Volume XXII 2019
ISSUE no.1
MBNA Publishing House Constanta 2019

Scientific Bulletin of Naval Academy

SBNA PAPER • OPEN ACCESS

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To cite this article: A. Dănilă, A. C. Cucuteanu and I. Giurma, Scientific Bulletin of Naval Academy, Vol. XXII 2019, pg. 351-357.

ISSN: 2392-8956; ISSN-L: 1454-864X

doi: 10.21279/1454-864X-19-I1-049

Estimation of economic damages caused by the flood risk

Anca Dănilă[1], Adelina-Cristina Cucuteanu[2], Ion Giurma[3]

[1]Phd. Anca Dănilă ("Gheorghe Asachi" Technical University of Iași, Faculty of Hydrotechnical Engineering, Geodesy and Enviromental Engineering (ROMANIA)), anca.danila@tuiasi.ro

[2]Phd. Adelina Cucuteanu ("Gheorghe Asachi" Technical University of Iași, Faculty of Hydrotechnical Engineering, Geodesy and Enviromental Engineering (ROMANIA)), adelina.cucuteanu@tuiasi.ro

[3]Prof. univ. dr. Ing. Ion Giurma ("Gheorghe Asachi" Technical University of Iași, Technical University Gheorghe Asachi of Iași, Faculty of Hydrotechnical Engineering, Geodesy and Enviromental Engineering (ROMANIA)), igiurma@hidro.tuiasi.ro

Abstract

In recent years, we have become increasingly aware of the importance of factoring the risk to people, property, the overall economy and the environment from flooding into the planning system, and the role that good planning has in avoiding and reducing such risk that could otherwise arise in the future need to pro-actively manage flood risk. There are many areas, including towns and cities that are already at risk from periodic flooding. One of them is Jijia hydrographic basin is characterized by frequent and sharp variations of flow volumes and levels which lead to floods and flooding throughout the basin. Dorohoi town is located in this basin and experienced a significant flooding from a heavy rainfall event in June 2010. The article describes the undergoing work on model development to estimate the damage that was produced by this flash flood. Different land-use data sets have been used to represent the uncertainties in the exposure, value and susceptibility components. For the flood hazard component, inundation depth has been varied systematically to estimate the sensitivity of flood damage estimations to this component.

Keywords: economy, flood, risk, hydrographic basin, flow, damage, hazard, inundation depth.

1. INTRODUCTION

Floods are the most common natural process causing damage to property and loss of life in our geographical area. Efforts to reduce the risk of flooding require methods for assessing the flood risk.[3]

Damage caused by flooding varies depending on the vulnerability of the affected receptor. Under these circumstances, Romania remains one of the most vulnerable countries to these phenomena, firstly due to the lack of a sustainable infrastructure for protection against dangers and irrational exploitation of the territory. Over time, floods have been manifested in various river basins in the country's regions, causing significant direct damage to both households and infrastructure and agriculture. [5]

Jijia hydrographic basin is characterized by frequent and sharp variations of flow volumes and levels which lead to floods and flooding throughout the basin. Dorohoi town is located in this basin and experienced a significant flooding from a heavy rainfall event in June 2010.

The paper describes the undergoing work on model development to estimate the damage that was produced by this flash flood. Different land-use data sets have been used to represent the uncertainties in the exposure, value and susceptibility components. For the flood hazard component, inundation depth has been varied systematically to estimate the sensitivity of flood damage estimations to this component.

2. MATERIALS AND METHODS

2.1. Case Study

The study area is located in Dorohoi Municipality, located in the north-west of the Upper Moldavian Plain, in Botosani County, at the Jijia Plain Field with Bour Hills, at the confluence of the Jijia River with the Buhai River, at 200 m altitude on the right bank of the Jijia River. Geographically, the city is situated in the northern part of Romania, in the contact area of the Bourul-Ibaneşti high hill area on the Siret Valley and Moldavia Plain, on the upper Jijia River.

The northeastern town of Dorohoi witnessed deaths during the night of June 28–29 as floods rose to just over 1 meter in some places. Several roads into Dorohoi remained either washed away or under water, the heavy rain that had been falling for close to a week.

