



World Scientific News

WSN 78 (2017) 183-192

EISSN 2392-2192

Deficiencies of the common warning and notification system for the population

Piotr Romanowski

Command and Operations Department Maritime, Polish Naval Academy in Gdynia, Poland

E-mail address: p.romanowski79@o2.pl

ABSTRACT

The state is obliged to provide their citizens with one of the basic need which is security. The aim of the article is to present the issues associated with a system of universal alerting and warning people about various threats. Author, within this publication shows the selected drawbacks which include currently used solutions. He also tries to emphasize courses of action that will result in improving the effectiveness of public warning and alerting system for the population about the threats.

Keywords: Warning systems, alerting, warning, notification

1. INTRODUCTION

Probably every one of us has heard the alarm signals on the streets of our towns and villages. The problem is that most of the recipients of those signals, when listen to them just wonder what kind of national holiday or any other import event they try to commemorate or bring to our memory, without even trying to analyze them from the possible threat point of view. But after all the main objective of the alarm sirens is to provide some information related to warning and notification about threats. "The meaning of an alarm system is to be the first link in the chain of assistance and safety provision. The main task of the alarm system centres (Emergency Response Centres or ERCs), and their dispatchers, is to receive emergency calls and other information related to the safety of people, property and the

environment, requiring immediate action, and to forward them to the units designated by law. These units are the different police, fire and ambulance/first-help departments.”

Even if we assume that alarm signals recipients would know warning system signals related to the possible threats we still face the question whether state provides for them a real chance to reduce negative effects of the emerging threat? Getting familiarize with the available data related to the preparation of the state to possible threats we can come to the conclusion, that the Polish State is not prepared to provide required protection level to its citizens. Legal basis for functioning of the common warning and notification system for the population about threats in Poland is the Government Order on 7 January 2013 about contamination detection systems and notification about their presence together with the government and local structures competences within this area (Law Gazette, from 2013, item 96). Government Order has been issued based on the article 6, section 2, paragraph 5 of the Parliamentary Act on 21 November 1967 about common obligation to defend Poland (Law Gazette, from 2012, item 461, with later amendments). Annex to aforementioned Government Order describes different kinds of alarms and alerting signals. “In recent decades, scholars have explored the power of international norms to shape state behavior across a variety of different domains, including compliance with international law, respect for human rights, and changing patterns of humanitarian intervention. One set of norms that have received particular attention from scholars relate to the normative prohibitions on states’ choices of weapons and tactics during armed conflict, such as the use of chemical weapons.”

Within this paper I would like to concentrate on the deficiencies of the currently applied solutions, which to my opinion do not fit present time requirements and do not guarantee required effectiveness of the warning system for the population.

2. WARNING AND NOTIFICATION SYSTEM FOR THE POPULATION

Report from 2015 presented by the National Headquarters of the State Fire Service Office for the Protection of Population and Civilian Defense shows that only 76,6% of the civilian population lives within the range of action of the stationary alerting sirens and almost 23,4% is not protected by their use. According to the authors of the report the population who is not protected by the application of the stationary sirens lives in less populated and rural areas and also in small towns. Compensation for the limitations of the alerting system with the use of sirens is supposed to be provided by the usage of the other warning and alerting means such as: SMS Informing System (SI SMS), TV and radio. Authors of the report present data, which shows that in the year 2015 informing population about the threats with the aid of the SI SMS covered 33,8% of the population, with the aid of the TV 70,8% and with the aid of the radio 64,8%. We need to add to that also that part of the population which is not protected by the stationary sirens might be warned with the use of the mobile sets and also other means such as: hands-free sets, gongs, bells etc.

Conformation of the Report conclusions might be found at the local governments’ level. From the information received from the Rumia Municipal Council appear that 80 % of the Rumia population is under the coverage of the alerting sirens. Remaining 20 % of the population in case of threat is supposed to be informed about that with the use of mobile hands-free sets. Theoretically, after familiarizing with the above data one might come to the conclusion that applied solutions provide capability to alarm civilian population in every

condition. From my point of view the situation is not like that. Confirmation of my point is provided by the authors of the above cited report presented by the National Headquarters of the State Fire Service Office for the Protection of Population and Civilian Defence from 2015. The authors show that equipment use for warning and alerting is very diverse.

