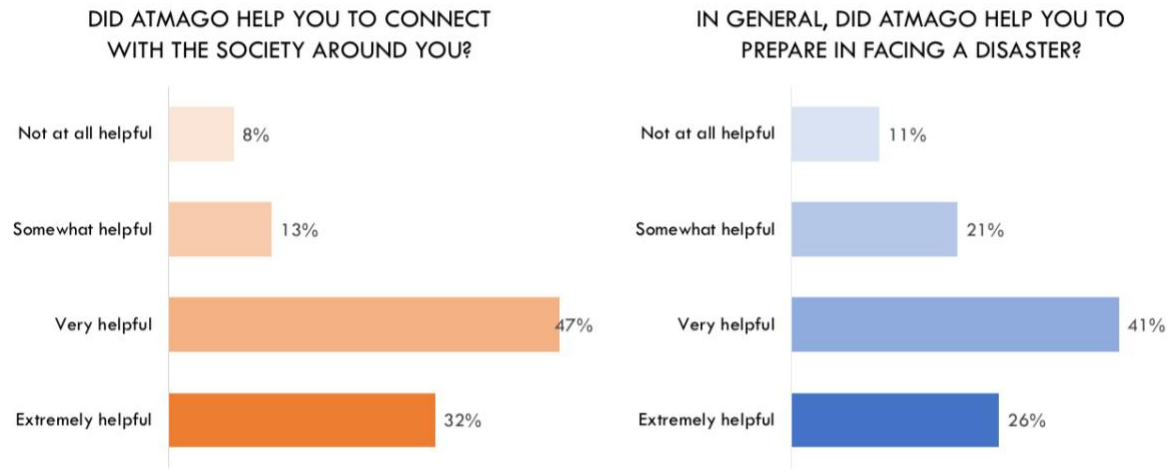
Disease / Disaster	DALYs per 100,000 population
Flood (based on survey)	1,339.3
Tuberculosis	1,361
Diarrheal Diseases	935.1
Chronic Obstructive Pulmonary Disease (COPD)	919.2

[15] More information is available at http://www.healthdata.org/indonesia

4.4 Impact on social cohesion

Research shows that social cohesion is an important factor in reducing real-world impacts from disasters and in improving community resilience. With this in mind, we also assess the benefits of AtmaGo in improving people's sense of engagement with the neighborhood and sense of safety. We look explicitly at community engagement because of a research that shows that "social participation" is closely linked to a person's willingness to take DRR actions (Witvorapong, Muttarak, & Pothisiri, 2015). Research by Aldrich & Sawada (2015) finds "compelling evidence that the strength of social ties within" a community reduces the impacts of natural disasters (p. 72). To look at this impact, we refer to the data on users' impression as shown in Figure 21.

Figure 21 User sentiment in regard to social cohesion and disaster preparation (n=152)



The graph on the left shows that more than 79% of users found AtmaGo very helpful or extremely helpful in connecting them with their broader community. Additionally, the graph on the right revealed that about 67% of respondents find AtmaGo very helpful or extremely helpful in assisting users to prepare in facing a disaster.

5 Conclusion

This research seeks to examine whether ICT in general, and the AtmaGo app specifically, can serve as a tool to improve disaster preparedness. By looking at the impact of AtmaGo in five locations in Greater Jakarta area, this study finds that AtmaGo can create substantial benefits to help users respond to disaster situations.

First, looking at property damage caused by floods, we find that AtmaGo can create an avoided damage benefits of **$324 per household per year, assuming that messages reduce flood impacts by about 50%.** If the application can reach a scale equivalent to 5% to 10% percent of Jakarta's population, we estimate that AtmaGo can provide a total avoided damage benefit of between **$53 million to $106 million** per year.

AtmaGo can also provide economic benefits in the form of avoided healthcare spending of an average of **$14 per household per year**. If the application can reach a scale equivalent to 5% to 10% percent of Jakarta's population, then we estimate that this could avoid healthcare spending of between **$2.3 million to $4.7 million** per year.

Our study also found that effective warnings from AtmaGo can reduce mortality and morbidity caused by urban floods and other disasters. Based upon our survey, we estimate that AtmaGo can reduce morbidity and mortality impacts from floods by **643 years per 100,000 population**, as measured by disability adjusted life years (DALYs) and again **assuming that messages reduce flood impacts by about 50%.**

Looking at the social benefits, **79% of respondents found AtmaGo very helpful or extremely helpful in preparing for disasters**, and **67% of users found AtmaGo very helpful or extremely helpful in connecting them** with their broader community.

