CROATIA EARTHQUAKE

Rapid Damage and Needs Assessment

2020

Government of the Republic of Croatia

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Rapid Damage and Needs Assessment 2020

Prepared by

Government of the Republic of Croatia

Facilitated by

THE WORLD BANK
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The Croatia Earthquake - Rapid Damage and Needs Assessment 2020 report has been prepared by the Government of Croatia, with the support of the World Bank. This report summarizes the findings of the Rapid Damage and Needs Assessment that was carried out between April and June 2020. The report is based on data as of June 5, 2020 gathered during the assessment which was coordinated by the Ministry of Construction and Physical Planning.

Respective sector assessments are the work of the line ministries: Ministry of Construction and Physical Planning, Ministry of Culture, Ministry of Finance, Ministry of Health, Ministry of Interior, Ministry of Regional Development and EU Funds, and Ministry of Science and Education, with contributions from the City of Zagreb, Krapina-Zagorje County, Zagreb County, Faculty of Civil Engineering - University of Zagreb, Croatian Seismological Survey – Faculty of Science, University of Zagreb, Croatian Bureau of Statistics, and the World Bank.

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Cover photo
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ABBREVIATIONS AND ACRONYMS

AeDES	Post-Earthquake Damage and Safety Assessment and Short-Term Countermeasures form
ArcGIS	Aeronautical Reconnaissance Coverage Geographic Information System
AROP	At-Risk-of-Poverty Rate
BBB	Build Back Better
CAB	Current Account Balance
CAD	Current Account Deficit
CBS	Croatian Bureau of Statistics
COVID-19	Coronavirus Disease 2019
CoZ	City of Zagreb
CPI	Consumer Price Index
CSS	Croatian Seismological Survey, Department of Geophysics, Faculty of Science, University of Zagreb
DaLA	Damage and Loss Assessment
DInSAR	Differential Synthetic Aperture Radar Interferometry
DRM	Disaster Risk Management
DRR	Disaster Risk Reduction
EC8	Eurocode 8
EE	Energy Efficiency
EMS	European Macroseismic Scale
ENV	ENV Eurocode - Version of Eurocode published by CEN as a pre-Standard ENV (for subsequent conversion into EN)
EOC	Emergency Operations Center
EQ	Earthquake
ERCC	Emergency Response and Coordination Center
ESA	European System of Accounts
EU	European Union
EUR	Euro Currency
EUSF	European Union Solidarity Fund
FCE	Faculty of Civil Engineering, University of Zagreb
FINA	Financial Information Agency
GDP	Gross Domestic Product
GIS	Geographic Information System

GoC	Government of Croatia
HBOR	Croatian Bank for Reconstruction and Development
HCPI	Croatian Center for Earthquake Engineering
HNS	Host Nation Support
HRK	Croatian Currency Kuna
HZZ	Croatian Employment Service
IFI	International financial institution
ISDR	International Strategy for Disaster Reduction
KB	University Hospital
KBC	University Hospital Center
KZC	Krapina-Zagorje County
LOS	Line of Sight
M	Magnitude
MCS	Mercalli–Cancani Scale
MoC	Ministry of Culture
MoCPP	Ministry of Construction and Physical Planning
MoEEC	Ministry of Economy, Entrepreneurship and Crafts
MoF	Ministry of Finance
MoH	Ministry of Health
MoI	Ministry of Interior
MoRDEUF	Ministry of Regional Development and EU Funds
MoSE	Ministry of Science and Education
Mw	Moment Magnitude Scale
N1	Unusable due to external risks
N2	Unusable due to damage
NDS	National Development Strategy
NSI	National Statistical Institutes
OECD	Organization for Economic Co-operation and Development
OSCE	Organization for Security and Co-operation in Europe
PDNA	Post-Disaster Needs Assessment
PN1	Temporarily unusable and requiring a more detailed inspection
PN2	Temporarily unusable with suggested short-term countermeasures
PPP	Purchasing Power Parity
RDNA	Rapid Damage and Needs Assessment
SILC	Statistics on Income and Living Conditions
SMEs	Small and Medium-sized Enterprises
U1	Usable without limitations
U2	Usable with a recommendation for a short-term countermeasure
UCPM	Union Civil Protection Mechanism

UN	United Nations
UNDP	United Nations Development Programme
UNHCR	United Nations High Commissioner for Refugees
UNICEF	United Nations International Children's Fund
UTC	Coordinated Universal Time
WB	The World Bank
WDS	Whole Day School
WMO	World Meteorological Organization
ZC	Zagreb County

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FOREWORD

Forces of nature are unpredictable and their power is often unstoppable. On March 22, 2020, a powerful earthquake struck Zagreb and parts of the surrounding Krapina–Zagorje and Zagreb counties. In only ten seconds, the earthquake damaged or destroyed some 26,000 buildings and homes, alongside cultural, religious, educational, health and sports facilities. One person lost her life and an estimated thirty thousand people had to leave their homes. Countless others faced disrupted gas and water supplies, and many still do.

In particular, the earthquake seriously damaged buildings that are valuable architectural achievements and ruptured the urban fabric of Zagreb's historically recognizable city centre. Zagreb is a cultural and architectural gem, especially representative of the grand styles of the nineteenth and twentieth centuries. Downtown Zagreb and its distinctive Central European ambience were particularly affected.

Earthquakes have hit Zagreb on several occasions during its long history. This year's earthquake was the strongest in 140 years. Each time, the Croatian capital recovered by strengthening its identity, while at the same time changing, modernizing and growing. Once again, Zagreb finds itself facing the challenge of reconstruction and development. Family homes need to be rebuilt and the quality of life restored. The city's historic fabric needs to be reconstructed and strengthened, but also reimagined through new structural, spatial, infrastructural and environmental solutions that will make Zagreb safer, more resilient, more sustainable and greener. Our strategy of urban renewal will stay true to Zagreb's heritage, but also build on modern technologies and environmental standards, creating a better life for all of its current and future residents.

At the centre of our strategy for Zagreb are its people. Our aim is to bring life back to the city by returning residents and restoring the daily routines of the city as soon as possible. The rebuilding of people's homes needs to run in parallel with the reconstruction of kindergartens, schools, universities, hospitals, businesses, theatres and museums.

All our post-earthquake efforts must be in the function of achieving progress and enhancing social welfare. As we rebuild Zagreb and its surroundings, in our work we must demonstrate qualities that as a society we want to promote: reliance on expertise, innovation, solidarity and social inclusion.

In that vein, together with the World Bank, the Croatian Government prepared the report in front of you to document the damage and destruction that the earthquake caused and to support its request for international assistance in reconstruction efforts. The Croatian Government, citizens of Croatia and especially Zagreb warmly welcome such help.

I hope that in the not-too-distant future, we will look upon the earthquake of March 22, 2020 not only as a destructive force of nature, but also as a turning point that allowed us to draw lessons from the past and create a better living space for the generations to come.

Andrej Plenković
Prime Minister of Croatia

EXECUTIVE SUMMARY

Photo: Ministry Of Culture

ZAGREB EARTHQUAKE
M 5.5, 7 km north of Zagreb, Croatia
Origin Time: 22.03.2020 05:24:03 UTC (Sun 06:24:03 local)
Depth: 8 km

EXECUTIVE SUMMARY

CONTEXT

On March 22, 2020 at 6:24 am, Croatia was hit by a powerful earthquake with a magnitude of 5.5. The epicenter was at Markuševec, 7 km north of the center of Zagreb, at a depth of only 8 km. The March 2020 earthquake resulted in one fatality, 26 injuries, and the displacement of thousands of people. In the aftermath of the earthquake, 488 people were housed in an evacuation center, and an unknown number took shelter with friends and relatives. The earthquake resulted in damage to about 26,000 buildings in the City of Zagreb, Krapina-Zagorje County and Zagreb County. The earthquake occurred in the middle of a nationwide lockdown linked to the COVID-19 outbreak, requiring an immediate response in unique, unprecedented circumstances. Overall, the Croatian government is currently addressing a multifaceted emergency caused by the global pandemic, an economic recession and the earthquake of March 22.

In the weeks following the earthquake, the Croatian government launched the preparation of a Rapid Damage and Needs Assessment (RDNA), which was coordinated by the Ministry of Construction and Physical Planning. The damage, loss, reconstruction and recovery estimates have been compiled in this report. The RDNA aims to provide a structured and comprehensive account of the earthquake's effects. The report will complement the further planning of an overall post-earthquake recovery strategy and the development of the necessary institutional, legal and financial framework for the reconstruction. This coordinated assessment process has also been used by the Croatian government to prepare its application to the European Union Solidarity Fund.

Photo: Damjan Tadić / CROPIX

SUMMARY OF DAMAGE AND LOSSES

Total Damage and Losses and Key Findings

The total cost of the earthquake in the City of Zagreb, Zagreb County and Krapina-Zagorje County is estimated at 11.301 billion EUR,[1] of which 10.661 billion EUR represent the value of destroyed physical assets and 0.640 billion EUR refers to losses.[2] The impact of the disaster on Zagreb's historical center is one of the main reasons for the very high cost of earthquake damage. Buildings classified as cultural heritage are present in all five sectors, and their percentage in each sector is significant. Estimates of damage and losses have been grouped into five main sectors: housing, health, education, culture and cultural heritage, and business.

Photo: Ronald Goršić / CROPIX

1 Exchange rate used is of March 22, 2020, 1 EUR = 7.599120 HRK.

2 Damage is estimated in terms of the replacement value of both public- and private-domain physical assets damaged or destroyed; losses are estimated based on the changes in economic flows resulting from the temporary absence of the damaged assets or disruption to access to goods and services in terms of reduced revenue; higher operational costs; and actions taken to reduce risk.

Sectors: Most damage was sustained by the housing sector (64%), followed by the culture and cultural heritage sector, which includes historical government buildings (13%), education (10%), health (8%), and business (5%). The sector most affected by total losses is the housing sector (57%), followed by business (29%), health (10%), culture and cultural heritage (3%) and education (1%). Overall 78% of the damage and losses are in the private sector, and 22% in the public sector. In the private sector, damage and losses are mainly in housing and business, while, in the public sector, they are mainly in health and education. For the culture and cultural heritage sector, the ownership distribution of damage and losses is 39.2% public and 61% private (Table 1).

Housing: Housing is the sector most badly hit by the disaster, with approximately 24,000 damaged buildings spread across the whole of the earthquake-affected area. An estimated 4,600 of these have moderate to severe structural damage (19%), while 1,243 have high structural damage (5%). The total value of damage to the housing sector stands at approximately 6.88 billion EUR, while the valuation of losses amounts to 364 million EUR. The figure for losses takes into account the displacement of people from unsafe buildings, and the disposal of earthquake debris. Ninety-nine percent of all estimated costs relate to the City of Zagreb, as it is here that the density of buildings and population is at its highest.

Health: The total number of affected buildings in the health sector stands at 214, of which 46 are healthcare centers (22%), 125 are hospitals and clinics (58%), 20 are medical institutes (9%) and 23 are pharmacies (11%). Moderate to severe structural damage is reported in a total of 40 buildings (19%), and heavy structural damage in eight buildings (4%). The total cost of damage to physical property is estimated at 826 million EUR. Most of this cost relates to hospitals and clinics (88%). The reported losses amount to 61 million EUR and are mainly linked to the emergency evacuation of patients; and the inability of medical institutions (mainly hospitals and health centers) to provide medical services during the emergency period (due to severe structural damage) and charge their costs to the Croatian Health Institute. As much as 96% of the total costs relate to the City of Zagreb (96%) due to its large concentration of healthcare institutions and its central position in the earthquake-affected area.