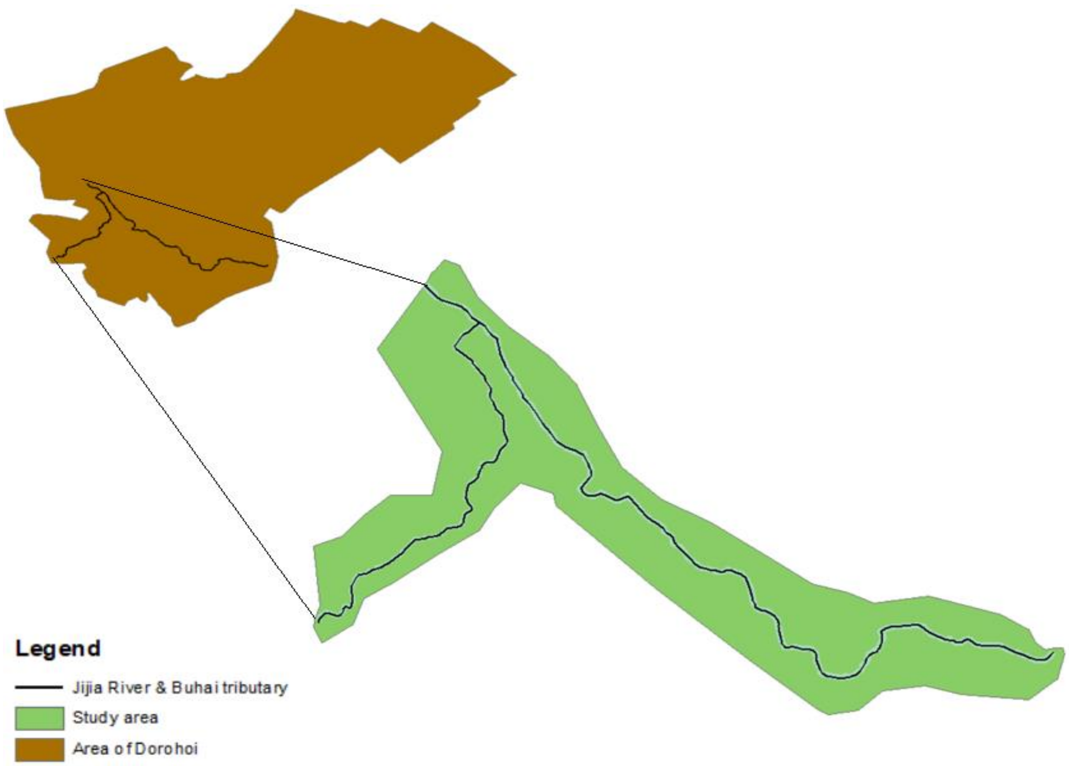

Fig. 1. Map of study area

2.2. Data Analysis

The derivation of the (economically) acceptable level of risk can be formulated as an economic decision problem.

The study focused on the extent of flood damage at a very high rate.

In this study we utilize data from Geographic Information Systems (GIS) for assess the costs of flood-affected buildings for different recurrence periods (20, 50, 100 and 1000 years, and for the 2010 event) to estimate the expected annual damage to vulnerable areas.

2.3. Creation of the flood risk map

Four original land use categories have been delineated in this study, namely, Houses, Roads, Bridges and Railways. These are represented in the figure 2.

