

THE FAILURE OF PUBLIC UTILITIES, A MEASURE OF EARTHQUAKE IMPACT ON POPULATION

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Abstract: *"Prevenim, protejăm, salvăm" – "We prevent, we protect, we save" says the motto of the Romanian firefighters, which presents the everyday struggle and "raison d'être" – reason for being of the rescue services that plan and act for the well-being of the citizens that they protect. One of the types of risk that firefighters are called to address is the earthquake, which in itself poses an immense task for the emergency preparedness system, but given the disruptions that this type of event causes, the population affected by it finds itself threatened even after the end of its this type of risk's manifestation, by the failure of the systems that insure everyday commodities. That is the issue that is addressed in this paper, of the importance of taking into account the public systems that provide necessary support for everyday life, which can be disrupted in the event of a major seismic activity manifestation.*

Keywords: *Earthquake, Public Utilities, Failure, Response*

1. Introduction

One of the less emphasized sides of the impact that a major earthquake can have on population is that of the lack of basic living means such as sanitization, drinking water supplies, food and heat. In the surreal hypothesis that following a major earthquake there would be no casualties, but only infrastructure loses, loss of lives would follow. If even the most basic needs that we often overlook in our daily lives, such as waste management, would suffer an interruption, or even an overload, the consequences that follow could be dire, especially in correlation with the lack of sanitization means that could lead to the onset of epidemics.

Public utilities whose infrastructures do not suffer damage directly from seismic activities could still cease to function due to lack of fuel caused either directly through the stop of fuel production, or indirectly through the hindrance of transport from production site to, say, thermal power station or heating plants.

Major cities are consumer oriented establishments that are dependent at least on the transport infrastructure to link them to the production sites of various goods, for sustaining day to day activities and in the case of a major disruption caused by a significant earthquake, population safety and well-being is certainly the main concern of public authorities. Given this fact, this paper hopes to provide insight on the necessity of public utilities failure management in case of a major earthquake and shed light on the way that this failure might be used to assess the immediate impact on population of such event and help the decision making process of authorities in restoring temporal normal conditions in a short time span.

2. Public utilities failure impact on population

Day to day life as we know it, with its routine and comforts depends on the public utilities that are made available to us in the areas that we work, live and study. The lack of these utilities can lead to serious problems in a society that has developed such a strong dependence upon these comforts and the way things take place on a daily basis. As such, in the event of a major earthquake, the disruption of the same utilities becomes the main author of public unsettlement and strives. In the following, comes a brief evaluation of the chain of events that concur in aggravating an already unstable situation, marked by confusion, panic and rupture in the quotidian, powered to even further lengths by the failure of the following:

2.1. Water supply network

Water used for drinking and cooking is generally provided by a system of pipes and pumps or is available as bottled water. Rarely in urban settings are people dependent on private wells or get their water supply directly from a natural source. Given the important role that water has in everyday life and the amount of it needed daily for drinking and sanitization, a discontinuation of residential water supply will influence the bottled water demand, which, in turn, may over run the supply and cause uncontrolled migration and public safety violations.

In the event of a long-term disruption of water supplies, poor hygiene and waste management may lead to the onset single cases of diarrheal diseases, typhoid fever, infection with different types of parasites [1], or may result in the outbreak of epidemics.

2.2. Sewage

Tightly linked with the lack of water supply is personal hygiene and in the particular case of an earthquake, the excreta disposal process may be affected by the lack of infrastructure and/or means of due sanitization.

Even if the housing infrastructure resists an earthquake, the sewage disposal one can fail and result in indoor flooding and, if the problem persists, the inadequate sewage system may lead to health problems and disease outbreaks. Lack of education of the population regarding proper excreta disposal when sewage services are unavailable would speed up the disease spreading process.

Odor pollution and water supply contamination may be other possible threats to communities' well-being provoked by the affected sewage infrastructure, in correlation with poor education regarding community living and care for the environment. In this situation, information about proper excreta management should be popularized.

2.3. Waste management

Following a major earthquake, the waste management facilities may suffer major damages which could hinder the normal processes, or the personnel may not be able to work as usual, resulting in a reduction or stop of waste collecting activities, or even the transport infrastructure damage may prevent normal functioning of the waste management agencies.

Improper storage or the accumulation of household waste may lead to disease outbreaks, a reduction of living comfort by odor pollution and animal attacks caused by the various creatures that may thrive on garbage and are drawn to the area.

2.4. Electricity

Failure of electricity delivering systems, either by stop of production or by failure of transport infrastructure would cause the population to resort on power generators, dependent on fuel. Lack of electricity in an area could lead to panic, a rise in crime rates, and if the problem persists, more complications may result in communications failures because of the loss in functionality of TVs, radios, computers and phones, even mobile ones or the inability of people to buy goods because of the loss of power of banks and mobile pay means. A more urgent need that would arise in the unfortunate event that the electricity is cut off for an extended period of time is that of food preservation, given the fact that all cooling apparatus would stop working. In the same manner, the hospitals and blood banks may be unable to deliver their services to the more than ever in need population, due to the lack in power.

2.5. Natural gas

Depending on the season of year that a major earthquake might critically affect natural gas delivery systems to a major city, the consequences would be more or less dire. Used either as fuel for food preparation and heat generation, natural gas is a public utility that can be replaced by the use of electrical power, if that is available. In the event that homes would rely on natural gas for heating, the means for electrical heating might not be available and distributors might be overwhelmed by the growing request.