There are limits to this research that we discuss above. Because we rely on a small sample of 358 users that was chosen in a non-random fashion, sample bias is a potential threat to validity. We surveyed respondents from various neighborhoods across Jakarta to improve the robustness of our results. As our survey shows, there are differences in education and income between users and nonusers, which can also create sample bias. However, both groups report near universal access to the internet via a computer, tablet or phone. Another set of limitations comes from our approach to estimation. We surveyed residents in predominantly low-income areas of Jakarta, but we estimate our results at-scale in a linear fashion based on population; future studies could focus on creating demographically-weighted estimates of avoided damage and healthcare costs.

One final issue to consider is that although we use a cost-benefit framework for estimation, we focus only on estimating the potential benefits. Atma Connect, the organization that has created AtmaGo, has a budget of approximately $1 million for the current fiscal year. To provide benefits at a greater scale, the organization will have to grow. In addition, we do not estimate the potential costs of false alarms or inappropriate responses to alerts.

With those issues noted, we conclude by noting that respondents of all income levels in Indonesia have access to the internet, and that mobile phone-based alert systems such as AtmaGo have very low costs as compared to the potential benefits. Given that the estimated benefits created by AtmaGo are at least an order of magnitude greater than the operational costs, this study supports the continued development and deployment of mobile systems such as AtmaGo.

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Appendix A: Questionnaire

No. Booklet:

RESEARCH QUESTIONNAIRE

"MEASURING ICT FOR DISASTER-RELATED EARLY WARNING SYSTEM"

CIPG – ATMAGO 2017

I. LOCATION IDENTIFICATION								
Interview Locations								
II. DATA COLLECTOR								
1	Enumerator		4	Team Leader Name		7	Respondent contact (Phone no.)	
2	Date of Data Collection (dd-mm-yyyy)		5	Date of Data Checking (dd-mm-yyyy)		8	Signature of respondent	
3	Signature of enumerator		6	Signature of team leader				

Introduction

We, a research team from **Centre for Innovation Policy and Governance (CIPG)** cooperate with **AtmaGo** in conducting research named **"Measuring ICT impact for the disaster-related early warning system."** This research aims to measure how ICT could give a beneficial impact in helping the society's awareness and preparation to face a disaster in Indonesia. Thus, we ask for your participation to contribute to this survey by giving answers and input about ICT usage for the early warning system. Your identity and your answers will be kept confidential, and only be used for the analysis of this research. Thank you for your participation.

3. RESPONDENTS CHARACTERISTICS							
3.1 Name							
3.2 Gender	☐ Male			☐ Female			
3.3 Age	☐ 18-25	☐ 26-30	☐ 31-35	☐ 36-40	☐ 41-45	☐ 46-50	☐ > 50
3.4 Job title							
3.5 Last education	☐ SD	☐ SMP	☐ SMA/SMK	☐ D3	☐ S1	☐ S2	☐ S3
3.6 Marital Status	☐ Married			☐ Single			
3.7 House Ownership	☐ Owner		☐ Tenant		☐ Inheritance	☐ Others, mention …	
3.8 Family members			**3.9 Living here since year**				
3.10 Monthly spending	☐ < 600.000		☐ 600.001 - 1.200.000			☐ 1.200.001 - 1.800.000	
	☐ 1.800.001 - 3.600.000		☐ 3.600.001 - 4.800.000			☐ 4.800.001 - 6.000.000	
	☐ 6.000.001 - 7.500.000		☐ > 7.500.000				
3.11 Access and ICT Ownership	3.11.1 Home phone access		☐ Yes			☐ No	
	3.11.2 Internet access		☐ Yes			☐ No *(cont. to 3.11.5)*	
	3.11.3 If yes, via *(multiple answers possible)*	☐ Feature Phone	☐ Smartphone	☐ PC	☐ Laptop	☐ Tablet	
	3.11.4 What time do you usually access the internet? *(multiple answers possible)*	☐ 06.01 - 12.00		☐ 12.01-18.00	☐ 18.01 - 00.00	☐ 00.01 - 06.00	
	3.11.5 PC ownership / Laptop	Quantity					
	3.11.6 Tablet ownership / iPad	Quantity					
	3.11.7 Mobile phone ownership	Quantity					
		Brand/Type					
	3.11.8 Mobile phone usage *(multiple answers possible)*	☐ SMS and telephone					
		☐ Internet browsing					
		☐ E-mail					
		☐ Social media access & instant messaging *(cont. to 3.11.9)*					
		☐ News reading					
		☐ Watching video and listening to music					
		☐ Others, mention…					
	3.11.9 Social media & instant messaging usage *(multiple answers possible)*	☐ Facebook		☐ WhatsApp	☐ BBM	☐ Others, mention…	
		☐ Twitter		☐ LINE	☐ Path		
		☐ Instagram		☐ Telegram	☐ Kaskus		