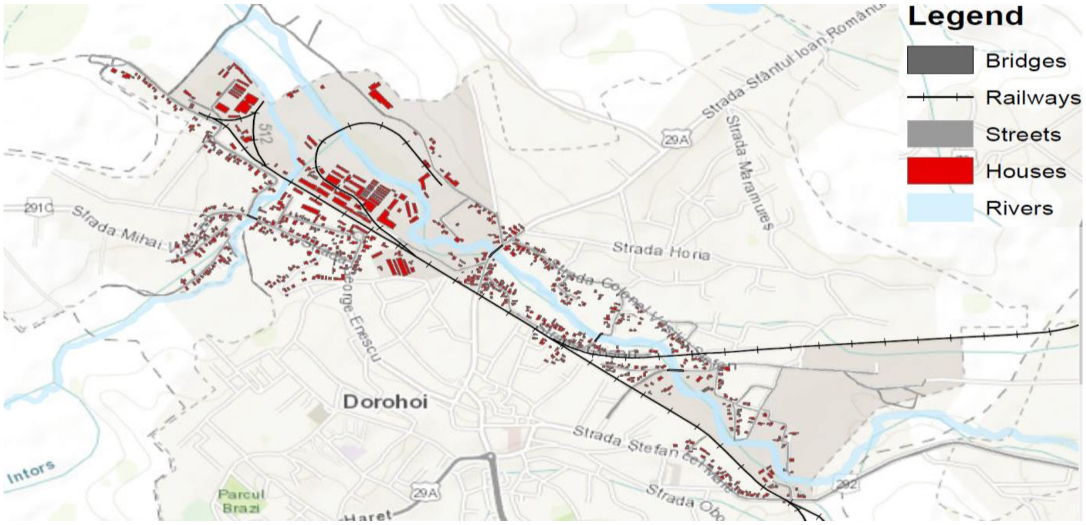

Fig. 2. Location of the considered study elements

In this research 5km of Jijia River was selected, reproduced and analyzed in order to generate the flood hazard map for the management of the future flood in basin. The river model was developed using InfoWorks ICM software modelling. To assess the hydrological risk and vulnerability of the Jijia, several floodplains were generated with theoretical assurance of 5% (20 years), 2% (50 years),1% (100 years) and 0,1% (1000 years). These simulations were designed to detect potentially flooded areas they generate so as we can calculate the damage produced.

Hazard map related to the flow depths is generated. Figure 3 shows the extent of the flooding for all return period that we considered across the river Jijia.

Fig. 3. Flood area

3. RESULTS

The application to the case study of Dorohoi of the proposed methodology has enabled us to estimate the average estimated damage to the buildings, roads, bridges and railways located in the area exposed to the inundation with the probability of occurrence once in 20 years (5%), once in 50 years (2%), once in 100 years (1%) and once in 1000 years (0,1 %).

In the figures 3 and 4 are illustrated the considered elements that are in the flood risk zones. It can clearly observed which are the portion of the streets and the houses that are affected by flood.