Another problem that may arise on a local plane due to the failure of natural gas transport infrastructure is the formation of explosive gas clouds that can be easily triggered by sparks and cause a lot of damage. Given the odorless nature of natural gas, and in the hypothesis that there isn't enough odorant in its composition for allowing facile identification of such clouds, their neutralization or avoidance could become a potentially tedious task without the use of readily available gas detectors.

2.6. Transportation

Transportation, be it public or private, can be disrupted in many ways following an earthquake. Evidently, the infrastructure that would be the most affected would be roads. Either by debris pile up or by the asphalt crumbling, the formation of sink holes or the failure of bridges, both public and private transport would be affected to some degree. Transportation is crucial both for providing assistance for the earthquake victims, and for evacuating affected areas. Access to hospitals would be cut off and survival supplies delivery would not be possible.

Another major inconvenient caused by a severe transportation disruption is the cutoff of fuel delivery to local gas station, in which case power generators might be affected and cause further complications of an already unstable situation.

In the case of a major loss of a city's housing capabilities, transportation is crucial for the population to move to relatives or find housing in unaffected areas.

3. Utilization of public utility failure as a measure of earthquake impact on population

In the passing of time, given humanity's frequent encounter with the destructive power of earthquakes and the need of cataloguing earthquakes' impact on settlements for the purpose of anticipating an adequate response in the event of similar manifestations, in the condition of little or none information available in the aftermath, there have been proposed several scales [2] for the expression of an earthquake's intensity.

Similar to the intensity scale, a scale or table, if you will, to measure immediate impact on population and to help authorities prioritize needs and develop quick and effective strategies for the reestablishment of temporal normal conditions might come in great use, and a representation of such a tool is found in Table 1.

Table 1: Earthquake assessment by public utilities failure

Code	Affected public utility	Authorities' priority
I	Natural gas	Provide alternative means of heating / food preparation Detect and seal leaks Aid companies in making critical repairs
II	Transportation	Asses alternative routes Clean debris Provide shuttles
III	Waste management	Designate and inform about waste storage areas Provide and promote immunization against infectious diseases [3]
IV	Sewage	Provide mass communication and enforcement of hygienic rules Provide basic sanitization materials Set up temporary public showers
V	Electricity	Insure public safety Provide power islands Aid companies in making critical repairs
VI	Water supply network	Provide and rationalize drinking water Insure public safety Set up temporary water purification stations Provide mass communication about dietary choices to avoid dehydration

This choice of hierarchy was used by reason of emergency that each public utility failure has. In that regard, a failure of natural gas providing utilities has the least impact on population day to day activities, given that other means of heating and food preparation can be used. In the case of the transportation infrastructure failure, the impact increases as time passes from the event and resources diminish. As such, it does not call for such an immediate response. Waste management utilities failure can become of major importance with the passing of time because of the potential outbreaks that it can cause. It doesn't call for an immediate response, but more of a reorganization and allocation of resources on behalf of the public authorities.

Moving into the higher end of threats, the sewage infrastructure failure poses an immediate threat due to the potentially rapid disease spread rate that it could generate because of high population concentration. Not only that, but in correlation with unfortunate weather, it can lead to flooding, especially in urban areas, which are heavily dependent on the sewage infrastructure for the drainage of meteoric waters.

Today's society is dependent on electricity for almost every aspect of its daily business. That is why a failure of the electricity infrastructure is so high on the list. With possible complications like rises in criminal rates, depletion of fuel for power generators, the impossibility of provision of medical care and banking services, the failure of the electricity infrastructure presents authorities with multiple urgent tasks.

The biggest threat to population well-being after a major earthquake in terms of utilities failure is the loss of access to drinking water. In this case, people may resort to using water directly from natural sources like rivers, lakes or ponds, which, without proper treatment, may result in the widespread of diseases. Another side effect of this issue might be a rise in criminality and the reason that this is the number one emergency is because water plays such an important role in daily life and conditions many other activities.

4. Interdependencies

As is the case often times, when a major earthquake occurs, there is not just one system failing, but series of failures result in the cascading of effects. For example, the failure of the natural gas and drinking water delivery infrastructure may result in the impossibility of boiling the water obtained from natural sources, thus leading to disease spread. The failure of electricity and transportation systems may lead to total blackouts given the impossibility for fuel delivery. The failure of the waste management system may be caused by the failure of the transport infrastructure, by limiting access of waste management companies. The failure of both sewage and water supply would quickly lead to a growing deterioration of public health. The list of interdependencies goes on and on and given the fact that the failure of only six public utilities systems were taken into account, one can study the dependencies and outcomes caused by the failures of each combination of systems, but such a study exceeds the compass of this article.

5. Conclusions

Given the above stated scenarios and the importance that education plays in all of these to keep population safe and secure in the aftermath that major seismic activity can cause in an area, emergency preparedness for earthquakes should encompass the information needed not only to survive during an earthquake and in the moments that follow, but also that needed to prevent the spread of disease and to live in restrictive conditions, within a community, for an indefinite period of time. As we have stated, not only the earthquake itself poses a threat to population, but also the disruption that it can bring to systems that provide basic necessities. Also, authorities must take into consideration courses of action in the event of different public utilities system failure, and have at hand a variety of plans of action for the quick, partial or full restoration of their functions.

As much as it implies a response from the authorities and a change in behaviour of the population, the failure of public utilities provides a measurement of the impact the earthquake had on

communities, by damage inflicted upon the public utilities services and level of effort needed for the restoration of normal conditions.

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