Education: A total number of 513 buildings in the education sector recorded damage, of which 484 (94%) are in the City of Zagreb, 23 (5%) in Zagreb County, and 6 (1%) in Krapina-Zagorje County. Moderate to severe structural damage was recorded in 160 buildings (31%), while 12 buildings (2%) suffered heavy structural damage. The total value of damage to buildings and other physical assets is estimated to 1.07 billion EUR. Most of this (98%) relates to educational institutions in the City of Zagreb. Losses are estimated at approximately 9 million EUR, and mainly refer to the short-term countermeasures needed to remove potential hazards to users, and to prevent further degradation of the buildings.

Culture and Cultural Heritage: The total number of affected buildings in this sector comprises 192 cultural institutions, 13 state heritage buildings, and 159 religious buildings across the City of Zagreb and the two counties. Since most of the buildings in this sector are very old, moderate to severe structural damage was sustained by 118 buildings (32%), and heavy structural damage was reported in 41 buildings (11%). Total damage to buildings and other physical assets is estimated at 1.38 billion EUR, most of which was incurred in the City of Zagreb. Losses estimated at 21 million EUR mainly relate to emergency measures taken to protect cultural heritage buildings, particularly churches. This sector includes damage and losses to cultural institutions and creative industries, state or government buildings situated in heritage buildings, movable cultural heritage, and churches and other religious facilities. Damage and losses to buildings which qualify as cultural heritage but which fall within other sectors are calculated in the estimates for those sectors.

Business: Based on the data collected, a total of 2,104 business entities have been affected by the earthquake, of which 98.2% are in the City of Zagreb, 1.4% in Zagreb County, and 0.4% in Krapina-Zagorje County. As much as 27% of the surface area occupied by business entities is estimated to have suffered moderate to heavy structural damage, and the total value of damage is estimated at approximately 505 million EUR. The valuation of losses stands at 185 million EUR, caused largely by the reduction of revenue arising from a slowdown or interruption of business activity.

TABLE 1
Damage and losses by sector (in million EUR)

	Damage	Losses	Total
Housing	6,881	364	7,245
Health	826	61	887
Education	1,071	9	1,080
Culture and Cultural Heritage	1,378	21	1,399
Business	505	184	689
TOTAL	**10,661**	**640**	**11,301**

TABLE 2
Damage and losses by county (in million EUR)

	Housing	Health	Education	Culture and Cultural Heritage	Business
Counties					
City of Zagreb	7,159	854	1,057	1,200	672
Zagreb County	41	8	19	136	15
Krapina-Zagorje County	46	25	3	63	2

As far as the geographical distribution of damage and losses is concerned, the City of Zagreb is most affected with 10,943 million EUR or 96.8% of total damage and losses, while the share of Zagreb County is approximately 219 million EUR (1.9%), followed by Krapina-Zagorje County with 139 million EUR (1.2%).

Overall, a total surface area of more than 22.2 million square meters has been affected by the earthquake. Eighty-two percent of the affected surface area is in the housing sector (18.1 million square meters) followed by the business sector with 1.4 million square meters, and the education sector with 1.3 million square meters. The culture and cultural heritage sector accounts for 0.7 million square meters (without the affected area of cultural heritage already accounted for in other sectors), while the health sector accounts for a total of 0.6 million square meters.

The historical center of Zagreb is divided into two zones of protected cultural heritage, of which Zone A denotes the original historical center of the city and Zone B denotes the wider urban complex, mostly built before the mid-20th century. A large share of residential buildings, hospitals, schools, businesses, cultural institutions, and government buildings are housed in cultural heritage buildings located in both Zones A and B. The extent of damage to Zone A, which is protected as cultural heritage as a whole, is proportional to its heritage value. A total of 72% of buildings in Zone A was damaged, which accounts for the high extent of damage across all sectors.

FIGURE 1
Surface area of buildings affected by the earthquake by sector (in m^2)

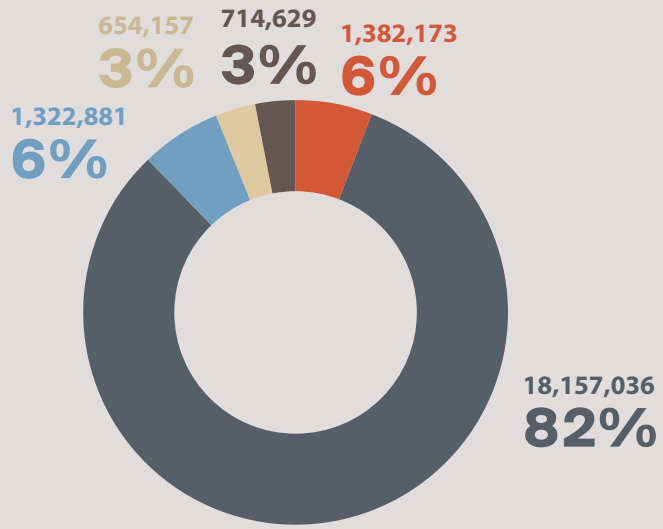


TABLE 3
Number and percentage of damaged buildings in the protected historical urban complex of the City of Zagreb

City of Zagreb – Protected Historical Urban Complex – Zones A and B									
Urban Zone	No.							TOTAL DAMAGED	
A	4,017	1,561	39%	1,088	27%	240	6%	2,889	72%
B	9,371	2,927	31%	737	8%	98	1%	3,762	40%

SUMMARY OF THE MACROECONOMIC IMPACT ASSESSMENT

Croatia is expected to experience a deep recession in 2020. COVID-19 mitigation measures have dramatically slowed economic activity, disrupted global supply chains as well as travel and tourism activities, significantly reducing Croatian employment and output. Bearing in mind that economic activity in March was already significantly reduced due to the COVID 19 lockdown, the direct effect of the earthquake on GDP growth for 2020 is estimated to be small. Preliminary World Bank estimates indicate that the pandemic and the earthquake may reduce Croatia's GDP by 9.3% in 2020, with an impact of only 0.1% attributable to the earthquake. More recent estimates by the European Commission suggest an even deeper recession for Croatia, due to a more challenging international environment and a sharper contraction of GDP in some of Croatia's most important trading partners. Fiscal effects of the earthquake in 2020 are also estimated to be small. Immediate post-earthquake reconstruction, alongside a relatively small direct impact to the private sector, could increase the general government deficit by about 0.1 percentage point of GDP. Whether the earthquake recovery will have a significantly adverse effect on public finances in subsequent years largely depends on the extent to which the costs of recovery are financed through grants or loans. The large-scale reconstruction efforts due to get under way already in the second half of 2020 could provide a boost to investment and help accelerate economic recovery in subsequent years. However, as the majority of the reconstruction costs will need to be borne by the private sector, any potential acceleration of growth will depend on the timeliness of private sector intervention and the availability of adequate financing schemes, especially for the housing sector.

Photo: Anto Magzan

SUMMARY OF HUMAN AND SOCIAL IMPACTS

The earthquake affected large sections of the population in Zagreb and the surrounding area. Twenty-six people were injured (18 severely), and one 15-year old girl was killed. As of June 5, 488 people had been accommodated in student dormitories, and a much larger number of residents had been taken in by family or friends (the total number is unknown but is estimated at around 30,000). According to figures from the Ministry of Interior, it is estimated that a total of 791,038 people were directly exposed to earthquake conditions of level-VII intensity. Based on field assessments, some 26,000 public and private buildings were affected by the earthquake, the vast majority of which belong to the residential sector. Of these, according to data collected at the time the RDNA was compiled, 5,816 buildings were declared unusable (1,236 permanently unusable and 4,580 temporarily unusable), while 18,065 remained in usable condition.

The earthquake significantly affected people's access to public services, including healthcare and education. In the health sector, patients, medical and non-medical staff were all affected. Preliminary estimates indicate that a total of 214 buildings in the health sector were damaged by the earthquake. According to Ministry of Health data, damage has affected the provision of healthcare services to a minimum of 1,424,327 patients normally served annually through the care of over 2,739 medical and non-medical personnel. In the education sector, figures from the Ministry of Science and Education indicate that the total number of pupils and students affected by damage to their places of education stands at a minimum of 9,538. If staff and other employees are included, this figure rises to more than 10,000 people. It is estimated that some 6,200 children will need to be relocated from damaged schools to new school environments.

Photo: Tomislav Kristo / CROPIX

The compounded effects of the COVID-19 crisis and the earthquake will continue to have a significant impact on the vulnerable population. The earthquake – in addition to the COVID-19 pandemic - is expected to increase poverty in several ways, including the sudden loss of assets (including housing) and capital, reduction of income due to damaged infrastructure and loss of employment, school closures, a general slowdown in growth and rising food prices. Of the estimated 791,038 people directly exposed to earthquake conditions of level-VII intensity, 53% were women, 17% were over 65, and 15% had some form of inability to perform everyday tasks.

While there was no event-specific data collected with respect to gender during this assessment, global experience suggests that women and people with disabilities are disproportionally affected by external shocks, including disasters and health emergencies. Women are constrained by their traditional role of primary caregivers, while people with disabilities are disproportionately affected by the immediate and long-term effects of disasters and health emergencies, particularly in their access to facilities associated with evacuation, response (including shelters, camps, and food distribution) or recovery and reconstruction.[3] Disability-based discrimination marginalizes people with disabilities and, in many cases, forces them into lives of dependency. Disasters exacerbate these conditions, enhancing the disparities between people with disabilities and other members of society, and increasing the likelihood that those with disabilities will be disproportionately affected both during and after an earthquake.

3 Global Facility for Disaster Reduction and Recovery. 2017. *Disability Inclusion in Disaster Risk Management*, 2017. Washington, DC: World Bank Group.

SUMMARY OF RECOVERY AND RECONSTRUCTION NEEDS

The needs for reconstruction and recovery add up to approximately 17.469 billion EUR. Of this amount, 4.5 billion EUR relates to short-term needs (26%), medium-term needs are estimated at 7.1 billion EUR (41%), while long-term needs stand at 5.8 billion EUR (33%), as shown in Table 4. The reconstruction and recovery needs are higher than damage and losses since they include, first, the application of a build back better[4] approach to the reconstruction of damaged infrastructure that reduces any future earthquake risks and involves functional improvements including energy efficiency; and, second, the resumption of production, service delivery, and access to goods and services. The cost of recovery is greatest in the housing sector and accounts for more than half of overall needs (52%), followed by the culture and cultural heritage sector, the health sector, and the education sector (each respectively accounting for 13-14% of overall recovery needs). The large amount of damage done to buildings of cultural heritage value across all sectors renders the recovery and reconstruction process particularly complex and challenging, both in financial and logistic terms.

TABLE 4
Summary of recovery and reconstruction needs (in million EUR)

	Short-term	Medium-term	Long-term	Total
Sectors				
Housing	2,739	4,102	2,287	9,128
Health	374	210	1,851	2,435
Education	571	881	909	2,361
Culture and Cultural Heritage	500	1,570	447	2,517
Business	338	351	339	1,028
TOTAL	**4,522**	**7,114**	**5,833**	**17,469**

Recovery will prove especially challenging due to the significant damage suffered by the historical center of Zagreb. The recovery of historical urban architecture will involve a comprehensive and interdisciplinary approach using appropriate methodology based on conservationist principles.

The process of determining all reconstruction and recovery needs is crucial in defining a long-term strategy for rebuilding Zagreb and the surrounding area and restoring the livelihoods of its people. The earthquake has exposed the vulnerability of the whole country to natural disasters of this kind. The preparation of this damage and needs assessment, a team effort led by the Croatian government, will provide a comprehensive picture of the total impact of the disaster and a solid foundation for recovery planning.