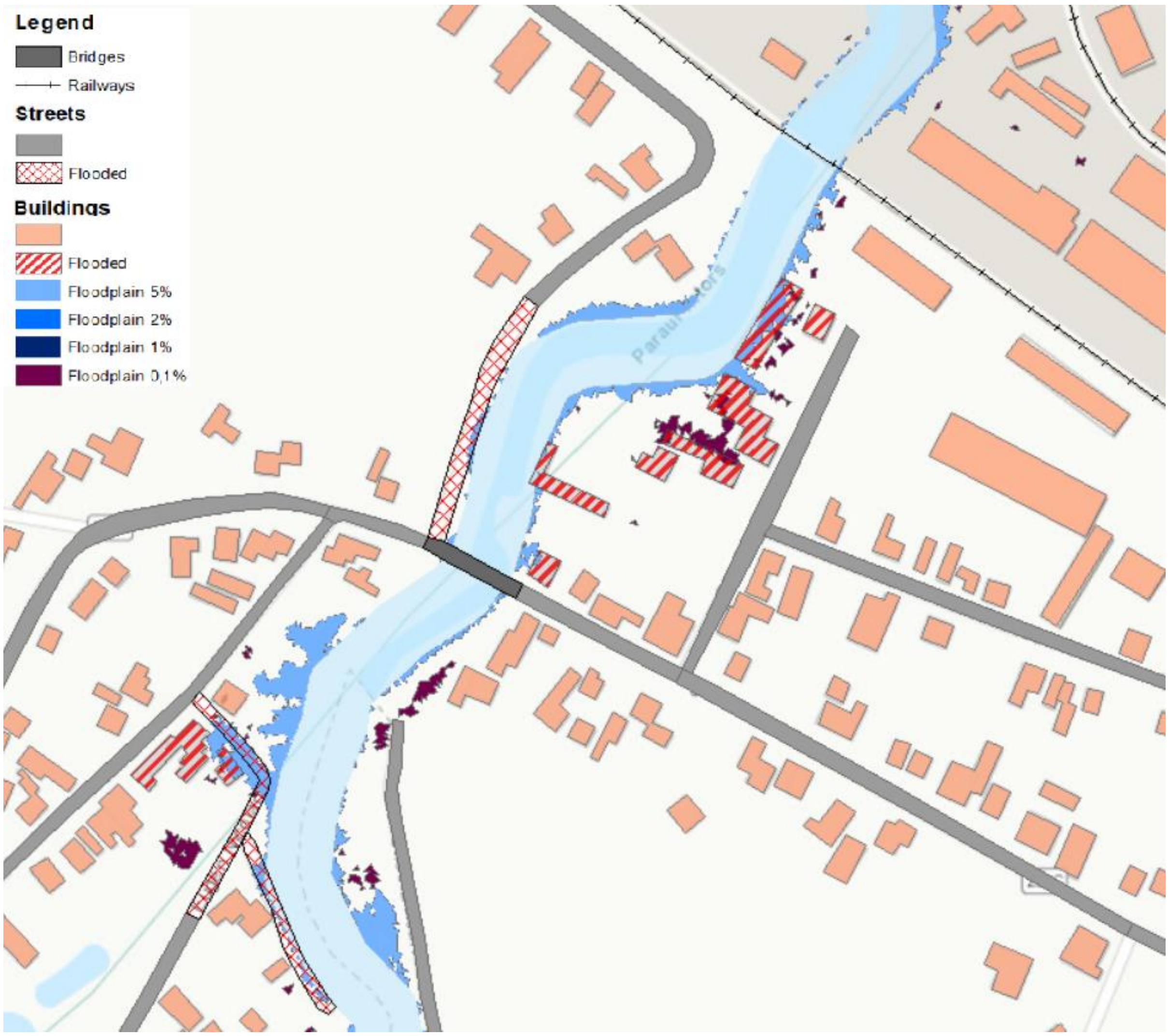

Fig. 4. Example of the study objects affected by the flood

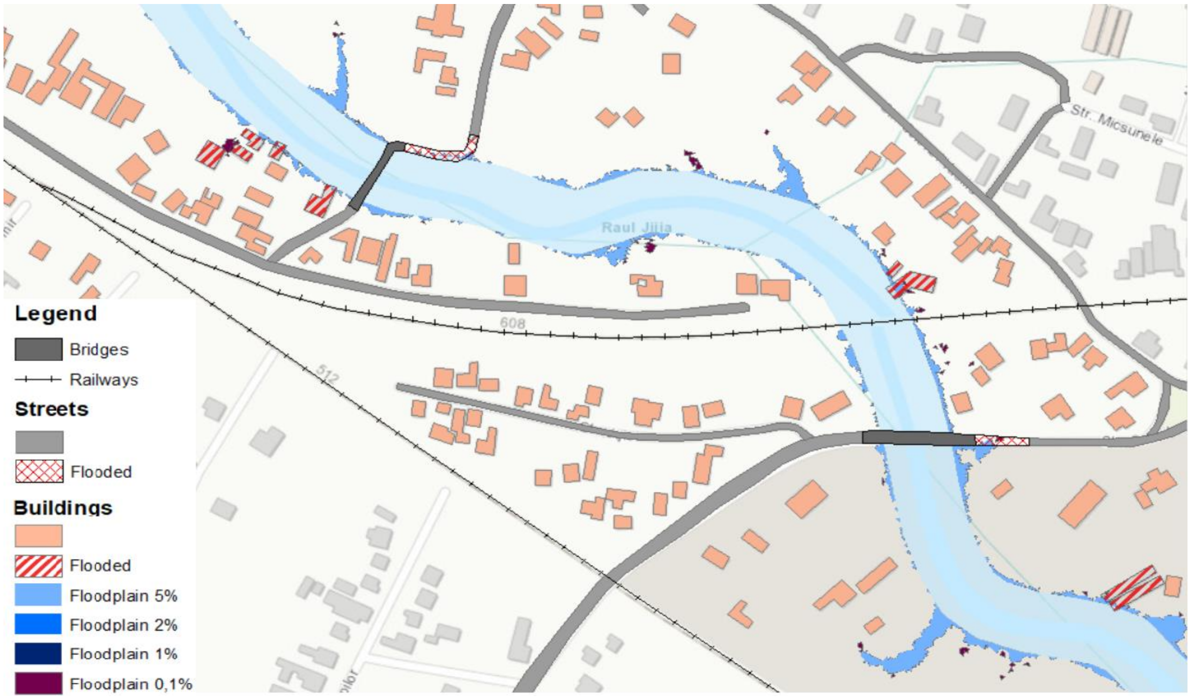

Fig. 5. Example of the study objects affected by the flood

Table 1 shows the results of the damage calculations in RON, using a market study with minimum value on the real estate market, for assessing the type of constructions according to materials, and for assessing damage to infrastructure, amounts per affected kilometer, which may differs depending on the material.