4. DISASTER-RELATED EXPERIENCE							
4.1 Did you experience any disaster while you live here?	☐ Yes *(Cont. no 4.2)*			☐ No *(Cont. no 4.6)*			
4.2 What kind of disaster and when did it happen? *(multiple answers possible)*	☐ Flood	☐ Fire	☐ Landslide	☐ Earthquake	☐ Trees fell down	☐ Dryness	☐ Others, mention …
4.3 Mention any kind of properties that were damaged or lost due to the disaster *(multiple answers possible)*	1. Electronic □ TV □ AC □ Refrigerator □ Rice Cooker □ Fan □ Others:	2. Vehicle □ Car □ Motorcycle □ Bike □ Others:	3. Furniture □ Cupboard □ Sofa □ Bed □ Others:	4. Marketable securities □ Diploma □ House Freehold Certificate □ Others	5. Jewellery □ Gold □ Others: …	6. Another category...	
4.4 Are there any members of your family who have been affected by the disaster?	☐ Yes *(Cont. to 4.5)*			☐ No *(Cont. to 4.6)*			

4.5 Mention illness or injury caused by the disaster of your family member	**No.**	**Name**	**M/F**	**Illness**	**Mild / Moderate / Severe**	**Out-patient care (Y/N)**	**Total fee of out-patient care?**	**In-patient? (Y/N)**	**Total days of hospitalisation**	**Total fee for hospitalisation**	**Years of illness**

4.6 Was there any death in the family member directly or indirectly due to disaster?	☐ Yes, numbers of people ..... *(cont. to 4.7)*	☐ No *(cont. to 4.8)*

4.7 Mention your family member that died during or post-disaster	**No.**	**Name**	**M/F**	**Month of mortality**	**Year of mortality**

4. DISASTER-RELATED EXPERIENCE				
4.8 What is your source of information about disasters occurring in your area? (*multiple answers possible*)	□ Conventional warning (*Kentongan* (bamboo stick alarm), whistle, direct announcement from microphone, etc.)	□ Online media (detik.com, tempo.com, kompas.com, etc.)	□ AtmaGo	
	□ Mass media (TV, radio, etc.)	□ Social Media (Facebook, Twitter, etc.)	□ Others, mention...	
4.9 Did you take preventive action after a warning?	□ Yes *(cont. to 4.10)*		□ No *(cont. to 4.12)*	
4.10 If Yes, What kind of preventive action that you did? (*multiple answers possible*)	□ Evacuate myself and family member *(cont. to 4.10.1)*		4.10.1 How many family members? ……. individuals	
	□ Move all valuable items *(cont. to 4.10.2)*			
	□ Remind friends or neighbours		4.10.2 Mention valuable items that could be moved...	
	□ Other action...			
4.11 Did the disaster warning you received help you in the following matters?	4.11.1 Find alternative route for school or office?		□ Yes	□ No
	4.11.2 Use alternative transport options?		□ Yes	□ No
	4.11.3 Looking for safer rescue path?		□ Yes	□ No
4.12 Did you use mobile app to receive disaster alert around you?	□ Yes *(cont. to 4.13)*		□ No *(cont. to 4.14)*	
4.13 Mention mobile app that you use to receive disaster alert around you				
4.14 In your opinion, what is the most effective early warning system for disaster? *(Choose only one as the most relevant answer)*	□ Social media (Facebook, Twitter, etc.)	□ Mobile app	□ Others, mention …	
	□ SMS	□ Conventional warning (*Kentongan* (bamboo stick alarm), whistle, direct announcement from microphone, etc.)		