The Croatian government has already responded to the earthquake by financing emergency repairs and preparing a new legal framework to regulate the reconstruction of damaged buildings. As revealed by the assessments of damage and losses, the extent of the disaster is so wide-ranging that it is simply not possible to determine a timeframe for recovery at this stage. The efforts invested so far will aid the development of a comprehensive long-term recovery strategy, which will ensure the thorough physical and socio-economic reconstruction of Zagreb and the surrounding area.

4 BBB is a reconstruction approach that seeks to reduce vulnerability and improve living conditions while promoting more effective and sustainable reconstruction. It takes the opportunity of having to rebuild following a disaster event to examine the suitability and sustainability of reconstruction activities.

INTRODUCTION

Photo: Anto Majzan

ZAGREB EARTHQUAKE
M 5.5, 7 km north of Zagreb, Croatia
Origin Time: 22.03.2020 05:24:03 UTC (Sun 06:24:03 local)
Depth: 8 km

INTRODUCTION

5.5 M
earthquake

March 22, 2020
at 6:24 am

7 km
north of of Zagreb

1
fatality

26
injured

30,000
displaced

1.9 million
people exposed (0.8 million at level VII intensity)

26,000
buildings damaged

CROATIA'S DISASTER RISK PROFILE

Croatia is subject to a range of natural hazards, including floods, wildfires, earthquakes, extreme temperatures, strong winds, and droughts. Croatia belongs to the Alpine–Mediterranean seismic region which comprises several geo-tectonic units: the Pannonian Basin, the Eastern Alps, the Dinarides, the Dinarides–Adriatic Platform transition zone and the Adriatic Platform. The entire area of the Republic of Croatia is highly active seismically, with thousands of earthquakes recorded each year, of which at least four a year might be of severe intensity. About 30% of the country is exposed to earthquakes, an area which is home to about 60% of the population[5] and produces 65% of the country's GDP.[6] Even though rare in comparison to other disasters, earthquakes pose a considerable risk to Croatia, especially given the number of buildings in city centers that were constructed prior to modern building codes. Until 1964, buildings were constructed with no consideration for seismic shaking – and about one-third of the existing building stock dates from this period. Despite introducing a seismic code in 1964, a code that has been progressively upgraded and which currently meets the standard of the modern Eurocode 8 (EC8), Croatia has fallen short in the comprehensive implementation and enforcement of the codes, leaving the physical infrastructure seismically vulnerable. Bearing in mind that close to 70% of buildings were designed without applying any seismic code until 1964, followed by a period of early application of the seismic code until 1981, an accurate survey is planned to determine the earthquake risk for the City of Zagreb as part of which a register of buildings will be made providing all the necessary data for a reliable risk assessment. The results of the risk assessment should create the baseline for the future strategic planning in construction development.

Flooding threatens more than 15 percent of the country's inland territory[7]- home to 31% of the population and 26% of its GDP.[8] According to World Bank figures, floods on average cause damage to the value of about 19.8 million EUR a year.[9] In 2014, flooding resulted in three deaths and affected over 9,000 people. Croatia's coastal zone is subject to storms, cyclones, and intense winds. Inland, Croatia is also exposed to storms that frequently bring hail, wind, and heavy rainfall, which can cause flooding in Zagreb and other densely inhabited areas. In its mountain zone, Croatia is subject to severe snowstorms. Drought damage is highest in the Mediterranean and Eastern parts of Croatia.[10] In 2003, droughts caused damage estimated at 300 million USD; severe droughts also occurred in 2012.

5 Disaster Risk Assessment for the Republic of Croatia, https://civilna-zastita.gov.hr/UserDocsImages/DOKUMENTI_PREBACIVANJE/PLANSKI%20DOKUMENTI%20I%20UREDBE/Procjena%20rizika%20od%20katastrofa%20za%20RH.pdf.

6 UNDP (United Nations Development Programme). 2016. *Risk-Proofing the Western Balkans: Empowering People to Prevent Disasters*. Human Development Report.

7 Croatian Crisis Management Association, http://hukm.hr/wp-content/uploads/2017/10/EMSN039-Final_Report.pdf.

8 UNDP. 2016. *Risk-Proofing the Western Balkans: Empowering People to Prevent Disasters.* Human Development Report 2016.

9 World Bank, ISDR (International Strategy for Disaster Reduction), WMO (World Meteorological Organization), and Finnish Meteorological Institute. 2008. "Strengthening Hydrometeorological Services in South Eastern Europe: South Eastern Europe Disaster Risk Mitigation and Adaptation Programme."

10 World Meteorological Organization, et al. 2012. "Meteorological, Hydrological and Climate Services to Support Disaster Risk Reduction and Early Warning Systems in Croatia." Chapter 4 in *Strengthening Multi-Hazard Early Warning Systems and Risk Assessment in the Western Balkans and Turkey: Assessment of Capacities, Gaps and Needs*. Geneva: World Meteorological Organization, Regional Office for Europe, 2012.

Wildfires occur throughout Croatia during dry periods; in coastal areas they occur mainly during the summer. In addition to the 2017 wildfire season, which was particularly devastating, Croatia has seen significant wildfire damage over the last two decades. The wildfire of August 2007 destroyed more than 3,400 ha of vegetation in the Dubrovnik region, and caused monetary damage to firefighting equipment of over 140,000 EUR, making it one of the worst fires in Southeastern Europe in recent decades. Croatia is also exposed to extremes of both heat and cold. The 2019 heatwave brought temperatures in excess of 40°C. In 2000, a severe heatwave affected the Zagreb, Split, Osijek, and Rijeka areas of Croatia, resulting in 40 deaths and 200 cases of severe illness.[11] Extreme temperatures also affected Croatia in 2003 (788 deaths) and 2005 (5 deaths).[12]

Climate change in Croatia could significantly increase the frequency and severity of weather-related disasters, which occur more often than any other type of disaster in the country. All across Croatia, decreasing rainfall and rising average temperatures are predicted for the future. The increase in mean annual air temperature during the 20th century varied between 0.02°C per 10 years (Gospić) and 0.07°C per 10 years (Zagreb). The frequency of dry spells—that is, the number of consecutive dry days — has also risen in recent years. Of the 10 warmest years since the beginning of the 20th century, 7 were recorded after the year 2000, with 2016 being the warmest year ever. Dry spells contribute to the risk of wildfires, which in recent years have been particularly widespread along the Adriatic coast; in 2007 alone, for example 2,700 wildfires were reported. Increasing temperatures and declining rainfall also bring an increased risk of droughts, adding further to the risk of forest fires.

Seismic Profile of the City of Zagreb and the Surrounding Area

The Zagreb area is one of Croatia's most active seismic and tectonic zones. The epicentral area includes almost the whole of Mount Medvednica and the wider surrounding area of Zagreb. Since the earthquake in 1502 (thought to have measured around 5.0 on the Richter scale), Zagreb has been shaken by felt earthquakes (of magnitude greater than 2.0) more than 900 times. The earthquake of 2020 is thought to have been the third strongest in history; the strongest of all being that of 1880, with an estimated magnitude of 6.3 on the Richter scale, with the epicenter on Mount Medvednica. Other recent significant earthquakes in the wider region include those in Imotski in 1942 (6.3 on the Richter scale), Makarska in 1962 (6.1), Skopje in 1963 (6.1), Banja Luka in 1969 (6.0), Montenegro in 1979 (6.5 -7.0), Ston in 1996 (6.0), the Italian city of L'Aquila in 2009 (6.0) and Northwestern Albania in 2019 (6.4). See also Table 5 for a summary of the main historical events in the Zagreb area.

The epicenters of the strongest earthquakes have mostly been located on the north-western slopes of Mount Medvednica. Historically, the strongest earthquake with an estimated magnitude of 6.3 and an epicentral intensity of VIII °MCS occurred on November 9, 1880 at 7:34 AM (UTC). Often called the "Great Zagreb Earthquake", it resulted in material damage estimated at close to half of the annual state budget of the time. Out of 2,500 residential buildings (Zagreb had around 30,000 inhabitants at that time), around 1,400 were damaged or destroyed. There were two fatalities and 29 casualties.

Seismic hazard map for the return period of 475 years is shown in Figure 2, noting the City of Zagreb and its surrounding to be part of a seismically active zone. The structural and tectonic formation of the Medvednica mountain ridge with its faults, particularly the seismogenic zone of the North Medvednica Fault and Kašina Fault, is the major historical cause for earthquakes in the Zagreb area.

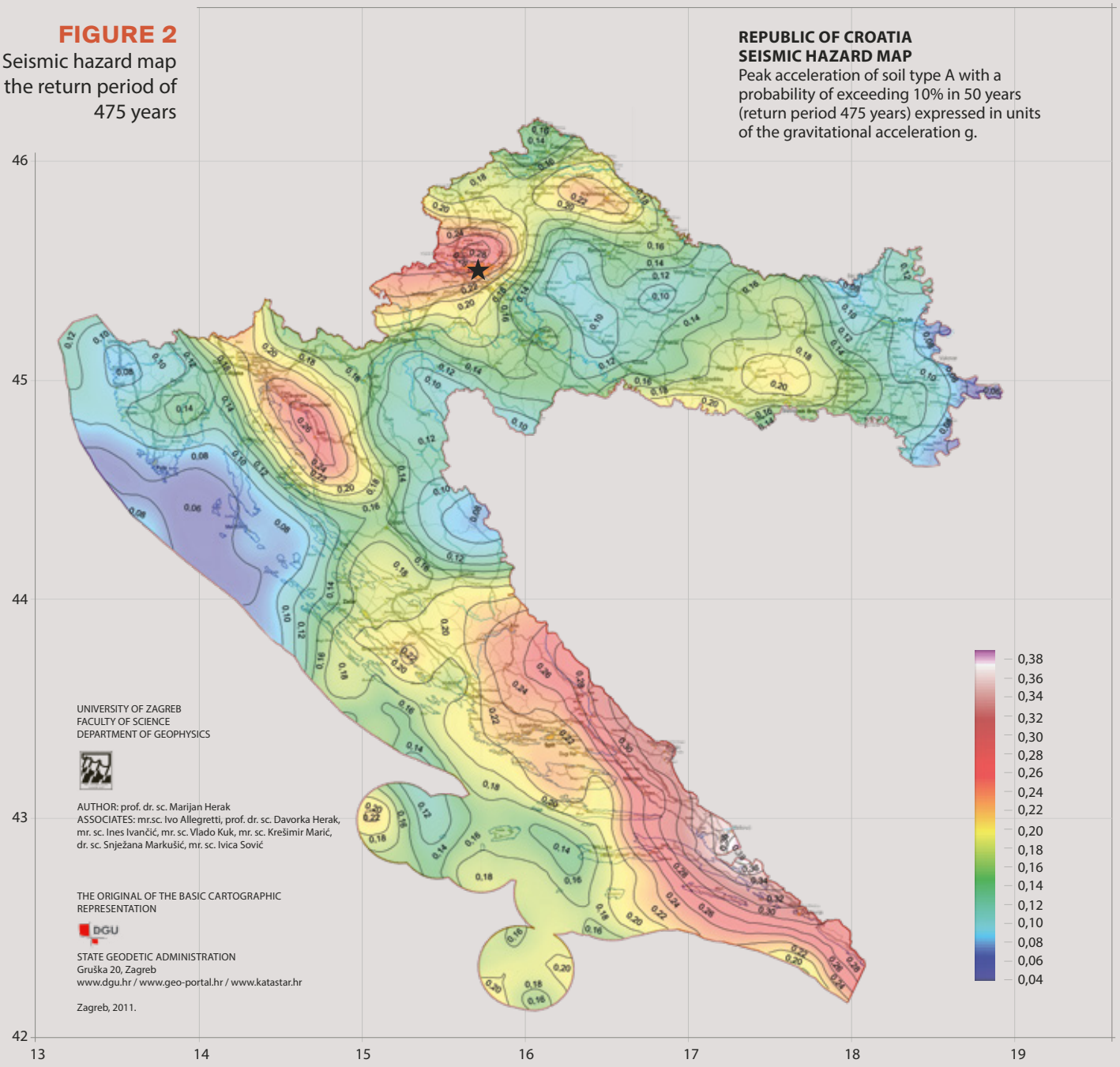
11 UNDP. 2016. *Risk-Proofing the Western Balkans: Empowering People to Prevent Disasters.* Human Development Report.