	$Q_{5\%}$	$Q_{2\%}$	$Q_{1\%}$	$Q_{0,1\%}$
	Average reconstruction cost	Average reconstruction cost	Average reconstruction cost	Average reconstruction cost
Buildings	2607979.912	8606333.71	11083914.63	13039899.56
Roads	2930056500	9669186450	12452740125.58	14650282500.68
Bridges	2305966.068	7609688.024	9800355.79	11529830.34
Railways	4770000.182	15741000.6	20272500.77	23850000.91

Average estimated damage (RON)	2939740446.30	9701143472.78	12493896896.77	14698702231.49

Table 1. Expected Annual Damage

The average estimated damage is assessed as integral value of curves shown in fig. 6 is reported in table 1.

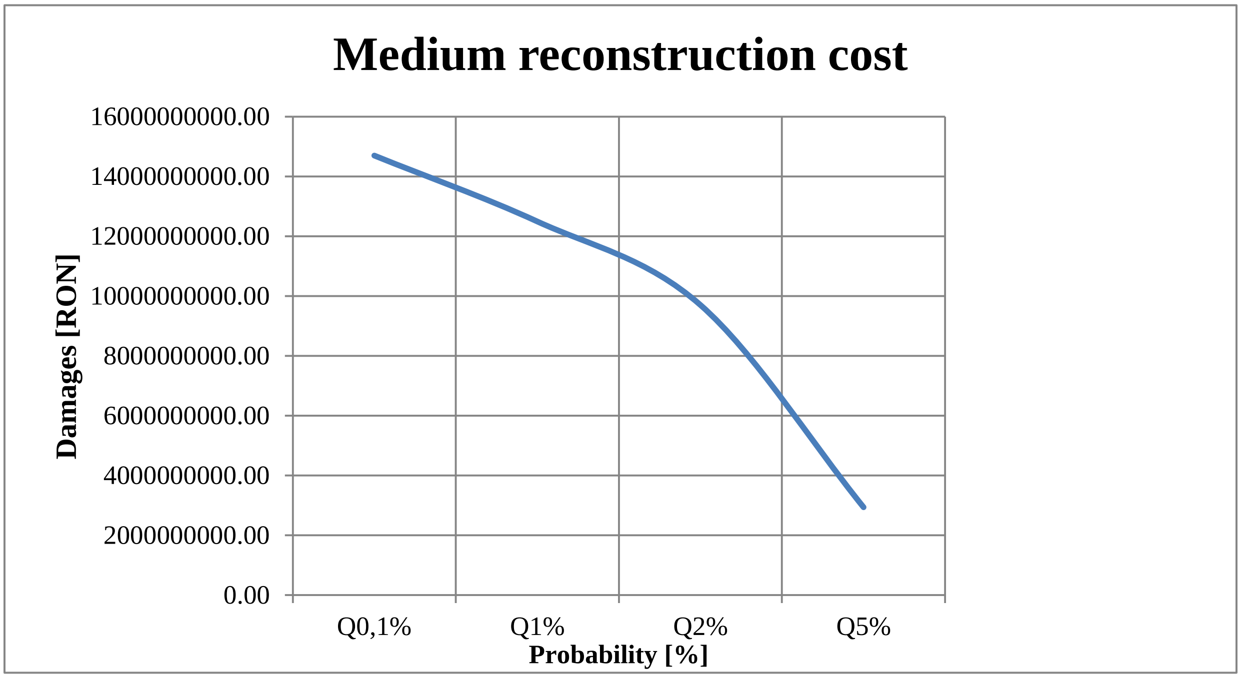

Fig. 6. Expected Annual Damage

4. CONCLUSION

The estimation of economic flood damage is gaining greater importance as risk management is becoming the dominant approach of flood control policies throughout Europe (European Commission, 2007).

Damages are the result of the exposure of the elements and the degree of vulnerability, and the mathematical combination of all potential damage with the probability of each event is defined as the risk.

The current state of studies in the field of risk assessment shows that at the basis of this process there are three main pores of risk, danger, exposure and vulnerability. Each study considers these pillars, assembling it in a new approach as they are essential for an estimate and comparison of the impact of an environmental hazard.

The results obtained from the risk assessments are important components for the cost-benefit analysis and to analyze the effects of the floods on the elements exposed to the hazard and also help to make objective comparisons of the different river basins.

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