Electronic sirens which have been installed in recent years are in a very good technical condition. This is the state-of-art equipment, multifunctional, supplied from single phase network; their constant availability is protected by unattended batteries. Lower level of the technical conditions, defined as sufficient (middle), is represented by electromechanical sirens. The authors of the report draw our attention to the deteriorating technical state of the Radio Activated Devices (Radiowych Urządzeń Włączających-RUW). Problem with the replacement to the modern RUW installations 4000 series is very high. We see also an ongoing process of the alarm systems modernization. Report reveals that Radio Control Panels RCA 2300 and also RCA 3000 are being replaced by the multisystem base stations and electromechanical systems are being successively replaced by the electronic sirens. Data from the report shows however, that the replacement process is at the very early stage.

According to the discussed report status of the alerting sirens in 2015 was as follow:

- Manually controlled mechanical sirens – 10.174;
- Radio controlled mechanical sirens – 6.672;
- Manually controlled electronic sirens – 416;
- Radio controlled electronic sirens – 2.236

Presented data do not leave any illusions about the degree of the progress of the warning and alerting system modernisation. All the time the majority of the system consists of old type electric (mechanical) sirens. They are not equipped with emergency power supply system and they do not have capability to transfer voice messages. The picture which is being shown globally for the country is the same at the local level. Based on the data received from the Rumia Municipal Council appears that there are 9 alerting sirens installed in the town. All of them are radio controlled, 4 of them are electronic sirens type DES-600, module RUW-4000, and the other 5 are mechanical sirens. Sirens are equipped with backup battery supply in case of the power failure.

3. ELECTROMAGNETIC PULSE AS A THREAT TO THE WARNING AND NOTIFICATION SYSTEM

Replacement of the old equipment with the new one in the electronic version shows the tendency and the will of the responsible bodies to improve the warning and notification system. But at the same time appears some risk of the technical nature. We need to ask themselves a question, whether newly mounted systems will be able to provide failure-free action in every threatening situation? It seems that nobody has not been able to notice a problem which constitute a danger to the warning and notification infrastructure as a whole and which might be caused by the possibility of the appearance of the electromagnetic pulse. We may distinguish four categories of the direct effects which accompany the use of the nuclear weapon, i.e. shock wave, ionizing radiation, thermal radiation and electromagnetic pulse.

I would like to concentrate on the influence of the gamma radiation on the environment. Electromagnetic pulse (EMP) has some impact on the work of the radio and electronic equipment. "The electromagnetic fields produced by weapons designed and deployed with the intent to produce EMP have a high likelihood of damaging electrical power systems, electronics, and information systems upon which (...) society depends. Their effects on dependent systems and infrastructures could be sufficient to qualify as catastrophic to the Nation." [7]

The strength of the electromagnetic pulse depends on the blast power and also on the blast height above the Earth surface. For example detonation of the 1MT bomb at the height of 600 km would not cause any damage to living organisms, would not produce significant radioactive fallout so it would not be a significant threat to population. However, the main objective of such an attack might be to cause significant damage to the power supply system, communication system and defence systems. Electromagnetic pulse might be compared to radio waves, however we might distinguish some differences between such waves. One of them is that electromagnetic pulse produces much higher electric force. For example, if radio signal induce a pulse of one thousandth of a volt, at the same time an electromagnetic pulse can generate a pulse with the voltage of even several thousand volts. The other difference we can notice is the time of the event. We need to understand that surge of energy together with significant increase of voltage precedes hundreds time faster than during well known to us lightning discharge and it also disappears within a fraction of a second. That is why we should realize that already installed lightning protection systems are useless since their action is too slow and they will not be able to provide required protection to electrical equipment. Because of that, among other things, we can expect damage to the phones, radio communication equipment, car ignition and navigation systems, air transport and computers. The most exposed to damage would be equipment which is connected to the electric network and overhead antennas. Consequently radio stations would lose their transmission capability and power system would stop operating. Electronic components of the powered receivers would also be destroyed to include those mounted on the vehicles. Another threat which results from the electromagnetic radiation influence on the natural environment is an increased activity of the ionosphere. It would cause jamming and even preclude radio communication. The most susceptible to jamming are short waves. We need to be aware that this problem for a shorter period of time will also apply to satellite communication and navigation.

It has been scientifically proven that impact of striking factors of the nuclear blast occur in different period of time. However, at the earliest, because at the same time like the blast, objects are under the impact of the electromagnetic pulse which lasts a few thousandths of milliseconds.