12 European Commission. "Croatia—List of Emergencies; Vademecum—Civil Protection." https://ec.europa.eu/echo/files/civil_protection/vademecum/hr/2-hr-6.html.

TABLE 5
Major earthquakes in the Zagreb area – historical overview of key events

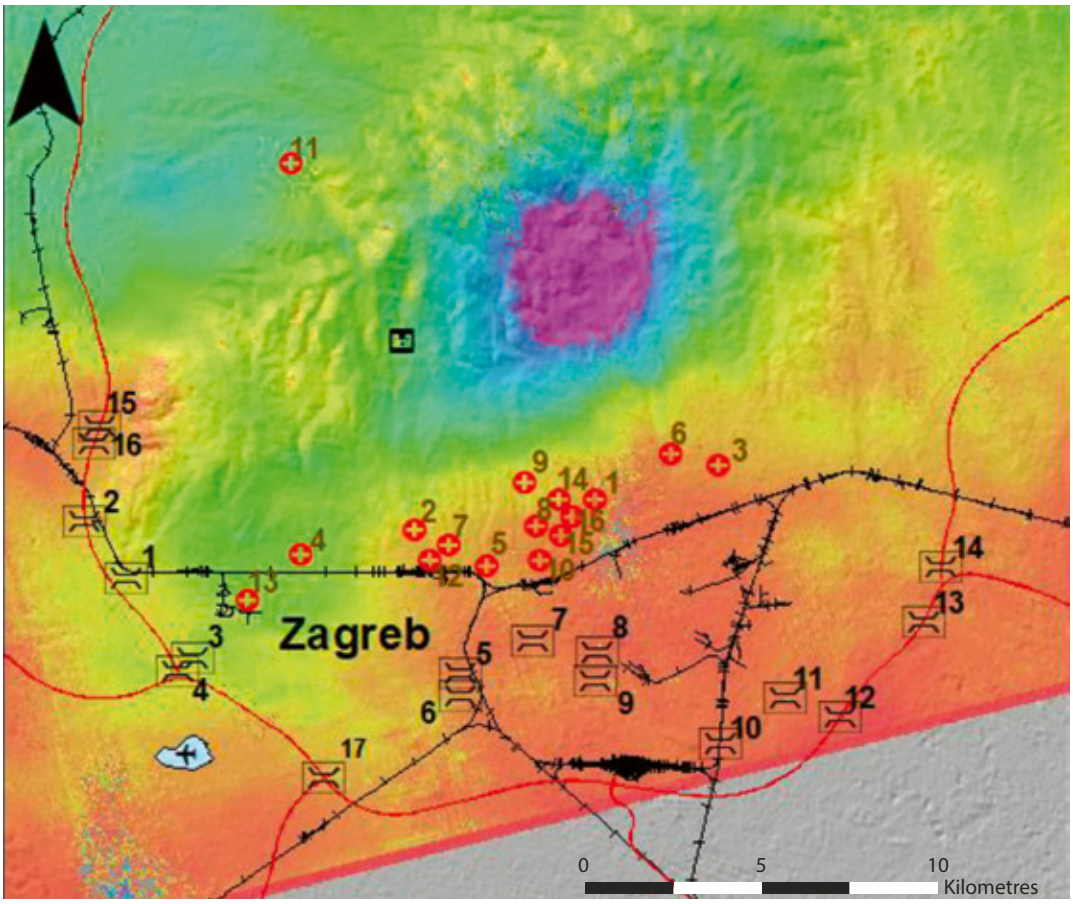
Date	Epicenter (in relation to city center)	Depth (km)	Magnitude (Mw)	Intensity (MCS)
November 9, 1880	estimated at app 12 km NE	N/A	6.3	VIII
December 17, 1901	estimated at app 12 km NE	N/A	4.6	VII
December 17, 1905	estimated at app 12 km NE	N/A	5.6	VII-VIII
January 2, 1906	estimated at app 12 km NE	N/A	6.1	VIII
September 3, 1990	10 km north-north-west	13	4.7	VII
March 22, 2020	7 km north-north-east	8	5.5	VII-VIII

FIGURE 2
Seismic hazard map for the return period of 475 years



Source: Faculty of Science, Department of Geophysics: Seismic hazard maps of Croatia, http://seizkarta.gfz.hr/.
Notes: Zagreb is marked with a black star.

FIGURE 3
Territorial distribution of surface level deformations in the City of Zagreb



Source: A geospatial intelligence application to support post-disaster inspections based on local exposure information and on co-seismic DInSAR results. The case of the Zagreb (Croatia) earthquake 22/03/2020. http://www.pmf.unizg.hr/_news/48356/Zagreb-A-geospatial-intelligence-application_Parcharidis_Issaak.pdf

Geophysical data point out that on March 22, 2020 the sudden movement of a large reverse fault released a huge amount of energy in the earthquake epicenter, at a depth of approximately 8 km, which was manifested at the surface and as a result triggered the Zagreb earthquake.

Figure 3 shows the observed surface deformation due to the Zagreb earthquake (with inclusive critical infrastructure) based on Sentinel-1 satellite imagery. The interferogram shows a surface level deformation on the basis of pre- and post-earthquake satellite images. Noting that the length of this seismogenic zone is approximately 20 km with a depth of 12 km, its seismogenic prospect is estimated at an earthquake potential of a maximum of 6.5 on the Richter scale. Besides that, it is clear that earthquakes of 5 Mw (moment magnitude) and above are to be expected in the wider Zagreb area, which means that these faults should be continuously monitored and analyzed. Most importantly, locations of future building construction sites should be selected to ensure that they would be able to withstand any 6.5 Mw earthquakes in the future.

Although earthquakes cannot be predicted, the risk of earthquake can be assessed for a given area, thereby allowing for risk reduction and disaster planning. Following the devastating earthquake in Skopje in 1963, anti-seismic features were introduced. Unlike reinforced concrete, classic masonry has little resistance to seismic tremors, and buildings of historic importance are often highly earthquake-prone as a result.

THE SOCIOECONOMIC CONTEXT OF ZAGREB AND THE SURROUNDING COUNTIES

The area affected by the earthquake – comprising the City of Zagreb, Zagreb County and Krapina-Zagorje County - have a combined population of 1,239,333 which accounts for 30% of Croatia's population. Economically speaking it is one of the most developed parts of the country, boasting a high concentration of entrepreneurs and entrepreneurial profits. Zagreb is the capital of Croatia and its largest city. According to the 2018 estimates, it is home to 804,507 inhabitants, or 19.7% of Croatia's population. It is also the economic, political, and cultural center of the country, generating 34.1% of its gross domestic product (GDP). Zagreb's historic center is an important economic asset, serving as a key tourist attraction in a country where tourism represents 20% of GDP. Zagreb County is a region with great investment potential and one of the fastest-growing regional economies in Croatia. Krapina-Zagorje County occupies an important place in communications due to the international highway that passes through the county. The economy is mostly export-oriented and has a positive balance in foreign trade. The basis of the county's economy is the processing industry, which accounts for almost half of total revenue and employs nearly half of all employees.

TABLE 6
Select socio-economic indicators for the City of Zagreb, Zagreb County, and Krapina-Zagorje County

Indicator	Value	Share in the Republic of Croatia (%)
City of Zagreb		
Population (2018)	804,507	19.7
GDP (2017) in m EUR	16,758	34.1
GDP (2017) p/c, in EUR	20,850	Index (Croatia=100) 175.3
Average monthly net salary (2017) in EUR	937	Index (Croatia=100) 117.1
Unemployment rate (March 31, 2018)	4.7 %	
Zagreb County		
Population (2018)	309,469	7.6
GDP (2017) in m EUR	2,820	5.7
GDP (2017) p/c, in EUR	9,042	Index (Croatia=100) 76.0
Average monthly net salary (2017) in EUR	788	Index (Croatia=100) 98.4
Unemployment rate (March 31, 2018)	8.0 %	
Krapina-Zagorje County		
Population (2018)	125,357	3.1
GDP (2017) in m EUR	0.981	2.0
GDP (2017) p/c, in EUR	7,764	Index (Croatia=100) 65.3
Average monthly net salary (2017) in EUR	681	Index (Croatia=100) 85.1
Unemployment rate (31 March 2018)	8.1 %	

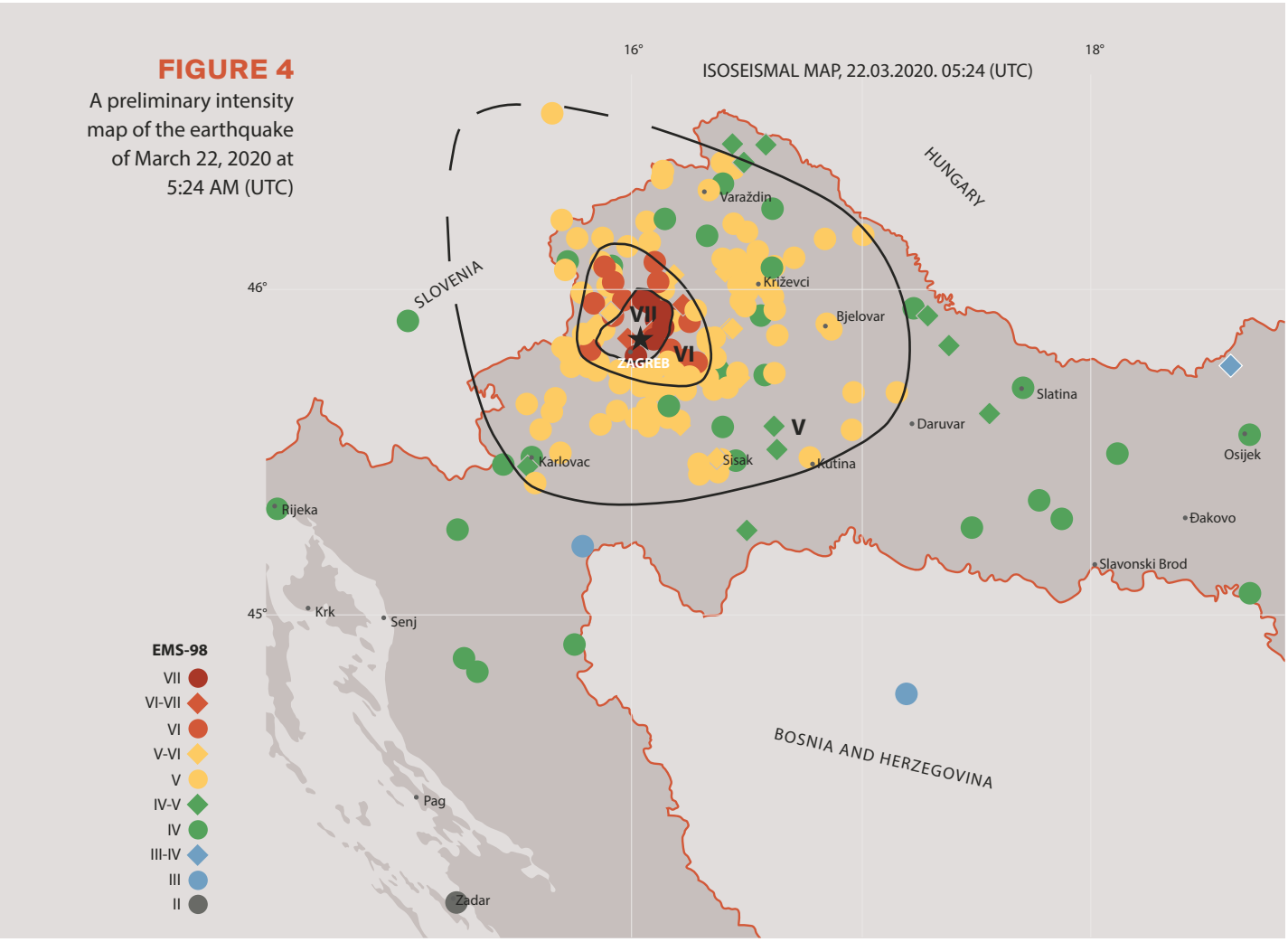
Source: Croatian Bureau of Statistics

DESCRIPTION OF THE 2020 ZAGREB EARTHQUAKE

On March 22, 2020, Zagreb was hit by the strongest earthquake since 1880, severely damaging public buildings and services, as well as the economy of Zagreb, the surrounding area, and the country at large. The earthquake resulted in one fatality, 26 injuries, and the displacement of hundreds of people. The earthquake took place in the context of the COVID-19 outbreak while the country was in a total lockdown because of the pandemic.

