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The Impact of the Natural Hazard Flooding in East Part of Croatia-Reducing Possible Consequences

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Abstract

Flooding is one of the most common natural hazards that produce substantial loss of life and property. Continuous, heavy rainfall with low pressure area affected a large area of Southeastern and Central Europe, resulted in extensive flooding in Croatia and neighboring countries. The paper presents a review of structural measuresthat were taken to cope with floods in some cities alongthe Sava river in north-east part of Croatia (Slavonia).The aim of this study was to highlight the risks that may expand to major consequences after occurrence of a disaster of this magnitude. Due to many variables, health authorities pointed the potential health exposure risks (communicable diseases occurrence and spread) according to which recovery phase activities were taken. Flood risk management and post-disaster assessments has high level of development in flood-prone areas in Croatia.

Keywords: Croatian flooding; Natural transmission diseases; Communicable diseases

Introduction

In recent decades we have witnessed more frequent and stronger weather and climate extremes: more frequent heat waves, heavy precipitation but also prolonged drought and strong winds. This trend was significant not only for Croatia but also the whole world, and it is a result of global climate changes. This study highlights the potential health exposure risks (communicable diseases occurrence and spread) according to which recovery phase activities were taken, as well as the synoptic analysis of the weather situation which describes the terms and processes that led to a record rain fall and flooding of massive proportions. During a weather front that passed over north-east of Croatia on May 2014, extreme rainfall events were triggered causing several severe flash floods. Ground and altitude synoptic analysis of weather situation describes the terms and processes that led to extreme rainfall (Figure 1). Additional to analysis, it should be noted that this event was preceded by long-term, relatively rainy season, which is why the ground was already quite saturated with moisture. Figure 2 explains cumulative precipitation in mm for May of 2014. On station Slavonski brod. Case report area is located in Vukovar-Srijem County, in the Zupanja-Posavina region of Eastern Croatia [1]. The Flooded region is located between 44° 56′ 30, 34′′ N and 44° 55′06, 7′′ N and between 18° 45′ 11, 95′′ E to 19° 04′ 57, 10′′E at 78 to 89 meters above sea level (m.a.s.l) in Croatia (Figure 3). The most affected towns and villages were Gunja, Rajevo Selo, Racinovci, Durici, Posavski Podgajci, Vrbanja, Strosinci, and Bosnjaci. World Health Organization's Regional Office for Europe (WHO/EURO) reported that two million people were affected by the flooding, more than 60,000 were displaced and 60 people died in three neighboring countries [2]. Total number of casualties in Croatia is 4 (two in flooding period and two in period of resolving post catastrophic consequences). Information about the statistical characteristics of the event as a part of such post event surveys in combination with available field data provides fundamental basis for designing, implementation and operation of measures and instruments for effective and sustainable consequence flood risk reduction. Rusjan S, et al. [3] A few global studies [4,5] have started to estimate the exposure to flooding, and some of them were conducted from this part of Europe (Croatia) [6].

Public health issue

After a flood event, questions arise about health risks with using outdoor areas such as residential yards, playgrounds, animal facilities and agricultural fields. Public health authorities, emergency response managers and government decision makers reacted with high priority, with developing a public health risk management in order to prevent potential exposure to microbiological contaminationand

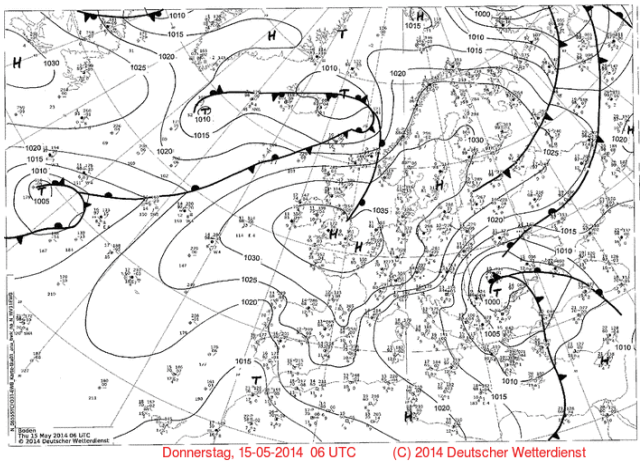

Figure 1: Ground analysis of air pressure and the position of the frontal system 05/15/2014. 8hr.