5. ATMAGO RELATED QUESTIONS			
5.1 Did you know about the existence of AtmaGo?	□ Yes *(cont. to 5.2)*	□ No *(cont. to 5.7)*	
5.2 How do you know AtmaGo?	□ Social media (FB, Twitter, YouTube, Instagram, etc.)	□ Workshop and roadshow from AtmaGo	□ Broadcast SMS
	□ Mass media (TV, newspaper, radio, internet, etc.)	□ Public announcement	□ Public figure
	□ Brochure, pamphlet, etc.	□ Non-Governmental Organisation	□ Others, mention…
5.3 Have you ever used AtmaGo?	□ Yes *(cont. to 5.4)*	□ No *(cont. to 5.7)*	
5.4 Since when did you use AtmaGo?			
5.5 How do you access AtmaGo?	□ Android app	□ Website	
5.6 What is your reason to use AtmaGo? *(Choose only one as the most relevant answer)*	□ Accountable and reliable information	□ AtmaGo is integrated with some institutions	□ Can report anonymously
	□ Practical, easy to use	□ Get notification when disaster occurs	□ Others, mention…
5.7 *(Non-user only)* What is your reason for not using AtmaGo? *(Choose only one the most relevant answer)*	□ Do not know AtmaGo	□ Too many similar apps	□ Not interested
	□ Run out of memory space	□ Do not have PC / Laptop	□ Others, mention…

6. ATMAGO USAGE *(USERS ONLY)*				
6.1 Have you ever read a post/information on AtmaGo?	□ Yes *(cont. to 6.2)*	□ No *(cont. to 6.4)*		
6.2 What kind of information did you read?	□ Society news	□ Job vacancy	□ Others, mention…	
	□ Report	□ Event		
	□ Sharing solutions	□ Sell-buy		
6.3 Why do you read information from AtmaGo?				
6.4 Have you ever posted or written an article on AtmaGo?	□ Yes *(cont. to 6.5)*	□ No *(cont. to 6.7)*		
6.5 What kind of information you posted?	□ Society news	□ Job vacancy	□ Others, mention…	
	□ Report	□ Event		
	□ Sharing solutions	□ Sell-buy		
6.6 Why do you want to write a post or article in AtmaGo?				
6.7 Have you ever contributed to any social activity conducted by AtmaGo?	□ Yes *(cont. to 6.8)*	□ No *(cont. to 6.10)*		
6.8 If yes, mention the type of activity	□ Seminar	□ Community service		
	□ Workshop	□ Others, mention…		
6.9 Why do you want to be involved in community activities conducted by AtmaGo?				
6.10 Have you ever share articles/information from AtmaGo to your family, friends, or neighbours?	□ Yes *(cont. to 6.11)*	□ No *(cont. to 6.14)*		
6.11 What kind of information that you have shared?				
6.12 For how many people did you spread the information?				
6.13 Why do you share information from AtmaGo?				
6.14 What is your evaluation for AtmaGo?	□ Bad	□ Standard	□ Good	□ Very good
6.15 Would you like to recommend AtmaGo to another user?	□ Yes	□ No		
6.16 What is your suggestion to improve AtmaGo?				

7. ATMAGO AND EARLY WARNING SYSTEM (USERS ONLY)				
7.1 Have you ever received early warning information about disaster from AtmaGo?	□ Yes *(cont. to 7.2)*		□ No *(cont. to 7.5)*	
7.2 If yes, did you perform any kind of preventive action?	□ Yes *(cont. to 7.3)*		□ No *(cont. to 7.5)*	
7.3 What kind of preventive actions that you did? ***(multiple answers possible)***	□ Evacuated myself and family member *(cont. to 7.3.1)*		7.3.1 How many family members? ……. individuals	
	□ Moved all valuable items *(cont. to 7.3.2)*			
	□ Reminded friends or neighbours		7.3.2 Mention valuable items that could be moved...	
	□ Other action...			
7.4 Did the disaster warning you received from AtmaGo help you in the following matters?	7.4.1 Find alternative route for school or office?		□ Yes	□ No
	7.4.2 Use alternative transport options?		□ Yes	□ No
	7.4.3 Looking for safer rescue path?		□ Yes	□ No
7.5 Have you ever posted a disaster nearby by information through AtmaGo?	□ I have *(cont. to 7.6)*		□ Not yet *(cont. to 7.7)*	
7.6 Mention the disaster-related information that you have posted				
7.7 Have you ever invited others to a disaster-related activity via AtmaGo?	□ I have *(cont. to 7.8)*		□ Not yet *(cont. to 7.9)*	
7.8 Mention the activities that you did with AtmaGo ***(multiple answers possible)***	□ Working to clean up the environment that is affected by the disaster		□ Clean up the garbage before flood happens	
	□ Renovating the damaged facilities		□ Participate in seminar/workshop	
	□ Others, mention…			
7.9 Did AtmaGo help you to connect with the society around you?	□ Extremely helpful	□ Very helpful	□ Somewhat helpful	□ Not at all helpful
7.10 In general, did AtmaGo help you to prepare in facing a disaster?	□ Extremely helpful	□ Very helpful	□ Somewhat helpful	□ Not at all helpful