The earthquake measured 5.5 on the Richter scale, with a shallow focal depth of 8 km. It occurred at 06:24 local time on Sunday, March 22, 2020 and hit the Croatian capital Zagreb as well as two neighboring counties, namely Zagreb County and Krapina-Zagorje County. A large VII-VIII MCS scale magnitude intensity was observed in the earthquake epicentral area just 7 km north of the center of Zagreb, a city with a population of close to one million. The earthquake was felt throughout Croatia (Figure 4), as well as the neighboring countries of Slovenia, Bosnia and Herzegovina and Hungary.

FIGURE 4
A preliminary intensity map of the earthquake of March 22, 2020 at 5:24 AM (UTC)

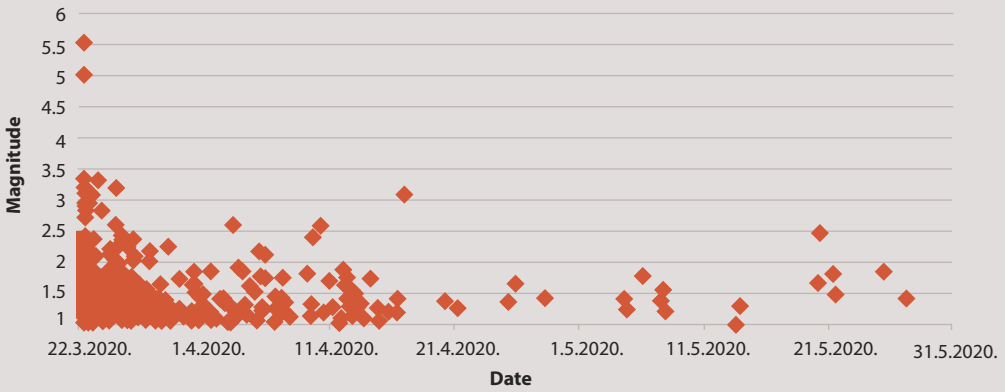


Source: Croatian Seismological Survey of the Geophysics Department - Faculty of Science, University of Zagreb. Notes: with the epicenter 7 km north of Zagreb city center (marked with a star).

From March 22 to May 31, seismographs recorded about 1600 tremors, of which 614 measured above 1.0 magnitude (Figure 5). The most significant of these tremors occurred just 37 minutes after the initial earthquake, had a very similar epicenter, and had an intensity of 5.0 Mw.

FIGURE 5

Temporal succession of earthquakes with magnitudes above 1.0 that occurred in the period from March 22 to May 31, 2020 in the Zagreb area



Source: Croatian Seismological Survey of the Geophysics Department - Faculty of Science, University of Zagreb.

Earthquake impacts

The earthquake resulted in damage to buildings in the health, education, culture and cultural heritage, business and housing sectors, whilst primarily impacting historic buildings in Zagreb's city center. The most substantial damage was sustained in the areas built prior to the widespread use of reinforced concrete. Almost all buildings built between the 1880 earthquake and the mid-20th century were made of bricks, without reinforced concrete elements. As buildings highly sensitive to seismic effects, they are rated in vulnerability class B according to the EMS scale.

As a result, the brick structures with wooden floors of Zagreb's historic center were seriously affected by the earthquake. Many of them had aged heating systems, obsolete chimneys and gas boilers which were either damaged or destroyed during the earthquake. Many inhabitants of the affected buildings no longer had access to heating or hot water as a result. Typical damage to the older buildings in the city included cracked walls, falling roof tiles and collapsing gable walls. Some houses sustained transverse cracks in exterior walls, indicating degree 4 damage. All of this was due to the fact that these buildings did not have reinforced concrete elements and were therefore vulnerable to seismic activity.

The initial field assessment revealed a certain typology of structural damage. Firstly, the failure of the mechanical resistance and stability of non-structural elements (such as chimneys, decorative elements on facades, etc.), the collapse of which caused additional exterior or structural damage and also enabled water penetration. Secondly, the failure of the mechanical resistance and stability of the kind of structural elements that significantly endangered the stability of the building (gable walls, masonry columns, parts of walls between or under windows, vaults, ceilings, staircases, etc).These elements include damaged roofs, which often become unstable due to the collapse of individual load-bearing walls (which carried wooden beams). And thirdly, questionable mechanical resistance and stability of entire individual buildings.

Government Response

Immediate Disaster Response

Following the earthquake, Zagreb County declared a state of emergency in 34 of its local administrative units, while the Krapina-Zagorje County did the same for three of its local communities. The City of Zagreb also declared a state of emergency. At the time, the national civil protection headquarters was active in coordinating the response to the COVID-19 pandemic. In Zagreb, the Civil Protection Directorate State Intervention Unit organized and established a tent settlement with five hundred beds, established communication with the Emergency Response and Coordination Center (ERCC) and coordinated humanitarian aid as part of the Host Nation Support (HNS).

Local civil protection headquarters were responsible for the coordination of the immediate disaster response and recovery actions following the declaration of the state of emergency in the City of Zagreb and the local administration units of the two affected counties. Participants and operational forces defined in the Civil Protection System Act were activated in order to carry out rescue and recovery activities. Moreover, the climbing community, consisting of alpinists, rock climbers and speleologists, provided assistance on their own initiative, especially in securing roofs and chimneys to ensure immediate safety. In addition to the climbing community, more than 500 civil engineers volunteered to help in the assessment of damaged buildings using the available technical resources both provided by the City of Zagreb and their private equipment. During the immediate response intervention some of the technical resources and equipment were damaged, destroyed, run-down or decommissioned, with fuel and energy noted as additional costs in civil protection operations.[13] At the time of the RDNA data collection, a total of 45,459 meals (amounting to EUR 126,759) were already prepared and used by the people placed in organized accommodation. In addition to the above, humanitarian aid in the amount of EUR 262,164 has been distributed. The evacuation and rescue costs have not been estimated during the time of the RDNA assessment.

TABLE 7
Type and number of activated participants and hours spent until May 15, 2020

Operational forces	Personnel engaged	Hours spent
Civil protection	725	160,384
Fire department	17,716	15,567
Red Cross	1,034	132,790
Croatian Mountain Rescue Service	104	674
Citizens Volunteers-civil engineers	500	37,840
Utility providers	1,096	126,799
Private companies	9	62
Croatian Army	616	N/A
TOTAL	**21,800**	**474,116**

Source: Ministry of Interior

13 Currently estimated damage to the buildings in the system of Civil Protection is not significant however this could change following the detailed inspections.

City of Zagreb Crisis Immediate Response and the Initial Field Assessment

Immediately after the earthquake and the activation of civil protection services, a local civil protection headquarters was formed at the premises of the City of Zagreb's Emergency Management Office. The employees of the Faculty of Civil Engineering were immediately called upon by the Interior Ministry's Civil Protection Directorate and the City of Zagreb's Emergency Management Office to help organize the response system and join the crisis and operational headquarters. In cooperation with the Interior Ministry's Civil Protection Directorate, and with the help of the Croatian Chamber of Civil Engineers, a call was made for the mobilization of civil engineers. On the very first day, as many as 150 engineers stepped forward to volunteer in carrying out the preliminary damage assessments of buildings. Their number rose to over 500 in the coming days. The work was carried out in extremely difficult conditions, not just due to continuing aftershocks, but also because the country was under a severe lockdown due to the COVID-19 pandemic. Travel was not allowed across borders or outside one's place of residence, thereby limiting the ability of experts from other parts of Croatia or from other countries to join the volunteers.

The response consisted of, on the one hand, preliminary assessments of the buildings, and the setting up of a hotline and a web-based application for registering damaged buildings; and, on the other, of clearing the debris, damaged roofs and chimneys and other potential hazards to safety and ensuring accommodation and food for people whose homes were damaged in the earthquake. The initial post-earthquake damage and usability assessment survey form of buildings was developed according to Italian experiences [AeDES],[14] adapted to local circumstances. A simplified form was created on the ArcGIS Online geoinformation platform in the application Collector for ArcGIS, which continued to be used for collecting information on preliminary inspections from the field. The application proved to be a very practical tool, especially in light of the COVID-19 pandemic, as it made it possible to collate information on residents who were in self-isolation. Field visits were carried out in accordance with the rules regarding hygiene, distancing and protective measures adopted in response to the COVID-19 pandemic. In a matter of days an application in GIS system was programmed and set up enabling the input of data in a form which was later simplified. This information was made available to the fire department, which were then able to take emergency measures and remove debris, damaged chimneys and other safety hazards. The City of Zagreb provided equipment to experts.

In the first phase of inspections, buildings were rated according to the following categories (Table 8): **green** (usable: without limitations U1 or with a recommendation for short-term countermeasure U2), **yellow** (temporarily unusable and requiring a more detailed inspection PN1, or can become usable with suggested short-term countermeasures PN2), and **red** (unusable: due to external risks N1 or due to damage N2). The aim was to commence emergency risk mitigation measures as soon as possible, to reduce the danger of parts of damaged buildings collapsing onto other buildings, sidewalks or people; and to determine whether people needed to be temporarily re-housed. All civil engineers who carried out the inspections underwent brief training. Interested residents and civil engineers were able to access all necessary information on the website www.hcpi.hr, which was set up after the earthquake by volunteer civil engineers.