During "Cold War" period the electromagnetic pulse has been acknowledged as significant threat which can damage and stop the weapon systems, power grids, communication networks and entire infrastructure which depends on electronics. Currently the threat of use of the electromagnetic pulse we can just recognize as the means of threatening, coercion or even electronic war.

The question arises whether already mounted warning and notification systems would be able to provide protection for the population and operate in case of application of the electromagnetic pulse? In my opinion they will not be able to provide it. Quoted earlier data related to the types of the alerting sirens and their activating equipment, shows that they are mainly based on radio activation. Usage of batteries within that equipment which are

supposed to support their operation in case of the loss of power, in my opinion, will not fulfill their role, since they will be damaged. Situation will not improve utilization of the mobile amplification equipment. Another issue is the fact that many vehicles will be stopped which will cause that traffic routs in big agglomerations will be jammed

I think that we need to replace outdated equipment used for the warning and notification and at the same time we should also install alternative sirens – mechanical ones. Reconstruction of the damaged warning and notification infrastructure, if possible, it would not be done in a short period of time during which this system would not function at all. What is worth underlying the electromagnetic pulse might be the result not only from nuclear blast which cause damage on the ground. Ground damages would cause physical destruction of the warning systems by the shock wave. In this case everything is going to be damaged so looking for the alternative options is useless. That pulse might be the result of the aforementioned example even without ground explosion.

We cannot exclude the scenario, that after initial attack as a result of which the electromagnetic pulse might damage warning and notification system, we can face the situation when the drinking water system will be deliberately contaminated. “Biological and chemical terrorism is a growing concern for the emergency preparedness community. While health care facilities (HCFs) are an essential component of the emergency response system, at present they are poorly prepared for such incidents”. Data provided by the Security and Crises Management Sections of the Provincial Councils show that percentage of the population covered by the water supply systems has been increased for the last three years but it still is at the level of 91 %. Very worrying is also the situation of the population which is not within the close range of so called emergency wells. It currently fluctuates around 39%. Such state of affairs cause that in the event of a threat the population will face shortages of drinking water.

Providing information to the residents will be significantly more difficult. Another issue is also effectiveness of work of the water delivery pump system. In the event of possible attack the electromagnetic pulse would definitely create significant damage to the power supply of the pump system. But to quite significant extent they are ready to by supply with the use of the mobile generators.

4. PREPARATIONS FOR EARLY WARNING ABOUT THREATS

Providing that all warning and notification systems will work properly and warning will be issued about an air raid warning for example, we need to ask themselves a question what kind of situation would generate an issue of the warning signal? In accordance with the already existing rules the emergency alerting the trainings and exercises might be executed only after they are announced by the mass media with 24 hours notice or in accordance with the local rules. They should also include information about the content and the territorial extent of the planned training or exercise.

The final result is that most of the citizens who can hear the alerting sirens more often try to bring to the memory memorable historical date which is commemorated with the use of such sirens rather than potential threat. However we still have other alerting means which can be used to protect inhabitants against the threat. Based on the example of the Rumia town we can say that municipal authorities are trying to provide local population with the access to information about any potential threats. Besides of the mobile hands-free seats and voice

messages transferred with the use of the alerting sirens, SMS messages for the citizens of Rumia registered within this system are used. 11 warnings were transferred with the use of this channel of information in 2016. Apart from that there is also available the web page of the Rumia Municipal Council and in case of any threat there is also an opportunity to use the local media. However, we can easily notice that all aforementioned solutions do not provide protection against that kind of threat which I have described earlier. In my assessment every warning and notification system is as strong and effective as the weakest link of the system. We should be aware that today's communication means are based on electronic systems, which are very susceptible to damages resulting from the electromagnetic pulse. In this case technological progress does not provide only good points. It is worth mentioning that equipment based on valve technology is more resistant to electromagnetic pulse. So that is why such equipment is used by the armed forces which need and know how to deal with such threats.

5. PROTECTION OF THE POPULATION AGAINST THE THREAT

Actual technical condition of the protective buildings in Poland is not satisfactory. We need to realize that most of those buildings do not fulfil basic protection functions. The problem is their air tightness and also mounted air filtering and ventilating systems and equipment. Modernisation costs are very high which cause that administrators of those buildings resign from taking care of the full efficiency of the equipment which has been installed there. We can easily notice the degradation, which significantly influence their utility. The problem is largely connected with the lack of the legal regulations related among others to the content of the definition and also to the technical parameters which should be fulfilled by the protective buildings. Beside that we should also remember about the issue of the financial resources for repair work and also for their maintenance and building of the new one which will meet appropriate criteria. Current regulations do not put any obligatory responsibility on civil defence for the maintenance of the protective buildings. Nevertheless the owners of such buildings are still obliged to apply all the general regulations related to their proper maintenance. It is mainly about the regulation from the Parliamentary Act on 7 July 1994 – Building Regulations (Law Gazette, from 2016, item 290).