8. ATMAGO AND PUBLIC COMPLAINT				
8.1 Have you ever complained about the government via online?	□ Yes *(cont. to 8.2)*		□ No *(cont. to 8.5)*	
8.2 In the recent one month, how many times did you complain to the government via online?	□ 1 time	□ 2-3 times	□ 4-5 times	□ > 5 times
8.3 Mention details of complaint that you have reported ***(please note that detailed answer should be linked to the previous answer. So if they reported 2-3 times then the details should be mentioned)***				
8.4 What kind of online system that you used for complaining to the government? ***(multiple answers possible)***	□ Facebook	□ LAPOR!	□ AtmaGo	
	□ Twitter	□ Qlue	□ Others, mention…	
8.5 Mention aspirations/problems that you want to complain regarding public service				
8.6 How should this aspiration be addressed?	□ Direct (face-to-face)	□ Social media (FB, Twitter, etc.)	□ AtmaGo	
	□ SMS	□ Website	□ E-mail	
	□ Others, mention...			

Additional Notes:

Appendix B:
Detailed data on property damage

Item	Price per item (IDR)	Price per item (USD)	Quantity of damaged property in each year				
			2017	2016	2015	2014	2013
TV	Rp 2,000,000	$ 147.06	13	19	7	4	20
AC	Rp 2,500,000	$ 183.82	4	2	1	0	0
Refrigerator	Rp 1,500,000	$ 110.29	10	19	9	4	22
Rice cooker	Rp 300,000	$ 22.06	7	8	2	3	11
Fan	Rp 200,000	$ 14.71	7	14	3	4	17
Car	Rp 150,000,000	$ 11,029.41	0	1	2	0	0
Motorcycle	Rp 10,000,000	$ 735.29	5	9	2	1	6
Cupboard	Rp 3,500,000	$ 257.35	23	26	14	11	30
Sofa	Rp 2,000,000	$ 147.06	12	12	9	4	19
Bed + frame	Rp 4,000,000	$ 294.12	21	25	14	6	24

Note: Quantity of damaged property in each year is an estimate given by respondents to our opinion survey. We surveyed 358 residents across five flood-prone communities in Greater Jakarta area.