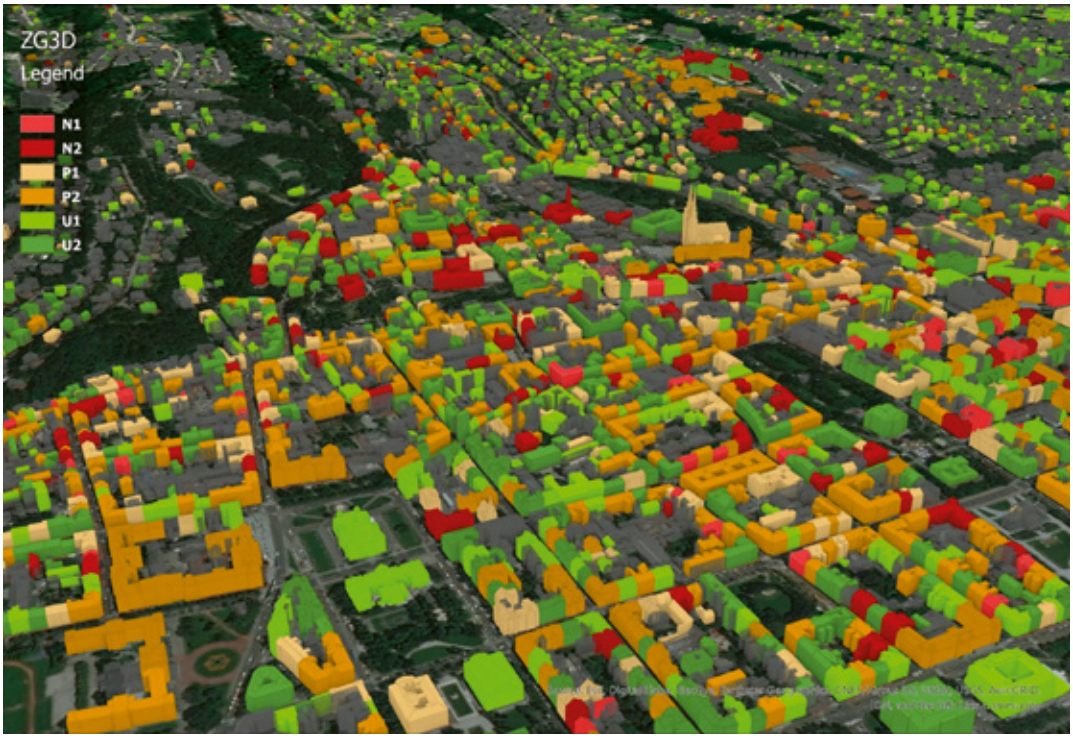
14 Post-Earthquake Damage and Safety Assessment and Short-Term Countermeasures Form

TABLE 8
Damage and building usability assessment levels

Damage states determined based on the conducted post-earthquake field surveys and the usability assessment	Level
Slight structural damage	
Moderate structural damage	
Heavy structural damage	

In the first month following the earthquake, i.e. by April 22, 2020, more than 13,000 buildings had been inspected, amounting to approximately 75% of all reported buildings. A 3D view of the lower and upper town of City of Zagreb buildings based on the usability classifications is presented in Figure 6. The status of inspected buildings could be monitored in real time on the website www.hcpi.hr. The work of civil engineers has been led by the Faculty of Civil Engineering in Zagreb, with support provided by others including the City of Zagreb's Emergency Management Office, the company GDi d.o.o., the Croatian Civil Engineers' Chamber, Zagreb City Office for Physical Planning, Construction, Utility Services and Transport, Zagreb City Office for Strategic Planning and Development, Croatian Association of Court Expert Witnesses and Valuers, Seismological Survey at the Department of Geophysics, Faculty of Science, University of Zagreb, the Interior Ministry's Civil Protection Directorate, the Ministry of Construction and Physical Planning, the Croatian Association of Crisis Management, the University of Zagreb's University Computing Center, and many experts from Split, Osijek, Rijeka and other parts of Croatia, as well as engineers from Serbia, Italy and Switzerland.

FIGURE 6
3D view of Lower and Upper Town of City of Zagreb buildings based on the usability classifications



Source: University of Zagreb Faculty of Civil Engineering.
Notes: 3D model of buildings represented by the usability classifications color (green, yellow, and red).

Photo: Saša Zinaja / NFOTO

BOX 1

City Heroes - Volunteers help Zagreb

Defying the coronavirus crisis, more than one hundred volunteers - many of whom were women – took to the roofs of Zagreb to help clear debris caused by collapsing chimneys and damaged tiles. Gathered under an initiative entitled "Alpinists, Speleologists and Climbers are Helping Zagreb", an ad-hoc volunteer army of climbers, cavers, window-cleaners, tree surgeons and even professional dancers was mobilized to help clear streets and stabilize rooftops.

Members of various mountaineering societies, climbing clubs and speleological associations were mobilized practically overnight thanks to an online platform enabling volunteers to sign up. The initiative spread quickly thanks to social media and word of mouth.

Relying mostly on their own equipment - ropes, harnesses and helmets – the volunteers helped secure loose or dangerous material in hundreds of cases. Mostly this involved debris from damaged chimneys hanging over densely populated city streets. Most volunteers were active in their free time, outside their regular working hours.

Football supporters' associations also mobilized their members to assist firefighters, the Civil Protection Service and other emergency crews, many of whom were too overwhelmed to respond to all calls for help. Soccer fans were particularly effective in helping to move patients and medical equipment from damaged hospitals.

"One for Another", a citizen's initiative set up just after the COVID-19 lockdown to assist the elderly, the disabled, and other vulnerable citizens with the delivery of food, medicine and other supplies, also rose to the challenge of the earthquake by helping elderly people living in seriously-damaged parts of the city center.

Several accounts have been set up to receive public donations for the post-earthquake recovery, most important of which is the government-supported project entitled "Together for Zagreb". In addition, several crowdfunding campaigns have been launched to finance specific volunteer projects, or to help individuals or groups who have been particularly affected by the earthquake.

Zagreb County Crisis Immediate Response
Due to extensive damage, Zagreb County declared a state of emergency but there was no need for rescue activities. Preliminary assessments of the safety of buildings were described in the previous chapter.

Krapina-Zagorje County Crisis Immediate Response
During the earthquake, Krapina Zagorje County sustained considerable damage and several people were lightly injured. Most of the activities were conducted by the firefighting department and emergency medical services. In the aftermath of the earthquake, 116 people were evacuated and 48 people were put in temporary shelters. Krapina-Zagorje County declared a state of emergency. Preliminary assessments of the safety of buildings were described in the previous chapter.

Disaster Response and Recovery Plan

The immediate response to the earthquake was led by the local authorities and there was no need to establish a crisis headquarters at the national level. The national government did however task the Ministry of Construction and Physical Planning with the coordination of the short, medium and long-term support. In parallel, the Ministry of Regional Development and EU Funds (MRDEUF) was tasked to prepare an application for the European Union Solidary Fund (EUSF), which was to be submitted within 12 weeks of the date of the first reported damage. The EUSF was set up to respond to major natural disasters and express European solidarity to disaster-stricken regions within Europe. Croatia has in the past benefited from the EUSF following the flooding in 2014.

The government also requested its development partners to support them in the preparation of needs assessment, thereby establishing the evidence base to set priorities for national reconstruction. The government allocated approximately 19 million EUR for the removal of damage that could endanger human life or health, including the repair and replacement of chimneys, gable walls, and elevators as well as the replacement of obsolete heating systems. In parallel, a draft Law on Reconstruction of Damaged Buildings in Zagreb and the Surrounding Area[15] has been drafted to regulate the approach to reconstruction. At the time of writing this report, the draft Law was undergoing a public consultation process open from May 15 to June 14, 2020. The Law was presented to the new Parliament in July and its approval is expected in September 2020. Based on initial field assessment, the Government is prioritizing the rehabilitation and reconstruction of damaged health and education facilities to ensure that the affected population regains access to critical health and education services, and so that critical activities related to public health preparedness can resume as quickly as possible.

Support from partners[16]

Following the activation of the European Union's Civil protection Mechanism (UCPM) and communication with the Emergency Response and Coordination Center (ERCC), several EU countries, including Austria, France, Hungary, Italy, Lithuania and Slovenia sent assistance in the form of tents, sleeping bags, electric heaters, folding beds, and similar equipment. In addition, the EU's Copernicus satellite program helped map the affected area. Many other countries including Bosnia and Herze-

15 https://esavjetovanja.gov.hr/ECon/MainScreen?entityId=14176; https://mgipu.gov.hr/vijesti/prijedlog-zakona-o-obnovi-upucen-u-saborsku-proceduru/10934

16 The list of partners reflects the information gathereted at the time of writing the report and by no means gives a total account of all partners who have stepped forward to offer assistance to the country. The information was provided by the Ministry of Construction and Physical Planning, the Ministry of Foreign and European Affairs, the Ministry of Interior, and the Ministry of Finance.

govina, China, Germany, Japan, Korea, Montenegro, Norway, North Macedonia, Slovakia, the State of Bavaria, and the USA provided or offered earthquake response assistance. Moreover, many cities and towns, NGOs, embassies, companies and individuals from Croatia and abroad (including the Croatian diaspora) sent their donations. Numerous countries expressed solidarity with Croatia.

The World Bank, which is supporting the Croatian government with various projects aimed at addressing the multifaceted emergency caused by global pandemic, economic recession and the earthquake, offered technical assistance for the RDNA. Additionally, the Earthquake Recovery and Public Health Preparedness Project supports the recovery and reconstruction of the priority sectors of health and education, including public health surveillance and preparedness. Other international financial institutions (IFIs) have expressed their interest in financing reconstruction.

The United Nations International Children's Emergency Fund (UNICEF), the United Nations High Commissioner for Refugees (UNHCR), the Organization for Security and Co-operation in Europe (OSCE) and the World Meteorological Organization (WMO) expressed solidarity and readiness to provide assistance.

Photo: Damjan Tadić / CROPIX

ASSESSMENT OBJECTIVES AND METHODOLOGY

The objective of the RDNA is to assist the government of Croatia in assessing the impact of the earthquake by estimating the financial cost of damage and loss in order to inform recovery investment planning. Specific objectives of the RDNA include (i) to estimate the sector specific and overall multi-sectoral effect of the earthquake in the affected area - namely the City of Zagreb, Zagreb County and Krapina-Zagorje County; (ii) to estimate multi-sectoral effects of the disaster; and (iii) to identify early, medium and long-term recovery and reconstruction needs, including reflected costs and timeline, and taking into consideration seismic safety, build back better (BBB)[17] and disaster risk reduction (DRR) concepts.

The assessment methodology is based on the damage and losses assessment (DaLA) guidelines,[18] with the objective of assessing disaster effects (based on the quantification of damage and losses) and disaster impacts and identifying recovery needs. Annex 1 provides further information about the methodology.

- **Damage** is estimated in terms of the replacement value of both public- and private-domain physical assets damaged or destroyed.
- **Losses** are estimated based on the changes in economic flows resulting from the temporary absence of the damaged assets or disruption to access to goods and services in terms of reduced revenue; higher operational costs; and actions taken to reduce risk.
- **Disaster's impacts** on economic performance are calculated based on the cross-sectoral damage and losses, and human development impacts are assessed.
- **Needs for recovery** are based on losses in terms of recuperation of economic and human needs, livelihoods, access to services, means of production, security, and so forth. Needs take into account BBB and DRR to reduce vulnerabilities and build resilience.

The RDNA was led by the Government of Croatia and conducted by a multidisciplinary team, comprising officials and experts from the government, the University of Zagreb Faculty of Civil Engineering, and the World Bank. Sectoral teams collected pre-disaster (baseline) data to compare with post-disaster conditions, evaluated the disaster effects and impacts in each sector, and identified prioritized recovery needs. The methodology underpins a consistent application of the basic concepts of damage, losses and post-disaster recovery needs across all the respective sectors. Baseline data provided by the Croatian Bureau of Statistics and other sources were used as a benchmark to guide the assessment of change in flows across major economic sectors. The sector teams used standardized damage and loss data[19] collected and analyzed by Zagreb University's Faculty of Civil Engineering as part of the preliminary damage assessment. Costs related to damage to furniture, equipment and goods[20] were also accounted for, whereas losses are calculated in regards to the costs of debris removal. Other available data was also taken into consideration (particularly in terms of baseline data) to provide realistic and credible estimates. Besides damage and losses, the sector teams identified recovery needs[21] for each sector and provided recommendations for increased resilience in their respective sector.