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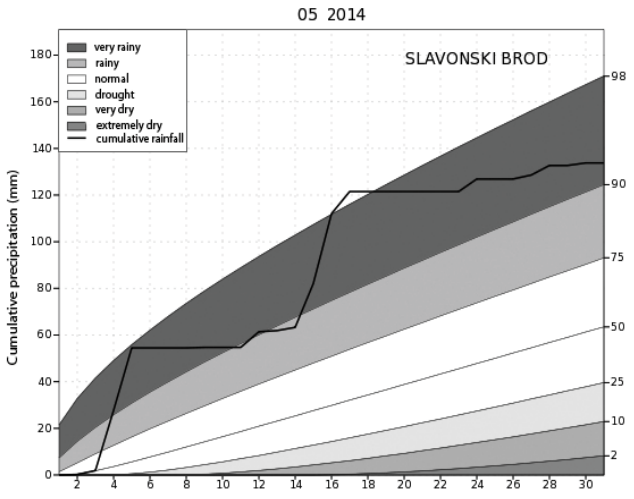

Figure 2: Cumulative precipitation (mm) for May of 2014.

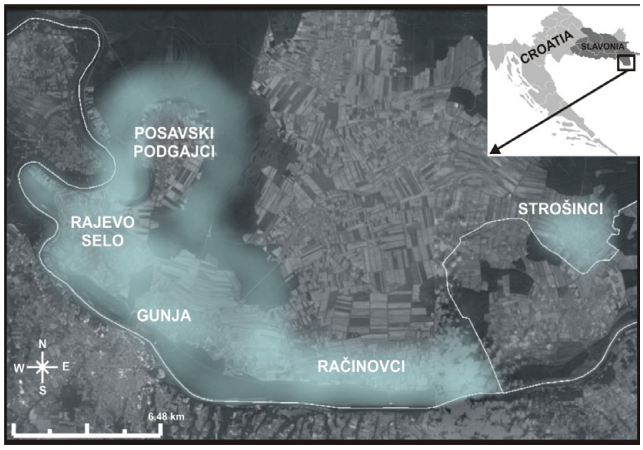

Figure 3: Flooded area in Slavonia. Zupanja-Posavina region.

communicable diseases occurrence and spread. After this natural hazard identification and examination of the magnitude of the exposure it was necessary to predict probability of adverse health effects. The main risks for communicable diseases following floods are related to: exposure to contaminated drinking water supplies and direct contact to pathogens in flooded area and in remaining sediments, mud and waste;expanded breeding sites for mosquitoes and other infectious disease vectors due to standing waters; and displacement of affected populations, overcrowding, and disruption in health services [7].

Waterborne infections and zoonoses.

The countries of the Balkan Peninsula have experienced outbreaks of the emerging and re-emerging diseases over the last 20 years. Outbreaks included tularemia, Q-fever, anthrax, rabies, viral hemorrhagic fevers, Lyme disease, and tick-borne encephalitis [8]. The flooding does not have to emerge any direct implications on these diseases but these diseases are strongly influenced by environmental drivers, and some long-term changes can already be anticipated. Also floods can lead to higher risk of outbreaks of waterborne diseases and zoonoses (particularly leptospirosis), hepatitis A, cryptosporidiosis, giardiasis, shigellosis and diarrheal diseases [9].

Leptospirosis transmission occurs when skin (especially if abraded) or mucous membranes come in contact with water, damp soil or mud that has been contaminated with urine or tissue from infected animals, most commonly rats [10]. Occasionally, transmission occurs through drinking or inhalation of tiny droplets (aerosols) of contaminated water. The disease incubation period is usually 5 to 14 days, ranging from two to 30 days. According to the data collected by Ahern M, et al. [11] on global health impacts of floods, leptospirosis is a great concern following flooding. There have been reports of flood-associated outbreaks of leptospirosis from a wide range of countries, including Argentina, Brazil, Cuba, India, Korea, Mexico, Portugal and others. A study conducted by Zhou, et al. [12], on the presence of hantavirus in rodents after the floods in China, showed a higher virus-carrying rate in rodents in flood regions compared to the surrounding areas.