Appendix C:
Detailed data on healthcare cost

No.	Year	Illness / Disease	Total fee of outpatient care (IDR)	Total fee for hospitalisation (IDR)	Total healthcare cost
1	2013	Dengue and Chikungunya	Rp -	Rp 800,000	Rp 800,000
2	2013	Typhus and Viruses	Rp -	Rp 800,000	Rp 800,000
3	2013	Diarrhoeal Diseases	Rp 200,000	Rp -	Rp 200,000
4	2013	Diarrhoeal Diseases	Rp 200,000	Rp -	Rp 200,000
5	2013	Diarrhoeal Diseases	Rp 200,000	Rp -	Rp 200,000
6	2013	Cold and Fever	Rp 10,000	Rp -	Rp 10,000
7	2013	Diarrhoeal Diseases	Rp -	Rp 10,000,000	Rp 10,000,000
8	2013	Itchy, Allergic, and Water Bug	Rp 1,000	Rp -	Rp 1,000
9	2013	Itchy, Allergic, and Water Bug	Rp 1,000	Rp -	Rp 1,000
10	2013	Itchy, Allergic, and Water Bug	Rp 1,000	Rp -	Rp 1,000
11	2013	Cold and Fever	Rp 50,000	Rp -	Rp 50,000
12	2013	Cough and Flu	Rp 70,000	Rp -	Rp 70,000
13	2013	Itchy, Allergic, and Water Bug	Rp 200,000	Rp -	Rp 200,000
14	2013	Diarrhoeal Diseases	Rp 200,000	Rp -	Rp 200,000
15	2013	Miscarriage	Rp -	Rp 4,000,000	Rp 4,000,000
16	2013	Dengue and Chikungunya	Rp -	Rp 1,500,000	Rp 1,500,000
17	2013	Itchy, Allergic, and Water Bug	Rp 60,000	Rp -	Rp 60,000
18	2013	Itchy, Allergic, and Water Bug	Rp 10,000	Rp -	Rp 10,000
19	2014	Cold and Fever	Rp 50,000	Rp -	Rp 50,000
20	2015	Itchy, Allergic, and Water Bug	Rp 150,000	Rp -	Rp 150,000
21	2015	Diarrhoeal Diseases	Rp 200,000	Rp -	Rp 200,000
22	2015	Diarrhoeal Diseases	Rp 200,000	Rp -	Rp 200,000
23	2015	Itchy, Allergic, and Water Bug	Rp 200,000	Rp -	Rp 200,000
24	2015	Cough and Flu	Rp 200,000	Rp -	Rp 200,000
25	2016	Diarrhoeal Diseases	Rp 200,000	Rp -	Rp 200,000
26	2016	Diarrhoeal Diseases	Rp 200,000	Rp -	Rp 200,000
27	2016	Diarrhoeal Diseases	Rp 200,000	Rp -	Rp 200,000
28	2016	Diarrhoeal Diseases	Rp 200,000	Rp -	Rp 200,000
29	2016	Cough and Flu	Rp -	Rp 600,000	Rp 600,000
30	2016	Typhus and Viruses	Rp 600,000	Rp -	Rp 600,000
31	2016	Itchy, Allergic, and Water Bug	Rp 1,000,000	Rp -	Rp 1,000,000

No.	Year	Illness / Disease	Total fee of outpatient care (IDR)	Total fee for hospitalisation (IDR)	Total healthcare cost
32	2016	Cold and Fever	Rp 2,000	Rp -	Rp 2,000
33	2016	Cold and Fever	Rp 2,000	Rp -	Rp 2,000
34	2016	Cold and Fever	Rp 350,000	Rp -	Rp 350,000
35	2016	Cough and Flu	Rp 30,000	Rp -	Rp 30,000
36	2016	Cough and Flu	Rp 30,000	Rp -	Rp 30,000
37	2016	Cough and Flu	Rp 40,000	Rp -	Rp 40,000
38	2016	Itchy, Allergic, and Water Bug	Rp 10,000	Rp -	Rp 10,000
39	2016	Itchy, Allergic, and Water Bug	Rp 10,000	Rp -	Rp 10,000
40	2016	Itchy, Allergic, and Water Bug	Rp 10,000	Rp -	Rp 10,000
41	2016	Diarrhoeal Diseases	Rp 800,000	Rp -	Rp 800,000
42	2016	Dengue and Chikungunya	Rp -	Rp 1,600,000	Rp 1,600,000
43	2016	Dengue and Chikungunya	Rp -	Rp 1,600,000	Rp 1,600,000
44	2017	Diarrhoeal Diseases	Rp 40,000	Rp -	Rp 40,000
45	2017	Itchy, Allergic, and Water Bug	Rp 40,000	Rp -	Rp 40,000
46	2017	Cough and Flu	Rp 1,000	Rp -	Rp 1,000
47	2017	Cold and Fever	Rp 60,000	Rp -	Rp 60,000
48	2017	Cough and Flu	Rp 60,000	Rp -	Rp 60,000
49	2017	Itchy, Allergic, and Water Bug	Rp 50,000	Rp -	Rp 50,000
50	2017	Itchy, Allergic, and Water Bug	Rp -	Rp 2,500,000	Rp 2,500,000
		Total healthcare cost (IDR)	**Rp 6,138,000**	**Rp 23,400,000**	**Rp 29,538,000**
		Total healthcare cost (USD)	**$ 451.32**	**$ 1,720.59**	**$ 2,171.91**