17 Build back better (BBB) is a reconstruction approach that seeks to reduce vulnerability and improve living conditions while promoting more effective and sustainable reconstruction. It takes the opportunity of having to rebuild following a disaster event to examine the suitability and sustainability of reconstruction activities.

18 European Commission, the United National Development Group, and World Bank, 2013 Post-Disaster Needs Assessments Guidelines, http://www.undp.org/content/dam/undp/library/Environment%20and%20Energy/Climate%20Strategies/PDNA%20Volume%20A%20FINAL%2012th%20Review_March%202015.pdf.

19 Potential exceptions to this approach might be explored in the culture and cultural heritage sector which needs to be additionally discussed.

20 Only in the education, health and culture and cultural heritage sectors with potentiall inclusion in the business sector (pending discussion and introduction of relevant Ministry in the RDNA process) whereas in the housing sector those costs will not be included due to time related limitations.

21 As a combination of hard reconstruction and soft recovery measures.

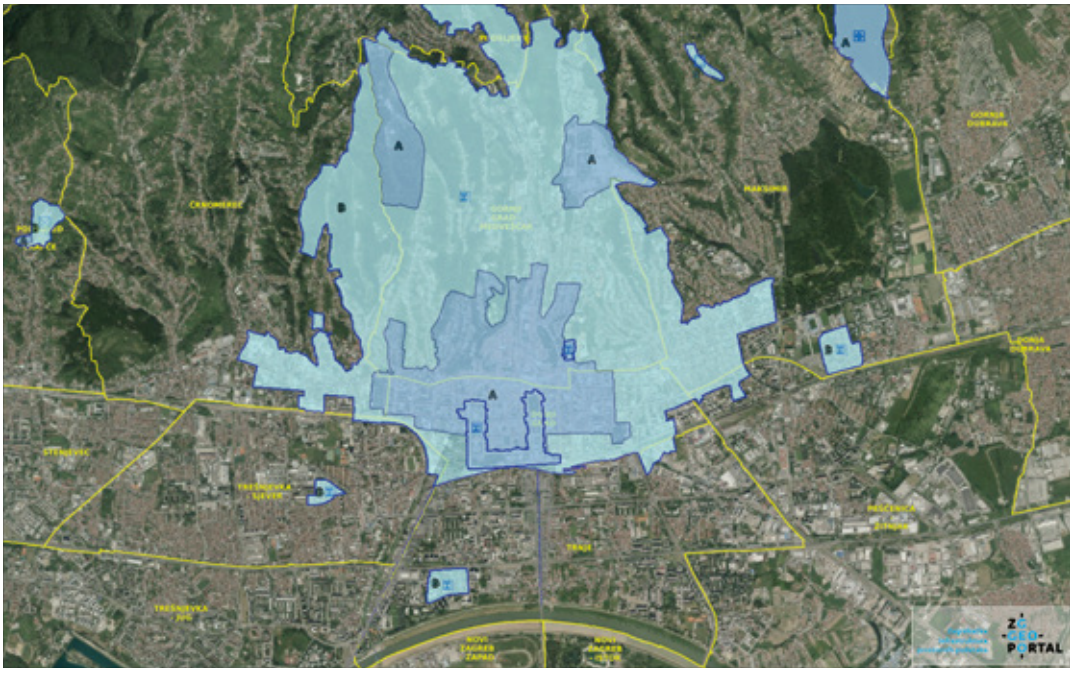
Specific context

The RDNA set out to analyze the extent of earthquake damage both by geographical area and by sector of activity (housing, health, education, business, culture and cultural heritage, civil protection and DR). The geographical area hardest hit by the earthquake was the historic urban complex of central Zagreb, where many buildings listed as protected cultural heritage suffered serious damage. Bearing in mind that many historical buildings are also hospitals, schools, business premises or housing stock, the damage to heritage buildings affects all the sectors listed above. Indeed it is this that makes the rehabilitation and reconstruction process so complex and challenging.

BOX 2
Zagreb's historical urban complex

Zagreb's historical urban complex is a protected area regulated by the Law on the Protection and Preservation of Cultural Heritage. The area is divided into two zones, Zone A and Zone B. Zone A encompasses the oldest and architecturally most valuable parts of Zagreb, and includes the Upper Town (Gornji grad), the Kaptol district and the Lower Town (Donji grad). All three areas contain buildings of exceptional architectural and historical value, and are characterized by densely constructed blocks of buildings made from stone, bricks or a combination of materials. Most buildings consist of massive longitudinal and perpendicular walls as well as masonry ceilings, wooden beams and trusses. Many hospitals, schools, business premises, residential and government buildings, cultural institutions, monuments, churches and chapels are situated in Zone A, and are protected either as part of the historical urban complex or as individual heritage buildings in their own right. A total of 72% of buildings in Zone A have suffered earthquake damage; indeed the damage suffered by this area is almost proportional to its cultural heritage value. Zone B comprises the remaining part of Zagreb's historical urban space, an area built predominantly in the first half of the 20th century. It consists of diverse urban patterns, and a large number of extremely valuable buildings. A total of 40% of buildings in Zone B have been damaged.

FIGURE 7
Zagreb's protected Zones A and B



Source: ZG Geoportal – Zagreb Spatial Data Infrastructure Geoportal

This RDNA assessment was completed in the weeks subsequent to the earthquake, in the midst of the COVID-19 outbreak, and it reports only on data received at the time of writing. The team undertook this rapid assessment between April 20 and June 5, 2020. Estimates are based on information collected by the team during field surveys, which complemented information provided by the line ministries and local authorities.

RDNA facts & figures

55 persons from 12 entities
directly involved in RDNA report preparation

More than
21,000 persons
involved in rescue and clean-up operations

Reported to have sustained damage

24,000
dwellings

214
health facilities

513
education facilities

192
cultural institutions

13
public government heritage buildings

159
religious buildings

2,104
economic operators

More than
22 million sqm
damaged area

SECTORS
Damage, Losses, and Needs

Photo: Anto Magzan

ZAGREB EARTHQUAKE
M 5.5, 7 km north of Zagreb, Croatia
Origin Time: 22.03.2020 05:24:03 UTC (Sun 06:24:03 local)
Depth: 8 km

SECTORS:
Damage, Losses, and Needs

RDNA TEAM / COORDINATION BODY

WORKING GROUP	SECTOR LEADS	CONTRIBUTING INSTITUTION/AGENCY/ ENTITY
Housing	Ministry of Construction and Physical Planning	City of Zagreb, Krapina-Zagorje County, Zagreb County, Faculty of Civil Engineering, University of Zagreb, the World Bank
Education	Ministry of Science and Education	Ministry of Construction and Physical Planning, City of Zagreb, Krapina-Zagorje County, Zagreb County, Faculty of Civil Engineering, University of Zagreb, the World Bank
Health	Ministry of Health	Ministry of Construction and Physical Planning, City of Zagreb, Krapina-Zagorje County, Zagreb County, Faculty of Civil Engineering, University of Zagreb, the World Bank
Culture and Cultural Heritage	Ministry of Culture	Ministry of Construction and Physical Planning, City of Zagreb, Krapina-Zagorje County, Zagreb County, Faculty of Civil Engineering, University of Zagreb, the World Bank
Business	Ministry of Economy, Entrepreneurship and Crafts	Ministry of Construction and Physical Planning, City of Zagreb, Krapina-Zagorje County, Zagreb County, Faculty of Civil Engineering, University of Zagreb, the World Bank
Macroeconomic	Ministry of Finance	The World Bank
Disaster Risk Reduction	Ministry of Interior	City of Zagreb, Krapina-Zagorje County, Zagreb County, the World Bank

Photo: Željko Puhovski / CROPIX

HOUSING

Background

With a total population of 1.23 million people, the three administrative areas affected by the earthquake - the City of Zagreb, Zagreb County and Krapina-Zagorje County - account for almost 30% of the overall population of Croatia.[22] A total of 586,069 housing units (houses, flats and other dwellings) are registered in the affected area, of which two thirds are located in the City of Zagreb. These two thirds, or 384,333 housing units, are located in 136,605 individual buildings.

The City of Zagreb is very densely populated, with an average of 264 inhabitants per square kilometer. Some areas of the city have a population density of up to 1,000 inhabitants per square kilometer due to a high concentration of apartment blocks. The historical center of the city is characterized by residential buildings which, although mostly privately owned, are protected as cultural heritage. The most common category of dwelling in the suburban areas of the City of Zagreb, in Krapina-Zagorje County and in Zagreb County is the family house. Single-family houses in these areas do not usually exceed two floors, whereas collective residential buildings mostly have a maximum of six residential floors – although a significant number of apartment blocks are higher.

Throughout the city's history a range of different construction techniques have been used, and different types of buildings have different levels of seismic resistance. Until 1920, buildings were usually masonry structures with timber floors and timber-framed roofs, whereas reinforced concrete ceilings were gradually applied from the 1920s to the 1940s. Between 1945 and 1964, rein-

22 According to the 2011 Census of Population, Households and Dwellings in Croatia, https://www.dzs.hr/Eng/censuses/census2011/censuslogo.htm.

FIGURE 8
Residential building stock in the earthquake affected area

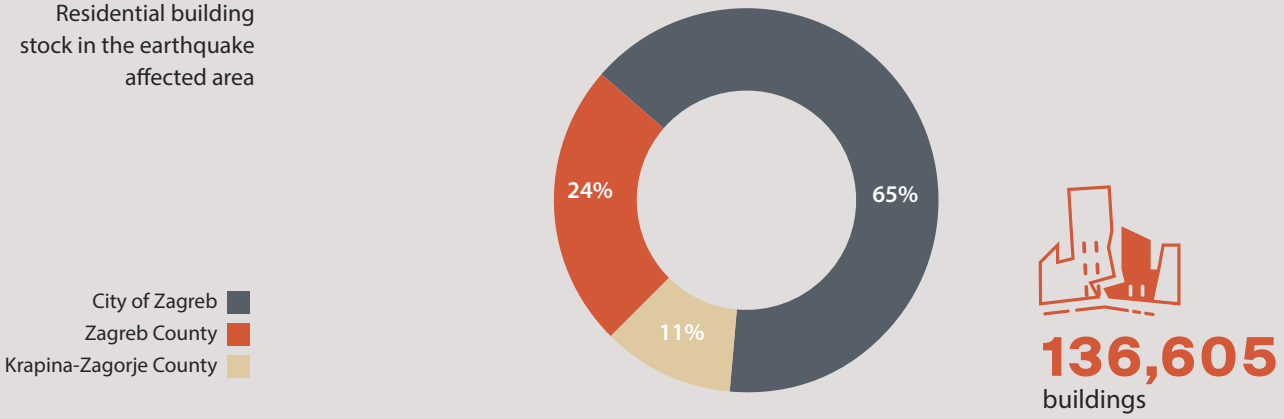
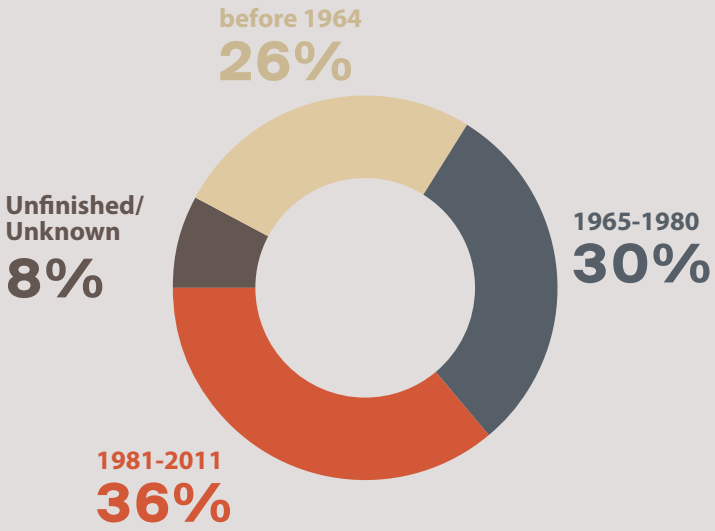


FIGURE 9
Distribution of housing units by year of construction



forced concrete ceilings prevailed. After 1964, when the first seismic codes were introduced, masonry buildings were systematically constructed with horizontal and vertical confining elements. From 1964 (and with a further modernization of seismic regulations in 1981), reinforced concrete load-bearing systems were used.