Croatia has been endemic (at low to intermediate levels) for hepatitis A virus (HAV) and are therefore prone to HAV outbreaks. HAV may be transmitted through consumption of fecal contaminated water [13]. During floods, HAV outbreaks are usually associated with sewage-contaminated or inadequately treated and disinfected sanitized drinking water. The disease incubation period is usually 28 to 30 days, ranging from two to 15 to 50 days. Due to the possible contamination of water used for agricultural purposes, there is a limited increase of risk of contamination of fresh or frozen fruits and vegetables, involving hepatitis A and other food borne infections associated with the consumption of non-heat-treated foods grown in the affected areas [10].

Exposure to enteric pathogens generally occurs during the acute phase of the flooding. Cryptosporidiosis, giardiasis, shigellosis and other diarrheal disease are transmitted through the fecal-oral route, particularly through contaminated water. Water can be contaminated through sewage overflows, storm water runoff or agricultural runoff (including spillage of manure). Some studies of health impacts of flooding in Europe, reports the presence of infections by fecal-oral route and diarrhea diseases as well as gastroenteritis [10]. In any case, there was an option for prevention and response in order to minimize infection risks, enhanced surveillance for communicable diseases outbreaks as well as laboratory capacity was maintained [14].

Vector borne diseases

Vectors can carry disease-producing parasites from one host to another. These potential disease carries are capable of rapidly reproducing and dispersing within favorable environments. Floods often provide conditions for proliferation, with flies, rodents, cockroaches, thick, lice's, mites and mosquitoes posing a greatest risk. The typical principal vector transmitted diseases are presented in Table 1.

Some flood-associated diseases may appear several weeks or months after the event. The creation of new breeding sites due to poor drainage is a potential flood related problem as well as creation of poor sanitary conditions in flood affected areas. In post event time that followed Croatian National and other regional institutes for public health teams and consultants were organized and included in ongoing situation to prevent possible risks.

Vector	Disease/Condition
Mosquitoes	Denguue, Malaria, Fever, West Nile Fever, Filariasis
Rats	Leptospirosis, Hanta virus, Bubonic Plague, Typhus
Flies & Cockroaches	Diarrheal diseases
Ticks, Fleas, Lice	Typhus

Table 1: Vector transmitted diseases and conditions.

Measures for prevention and control of communicable diseases

The implementation of disinfection, insect control and rodent control for the purpose of prevention and control of communicable diseases in Croatia is regulated by The Law on the Protection of Population against Communicable Diseases [15-17].

In case of misuse of biological agents or a natural disaster (flood, earthquake, fire, traffic accident, a mining accident, etc), which can lead to an epidemic or the occurrence of infectious diseases in a great number of individuals, the Minister may, if necessary, order the implementation of measures for preventing and combating infectious diseases: the mobilization of health care workers and other personnel, requisition of equipment, medications and medical products, transport of equipment, temporary use of business and other premises for the provision of health care, isolation and treatment and assignment of specific tasks to legal entities which perform health care services and private health care workers.

In affected Croatian villages, after the flood water retrieved, the residents had to prepare their homes for disinfection. That entailed removing all of the damaged furniture, appliances and water soaked wooden floors and other wooden parts of the house that couldn't be disinfected. After the rooms were emptied out, residents conducted mechanical disinfection by removing the mud and dirt and washing the surfaces, often times with the help of the fire department and the volunteers. Only when the house was prepared, chemical disinfection could be conducted. It was done by motor-spraying the surfaces with the chlorine based disinfectant. Industrial buildings, animal housing and auxiliary buildings were treated with a combination disinfectant containing aldehyde, quaternary ammonia, isopropanol and pine oil.