As a result of such a state of affairs in the whole Poland we have barely 2.9% of shelters and hideaways for the population. There are only 32.348 protective buildings on the area of the country and they can provide protection for 1.116217 person. We need to take into account that inventorying has been carried out by the local government units, so it might be inexact because of the lack of the legal regulations related to the protective buildings.

From the acquired information appear that there is neither single shelter nor hideaway on the Rumia town area. It is difficult to blame local authorities that they do not invest in such buildings since they are not obliged by the law to do so. It is easily to understand local authorities since to make such investments they need to allocate resources for their maintenance. Budgeted resources in such legal regulation are allocated to protect current needs of the town not for the protection of something which theoretically cannot ever happen.

Conditions of the protective buildings in Poland leave no illusion that they would be able to provide required protection level for the civilian population. It is obvious that they will not. On the other hand there is personal protective equipment in case of any threat, for

example chemical, like gas masks. 2015 data show that in Civil Defence warehouses we can find on stock 543.222 sets of gas mask but 396.546 from those sets are anticipated for decommissioning. The result is scary because it means that we will be left with only 146.698 sets ready for use. There is no better situation in case of the protective clothing. At the end of 2015 we had on stock 56.452 sets but 23.134 sets were marked for decommissioning. It means that we will be left with only 146.698 sets ready for use.

There is no doubt that this number is too small to cover the requirements in case of any threat. The threat may come suddenly. "Thirty years have passed since the worst nuclear reactor accident in the world occurred at the Chernobyl nuclear power plant in Ukraine. The radioactive contamination which resulted from the explosion and fire in the first few days spread over large areas of neighbouring Belarus and the Russian Federation, with most of the fallout in Belarus. While national and local authorities did not immediately disclose the scale of the accident, the mitigation measures, such as distribution of potassium iodine pills, food restriction, and mass evacuation from areas where the radioactive contamination was greatest, undoubtedly reduced the health impact of the radiation exposure and saved many lives."

It is worth mentioning the fact of the possible appearance of the chemical threat because modern chemical industry to the large extent uses huge amounts of the different intermediate products and raw materials among which we can find many highly toxic which are named toxic industrial chemicals. Admittedly toxic industrial chemicals are not rated to different types of the chemical weapons but in case of any kind of failure or damage to tanks with chemicals the final effect might be similar to the use of chemical weapon. Some of them like phosgene, chlorine or hydrogen cyanide are commonly used during production process of the goods for wide application but earlier they were listed at the register of the chemical weapons. They may be used during potential terrorist attacks.

As an example might be the above mentioned chlorine, which is widely used today and which because of its toxic properties during World War I was used as a suffocating chemical agent. It strongly irritates mucosal membranes, cause eyes smarting and their watering. It manifests with painful cough, pain in the chest and in case of the severe poisonings it can lead to pulmonary oedema and cyanosis. High concentration may lead to very quick death of the persons who are within the range of it. It shows how close we are to the chemical agents, which represent potential threats.

6. SUMMARY

In my opinion the warning and notification system in Poland does not keep up with the dangers which come from both internal threats within the country in the form of the technical failures and also from that kind of threats which might be caused by external organisations, for example terrorist in nature. It is also important in case of the development of the possible armed conflict with the use of technologies which can lead to the use of the electromagnetic pulse. It is not difficult to imagine chaos resulting from the sudden cut of power supply, stops of the vehicles or lost of the radio communication by the services which are responsible for providing help to injured persons and their lack of capability to inform the population about events and how they should act. Pursuit of ubiquitous electronisation and the desire to computerize every field of life leads to the threat which is difficult to be eliminated. It seems that the only way to reduce the effects of the possible damages caused by the use of the