Appendix D:
Detailed data on DALYs averted

1. Years Lost due to Disability (YLD)

No	Years of illness	Gender	Disease	Age during interview (in 2017)
1	2006	F	Diarrhoeal Diseases	46-50
2	2006	M	Diarrhoeal Diseases	46-50
3	2007	M	Typhus and Viruses	18-25
4	2007	M	Dengue and Chikungunya	>50
5	2007	M	Diarrhoeal Diseases	>50
6	2007	M	Diarrhoeal Diseases	46-50
7	2009	F	Diarrhoeal Diseases	18-25
8	2009	F	Diarrhoeal Diseases	18-25
9	2009	M	Diarrhoeal Diseases	18-25
10	2010	F	Dengue and Chikungunya	46-50
11	2012	M	Diarrhoeal Diseases	31-35
12	2012	F	Diarrhoeal Diseases	31-35
13	2012	F	Dengue and Chikungunya	36-40
14	2012	M	Typhus and Viruses	41-45
15	2012	M	Diarrhoeal Diseases	>50
16	2012	M	Diarrhoeal Diseases	>50
17	2013	M	Dengue and Chikungunya	41-45
18	2013	M	Typhus and Viruses	41-45
19	2013	M	Diarrhoeal Diseases	46-50
20	2013	M	Diarrhoeal Diseases	18-25
21	2013	M	Diarrhoeal Diseases	18-25
22	2013	F	Diarrhoeal Diseases	41-45
23	2013	F	Diarrhoeal Diseases	26-30
24	2013	M	Dengue and Chikungunya	26-30
25	2015	M	Diarrhoeal Diseases	31-35
26	2015	F	Diarrhoeal Diseases	31-35
27	2016	M	Diarrhoeal Diseases	41-45
28	2016	F	Diarrhoeal Diseases	41-45
29	2016	M	Diarrhoeal Diseases	41-45
30	2016	M	Diarrhoeal Diseases	>50
31	2016	F	Diarrhoeal Diseases	26-30
32	2016	M	Typhus and Viruses	18-25

No	Years of illness	Gender	Disease	Age during interview (in 2017)
33	2016	F	Diarrhoeal Diseases	>50
34	2016	F	Dengue and Chikungunya	36-40
35	2016	M	Dengue and Chikungunya	36-40
36	2017	F	Diarrhoeal Diseases	46-50
37	2017	F	Diarrhoeal Diseases	26-30
38	2017	F	Diarrhoeal Diseases	26-30
39	2017	M	Diarrhoeal Diseases	26-30
40	2017	F	Diarrhoeal Diseases	26-30

Years of illness	Disease	I (Number of Incidents)	DW (Disability Weight)	L (Average duration of cases, in years)	YLD	Total YLD each year
2006	Diarrhoeal Diseases	2	0.188	(1 month/12) = 0.083 years	0.031	**0.031**
2007	Dengue and Chikungunya	1	0.133	(1 month/12) = 0.083 years	0.011	**0.047**
	Diarrhoeal Diseases	2	0.188	(1 month/12) = 0.083 years	0.031	
	Typhus and Viruses	1	0.051	(1 month/12) = 0.083 years	0.004	
2008	-	-	-	-	0	**0**
2009	Diarrhoeal Diseases	3	0.188	(1 month/12) = 0.083 years	0.047	**0.047**
2010	Dengue and Chikungunya	1	0.133	(1 month/12) = 0.083 years	0.011	**0.011**
2011	-	-	-	-	0	**0**
2012	Dengue and Chikungunya	1	0.133	(1 month/12) = 0.083 years	0.011	**0.078**
	Diarrhoeal Diseases	4	0.188	(1 month/12) = 0.083 years	0.063	
	Typhus and Viruses	1	0.051	(1 month/12) = 0.083 years	0.004	
2013	Dengue and Chikungunya	2	0.133	(1 month/12) = 0.083 years	0.022	**0.105**
	Diarrhoeal Diseases	5	0.188	(1 month/12) = 0.083 years	0.078	
	Typhus and Viruses	1	0.051	(1 month/12) = 0.083 years	0.004	
2014	-	-	-	-	0	**0**
2015	Diarrhoeal Diseases	2	0.188	(1 month/12) = 0.083 years	0.031	**0.031**
2016	Dengue and Chikungunya	2	0.133	(1 month/12) = 0.083 years	0.022	**0.120**
	Diarrhoeal Diseases	6	0.188	(1 month/12) = 0.083 years	0.094	
	Typhus and Viruses	1	0.051	(1 month/12) = 0.083 years	0.004	
2017	Diarrhoeal Diseases	5	0.188	(1 month/12) = 0.083 years	0.078	**0.078**

2. Years of Life Lost (YLL)

Gender	Years of Mortality	Age of Mortality	Life expectancy	L (life expectancy at the age of death)	YLL
F	2013	43	71	28	28
M	2007	38	67	29	29
				Total YLL	57

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