Insect control measures were implemented in the goal of preventing diseases transmitted by mosquitoes, such as West-Nile or Usutu virus infection, which were present in Croatia during past years [18-21]. In surveillance for mosquito-borne virus infections after the flooding in Czech Republic conducted by Hubálek, et al [22], West-Nile virus was found among the examined mosquito population. The use of biocides and their application are strictly regulated by the EU: Biocides Directive 98/8/EC, Commission Regulation (EC) No 1451/2007 of 4 December 2007, and, more recently, Biocides Regulation 528/2012.

After the flood in Zupanja-Posavina region, as the flood water retrieved, it left behind a lot of new breeding places for mosquitoes and the stagnant water had to be regularly checked and treated by a larvicide. Adulticide treatments were conducted for the control of increased number of flying mosquitoes.

Rodent control measures were implemented, in the goal of preventing diseases transmitted by rodents, such as leptospirosis, hantavirus infection, trichinellosis and others. As the water level retrieved, the rodenticide, containing bromadiolone, a second-generation anticoagulant, was appropriately applied in every household in risk areas.

Flood risk management in Croatia

Floods belong to dangerous natural disasters and can cause loss of human lives, major damages, devastation of cultural properties and environmental damages. Because of the vast mountainous areas with high rain intensity, vast valleys of lowland rivers, major cities and valuable goods in potentially affected areas, and partly due to the lack of built protective systems, Croatia is quite vulnerable to floods. Analysis carried out for the preparation of the Water Management Strategy [23] showed that floods are threat to about 15% of the state's continental territory, of which the greater part is protected, but with different levels of security.

Operational management of flood risks and the immediate implementation of flood protection measures are governed by the National Plan of flood protection [24] and the Main implementing flood defence plan [25].

Flood risk management involves a comprehensive approach to reduction of the probability of occurrence of floods and their possible harmful effects on the population, economy and environment. It combines elements of precaution, protection, preparedness and emergency actions in case of high water encounters. With safeguards in water streams and other waters aiming at floods prevention, emphasis is put on preventive action in flood affected areas and their basins and reduction of potential damages in the events of flooding of unprotected or inadequately protected areas.

The Water Act provides for each river basin district, and if necessary, for its parts, prior assessments of flood risks, which include:

1. Maps of the water districts at the appropriate scales, with the specified limits of the sub-basins of water areas and, where appropriate, the coastal areas showing topography and land use;
2. Description of the floods occurrences in the past that have had significant adverse effects on human health, the environment, cultural heritage and economic activities and the likelihood of occurrence of similar events in the future which could lead to similar harmful consequences;
3. Assessment of the potential adverse consequences of future floods for human health, the environment, cultural heritage and economic activities, taking into account, as much as possible, topographic, general hydrological and geomorphological features and location of watercourses, including floodplains and including floodplains as natural retention areas, the effectiveness of existing structures for flood control, the position of populated areas, location of industrial zones, plans for long-term development and impacts of climate changes on the occurrence of future floodings. Based on previous estimates of flood risks, flood hazards and flood risks maps are made for each river basin district and, if necessary, for the parts of water areas and sub-basins [26]. Flood hazard maps should include representations of possibilities for the development of certain flood scenarios and risk maps representations of potential adverse consequences of the development of these scenarios.

Flood risk management plans are made based on hazard maps and they include: objectives for flood risk management measures for achieving these goals, preventive measures, protection, preparedness, flood forecasting, and informing and warning systems.

Conclusions

The recent floods in Croatia (Slavonia) caused substantial damage to the affected areas. During the acute phase (up to three mounts after the floods) no clusters or outbreaks of communicable diseases were reported to WHO. Recovery phase activities were active till the end of September (e.g. debris cleaning, disinfection, rodent control, control of vector borne diseases) in conjunction with post disaster needs assessments in the affected areas. The magnitude of this natural hazard can be seen on Figures 4- 6.

Although floods are natural phenomena which cannot be completely prevented, the constant development of the system of flood control, building of protection and water control structures

Figure 4: Flood affected house in village Gunja.

Figure 5: Water level in flooded area Rajevo selo.

Figure 6: The damage magnitude in village Račinovci.

and implementation of flood protection measures, flood risks can be reduced to an acceptable level.

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