electromagnetic pulse might be construction of the alternative power supply system, for example with the use of the liquid fuel generators. However, we should be aware about the enormous cost of such an investment. Based on the data which are related to the condition of the protective buildings in Poland and access to the personal protective equipment such as gas masks and protective clothing it is clearly seen that we are totally unprepared to face possible threats. Nowadays we are more concentrated on fulfilment of the temporary needs than thinking about the future and be able to envisage possible threats. In my opinion warning system is currently focused on fighting effects of the natural disasters like floods or hurricanes. Ways of communication have been oriented at permanent access to the electronic equipment which is used for notification of the population. There is no alternative for them when their use will not be possible. I take the view that replacement process of the alerting sirens used for warning and notification should go hand in hand with the development of buildings which can provide protection for the population in the threat situation. Since it does not provide effective protection for the population warning becomes ineffective. I dare to say that places where modern warning and notification systems are mounted should be also equipped with old type sirens it means mechanical. In case when modern system control infrastructure is damaged we will still have a chance to provide warning and notification with the use of the traditional mechanical sirens. In case of the protective buildings the legal regulations within this area would be necessary. In my assessment there is the need for statutory requirement to provide spaces which can meet population protective requirements in the newly constructed public buildings in order to preserve systematic percentage growth of the protective buildings in Poland. This should apply to schools, shopping centres, museums and newly established labour institutions. For sure within a few years percentage of such buildings would gradually grow and contribute to the level of safety. Hardly anyone from the living in haste citizens of our country thinks about aforementioned threats but we will never know when and where such a threat would appear.

BIBLIOGRAPHY

- [1] Wenzel, F., M. Baur, F. Fiedrich, C. Ionescu, and M. C. Ionescu. 2001. "Potential of Earthquake Early Warning Systems." *Natural Hazards* 23 (2/3): 407–416. 10.1023/A:1011180302201
- [2] Witte, K. 1992. "Putting the Fear Back into Fear Appeals: The Extended Parallel Process Model." *Communication Monographs* 59 (4): 329–349. 10.1080/03637759209376276
- [3] Witte, K., and M. Allen. 2000. "A Meta-analysis of Fear Appeals: Implications for Effective Public Health Campaigns." *Health Education and Behavior* 27 (5): 591–615. 10.1177/109019810002700506
- [4] Witte, K., K. A. Cameron, J. K. McKeon, and J. M. Berkowitz. 1996. "Predicting Risk Behaviors: Development and Validation of a Diagnostic Scale." *Journal of Health Communication* 1 (4): 317–342. 10.1080/108107396127988
- [5] Slovic, P., M. L. Finucane, E. Peters, and D. G. MacGregor. 2007. "The Affect Heuristic." *European Journal of Operational Research* 177 (3): 1333–1352. 10.1016/j.ejor.2005.04.006

- [6] Sutton, J., E. S. Spiro, B. Johnson, S. Fitzhugh, B. Gibson, and C. T. Butts. 2014. "Warning Tweets: Serial Transmission of Messages during the Warning Phase of a Disaster Event." *Information, Communication & Society* 17 (6): 765–787.10.1080/1369118X.2013.862561
- [7] Neuwirth, K., and E. Frederick. 2004. "Peer and Social Influence on Opinion Expression." *Communication Research* 31 (6): 669–703. 10.1177/0093650204269388
- [8] Nordgren, L. F., K. Banas, and G. MacDonald. 2011. "Empathy Gaps for Social Pain: Why People Underestimate the Pain of Social Suffering." *Journal of Personality and Social Psychology* 100 (1): 120–128. 10.1037/a0020938
- [9] Palen, L., S. Vieweg, S. B. Liu, and A. L. Hughes. 2009. "Crisis in a Networked World Features of Computer-mediated Communication in the April 16, 2007, Virginia Tech Event." *Social Science Computer Review* 27 (4): 467–480. 10.1177/0894439309332302
- [10] Radecki, J. M., and C. Jaccard. 1995. "Perceptions of Knowledge, Actual Knowledge, and Information Search Behavior." *Journal of Experimental Social Psychology* 31: 107–138.10.1006/jesp.1995.1006 [Crossref], [Web of Science ®], [Google Scholar]
- [11] Rauhala, J., and D. M. Schultz. 2009. "Severe Thunderstorm and Tornado Warnings in Europe." *Atmospheric Research* 93: 369–380. 10.1016/j.atmosres.2008.09.026
- [12] Terpstra, T., and M. K. Lindell. 2012. Citizens' Perceptions of Flood Hazard Adjustments: An Application of the Protective Action Decision Model. *Environment and Behavior* 45 (8): 993–1018
- [13] Malizia, A., T. Onorati, P. Diaz, I. Aedo, and F. Astorga-Paliza. 2010. "SEMA4A: An Ontology for Emergency Notification Systems Accessibility." *Expert Systems with Applications* 37: 3380–3391. 10.1016/j.eswa.2009.10.010
- [14] Martin, I. M., H. Bender, and C. Raish. 2007. "What Motivates Individuals to Protect Themselves from Risks: The Case of Wildland Fires." *Risk Analysis* 27 (4): 887–900. 10.1111/risk.2007.27.issue-4
- [15] Johnston, A. C., and M. Warkentin. 2010. "Fear Appeals and Information Security Behaviors: An Empirical Study." *MIS Quarterly* 34 (3): 549–566.
- [16] Kievik, M., and J. M. Gutteling. 2011. "Yes, We Can: Motivate Dutch Citizens to Engage in Self-protective Behavior with Regard to Flood Risks." *Natural Hazards* 59 (3): 1475–1490. 10.1007/s11069-011-9845-1
- [17] Earle, T. C. 2010. "Trust in Risk Management: A Model-based Review of Empirical Research." *Risk Analysis* 30 (4): 541–574. 10.1111/risk.2010.30.issue-4
- [18] Floyd, D. L., S. Prentice-Dunn, and R. W. Rogers. 2000. "A Meta-analysis of Research on Protection Motivation Theory." *Journal of Applied Social Psychology* 30 (2): 407–429. 10.1111/jasp.2000.30.issue-2
- [19] Griffin, R. J., S. Dunwoody, and K. Neuwirth. 1999. "Proposed Model of the Relationship of Risk Information Seeking and Processing to the Development of Preventive Behaviors." *Environmental Research* 80 (2): S230–S245. 10.1006/enrs.1998.3940

- [20] Grothmann, T., and F. Reusswig. 2006. "People at Risk of Flooding: Why Some Residents Take Precautionary Action While Others Do Not." *Natural Hazards* 38: 101–120.10.1007/s11069-005-8604-6
- [21] Kievik, M., E. F. J. ter Huurne, and J. M. Gutteling. 2012. "The Action Suited to the Word? Use of the Framework of Risk Information Seeking to Understand Risk-related Behaviors." *Journal of Risk Research* 15 (2): 131–147.10. 1080/13669877.2011.601318
- [22] Lee, D., J. Y. Chung, and H. Kim. 2013. Text Me When It Becomes Dangerous: Exploring the Determinants of College Students' Adoption of Mobile-based Text Alerts Short Message Service. *Computers in Human Behavior* 29 (3): 563–569. 10.1016/j.chb.2012.11.014
- [23] Lindell, M. K., and R. W. Perry. 2012. "The Protective Action Decision Model: Theoretical Modifications and Additional Evidence." *Risk Analysis* 32 (4): 616–632.10.1111/risk.2012.32.issue-4
- [24] Loewenstein, G. 2005. "Hot-cold Empathy Gaps and Medical Decision Making." *Health Psychology* 24 (4): S49–S56. 10.1037/0278-6133.24.4.S49
- [25] Casteel, M., and J. R. Downing. 2016. "Assessing Risk following a Wireless Emergency Alert: Are 90 Characters Enough?" *Journal of Homeland Security and Emergency Management* 13 (1): 95–112. doi:10.1515/jhsem-2015-0024
- [26] Atkin, C. K. 1972. "Anticipated Communication and Mass Media Information-seeking." *Public Opinion Quarterly* 36 (2): 188–199. 10.1086/267991
- [27] Bean, H., B. F. Liu, S. Madden, J. Sutton, M. M. Wood, and D. S. Mileti. 2016. "Disaster Warnings in Your Pocket: How Audiences Interpret Mobile Alerts for an Unfamiliar Hazard." *Journal of Contingencies and Crisis Management* 24 (3): 136–147.10.1111/jccm.2016.24.issue-3
- [28] Bean, H., J. Sutton, B. F. Liu, S. Madden, M. M. Wood, and D. Mileti. 2015. "The Study of Mobile Public Warning Messages: A Research Review and Agenda." *Review of Communication* 15 (1): 60–80. 10.1080/15358593.2015.1014402
- [29] Bhattacharya, D., and J. K. Ghosh. 2011. "Wireless Hazard Communication System." *Journal of Systems and Information Technology* 13 (4): 408–424. 10.1108/13287261111183997

(Received 14 June 2017; accepted 14 July 2017)