From 2007, ENV[23] norms (and as of 2013 structural Eurocodes) have been employed. However, every fourth residential building in the three affected areas was built before any seismic codes were introduced, has no confining or reinforcing elements, and, as a result, is extremely seismically vulnerable.

23 ENV Eurocode - Version of Eurocode published by CEN as a pre-Standard ENV (for subsequent conversion into EN).

Effects of the Disaster (Damage and Losses)

Accounting for the largest number of buildings, housing was the sector most affected by the earthquake. According to data collected until June 1, 2020, a total of 22,723 buildings were categorized as earthquake damaged. With assessment still ongoing, the estimated total of damaged buildings currently stands at 24,000.

Buildings were categorized in three groups according to the level of damage: "usable" (green), "temporarily unusable" (yellow) and "not usable" (red). The number of buildings categorized as damaged per area is shown in the table below. Strikingly, more than 18 million square meters of residential buildings were recorded as having sustained some level of earthquake damage.

TABLE 9
Number of damaged buildings and surface area affected in the housing sector

Counties	Number of damaged buildings						Total	Total damaged area in square meters
	Public			Private				
City of Zagreb	68	18	5	17,098	4,454	1,168	22,811	17,918,707
Zagreb County	17	1	1	371	25	30	445	132,121
Krapina-Zagorje County	7	1	1	596	101	38	744	106,208
TOTAL	**92**	**20**	**7**	**18,065**	**4,580**	**1,236**	**24,000**	**18,157,036**

The number of heavily damaged or totally destroyed buildings categorized as unusable stands at 1,243 (5.18%). Another 4,600 (19.17%) buildings experienced severe to moderate damage and were categorized as temporarily unusable, while 18,157 (75.66%) lightly damaged buildings were characterized as usable. The earthquake affected about 17% of the City of Zagreb's building stock (22,811 damaged buildings in a total of 136,605) with every 6th residential buildings in the city sustaining some seismic damage.

The total cost of the effects of the earthquake on residential buildings is estimated at 7,246 million EUR, with the total damage amounting to 6,881 million EUR (Table 10), and total losses estimated at 364 million EUR (Table 11).

Much of the damage to masonry buildings was compounded by a lack of maintenance and reconstruction works carried out without taking into consideration seismic regulations, such as the lack of integrity between different structural units, the lack of vertical confining elements, and the inherent weakness of many of the materials used. Significant damage to family houses also occurred due to inadequate seismic design and inadequate construction works. The assessment has also found that

TABLE 10
Total damage in the housing sector (in million EUR)

Counties	Damage		
	Public	Private	Total
City of Zagreb	24.55	6,775.25	6,799.80
Zagreb County	1.65	36.93	38.59
Krapina-Zagorje County	1.17	41.67	42.84
TOTAL	**27.38**	**6,853.85**	**6,881.23**

TABLE 11
Total losses in the housing sector (in million EUR)

Counties	Losses		
	Public	Private	Total
City of Zagreb	0.31	359.23	359.54
Zagreb County	0.006	2.08	2.09
Krapina-Zagorje County	0.005	2.73	2.73
TOTAL	**0.32**	**364.04**	**364.36**

there are two cadasters (one with the City of Zagreb and the other with the State Geodetic Administration) alongside the issue of low percentage of risk insured properties and risk transfer policies which are, *inter alia*, issues to be considered when developing the post-earthquake recovery strategy.

The recorded losses are comprised of costs arising from the temporary sheltering of 488 people,[24] and the estimated 30,000 people temporarily displaced during the reconstruction of their dwellings. Other estimated losses are related to the process of demolition and debris clearance which was necessary due to a large number of damaged chimneys and gable walls.

Disaster Impact on the Affected Population

The fact that the earthquake affected so many square meters of residential space has drawn particular attention to some of the underlying factors responsible for the vulnerability of the housing stock. Besides the fact that a large number of central buildings were constructed before the adoption of seismic codes, housing units were rendered additionally vulnerable due to factors such as the use of unreinforced masonry, unauthorized adaptation of ground-floor space for commercial activities, adding of floors to buildings, removal of load-bearing components, and other structural modifications. Another issue is the question of ownership (less than 0.4% of residential stock is public, whereas the rest is privately owned), and the lack of adequate maintenance and repair. In addition, many family houses in the affected area were built without legal permits, using unqualified labor. This leads to a conclusion that there is a general lack of understanding among local communities of seismic risk, coupled with a lack of initiatives aimed at raising awareness of damage-control strategies.

The existing seismic design code does adequately address an earthquake event of such magnitude. From a regulatory perspective, therefore, there is no urgent need to review the existing legislation. The effects of the earthquake on the housing sector will nevertheless have a significant impact on the government budget, as the damage to the housing sector alone is greater than the damage to all other sectors put together.

In addition, damage to residential buildings and concerns about their structural safety have led to the displacement of affected families, thereby causing additional losses. Since the earthquake, a total of 488 people has been accommodated in student dormitories, and a much larger number of residents have gone to stay with families or friends (the total number of displaced people is unknown, but is estimated at around 30,000). During the phase of immediate response, a tent settlement with a capacity of 500 beds was established one day after the earthquake. Moreover, shortly after the earthquake, the Croatian government and local authorities began providing rental subsidies for those who were forced to seek temporary accommodation during the reconstruction or rehabilitation of their homes.

24 Displacement costs for persons currently accommodated with friends, relatives or in other dwellings are not accounted for.

Recovery and Reconstruction Needs

Based on damage and losses, overall recovery and reconstruction needs are estimated at 9,128 million EUR over a short-, medium- and long-term period. The majority are reconstruction needs. The primary aim is to carry out reconstruction in the shortest possible time, thereby reducing the displacement period for those who have had to leave their homes. Throughout the displacement period, special attention will be paid to vulnerable groups such as children, women, the elderly, the poor, and people with disabilities.

TABLE 12
Recovery needs in the housing sector (in million EUR)

	Short-term	Medium-term	Long-term	Total
Reconstruction	2,720.71	4,081.07	2,267.26	9,069.04
Recovery	18.00	21.00	20.00	59.00
TOTAL	**2,738.71**	**4,102.07**	**2,287,26**	**9,128.04**

A total of 562,048 square meters will need to be rebuilt completely, while 17,594,988 square meters will need to be rehabilitated due to light or moderate earthquake damage. The reconstruction process should adhere to the principles of build back better (BBB) and energy efficiency (EE). The overall vision of recovery will emphasize the use of sustainable and environmentally-friendly materials, taking due note of the circular economy and climate change. The reconstruction process will also seek to bring benefits to the entire community, especially in the mitigation of future disasters through seismically-resistant retrofitting and construction. The process will also serve to strengthen the local economy through the initiation of reconstruction works, and the support of affected businesses.

An additional concern is that a significant number of residential buildings fall within the conservation area of the City of Zagreb because they are located in the protected historical urban complex or are designated as individually protected buildings. The reconstruction therefore requires an interdisciplinary approach and the application of suitable methodologies based on conservation principles and practices. This significantly affects the total estimated recovery cost and it will have an impact on the timeframe of reconstruction.

The overall vision of recovery also includes measures and activities targeting additional education and training on seismic risk, reconstruction and design, the initiation of a seismic risk certification process, raising disaster risk reduction awareness among citizens, training of first responders in earthquake response operations, and research, education and piloting in using renewable and environmentally friendly materials and circular economy principles for earthquake safe construction totaling an estimated 59 million EUR.

Photo: Igor Pavlović

EDUCATION

Background

Croatia's education sector consists of pre-school, primary, secondary (including general and vocational education and training) and higher education. In addition, scientific research is conducted at higher education institutions and at 25 public research institutes. Croatian education spending, at 4.7% of GDP, is close to the EU average of 4.6% (2017). As a proportion of general government expenditure, education spending (10.5%) is also close to the EU average (10.2%). The financing of pre-school education falls mainly to local government bodies, while national government is the main provider of education services for all other levels, thereby guaranteeing free access to education from primary level to higher education.

The majority of Croatian pupils and students attend state-owned schools and higher education institutions (97.3% of primary and secondary schools are state-owned, as well as 80.3% of higher education institutions). The share of private education providers is significant at pre-school level (43.3%). Nearly 50% of all schools in Croatia (primary and secondary) still organize teaching in multiple shifts, meaning that 65% of all pupils nationwide still attend classes in shifts. The lack of infrastructure to organize teaching in one shift and expand instructional time is particularly evident in large cities such as Zagreb, where 75% of pupils attend classes in shifts. Following the nation-wide implementation of curricular reform, the government intends to address the issue of short average instruction time (also caused by a lack of infrastructure and an inefficient school network) through the implementation of the Whole Day School model.

TABLE 13
Education sector at a glance

Level of education	No. of years	No. of pupils and students			No. of employees	Type and no. of institutions		
		M	F	Total		Private	Public	Total
Pre-school	1-6	61,588	57,277	118,865	19,796	272	356	628
Primary Secondary	8 3-5	235,063	225,972	461,035	70,850	70	2,487	2557[25]
Higher education	3-6	71,207	97,233	168,440	18,167	26	106	132[26]

Source: Ministry of Science and Education administrative databases and Croatian Bureau of Statistics

Effects of the Disaster (Damage and Losses)

The earthquake caused damage to educational institutions throughout the three affected counties (the City of Zagreb, Zagreb County and Krapina-Zagorje County). According to the Usability Assessment of Buildings Database and individual reports to the Ministry of Science and Education and local municipalities, 106 buildings intended for preschool education, 214 primary and secondary school buildings and education centers, and 12 pupils' dorms were damaged. In the higher education subsector, damage was reported to 145 buildings in 36 of the University of Zagreb's constituent units, including the Rectorate, 28 faculties, three academies of art, the University computing center, and three of the sites providing students with accommodation and food. Damage was also recorded in four private higher-education institutions, resulting in a total of 152 damaged buildings throughout the higher education subsector. In addition, the buildings of 29 research institutes were also affected.

Most of the affected buildings are in the City of Zagreb (only 23 buildings are in Zagreb County and six buildings in Krapina-Zagorje County). Approximately 94% of the damage was sustained by buildings in the public sector. It is important to note that the historic center of Zagreb is a protected cultural heritage zone. In this area, approximately 200 buildings in the educational sector are reported as damaged (about 40% of all educational buildings reported as damaged in the City of Zagreb), of which approximately 60 are individually protected cultural heritage buildings (about 10% of all educational buildings reported as damaged).

The following table and charts show the distribution of damage in the various education subsectors. Schools (including education centers) were affected the most, followed by the higher education and preschool subsectors. The total number of square meters damaged in these subsectors reflects the actual state of damage better than the number of buildings affected. Buildings in the higher education subsector, for example, are much larger than those in the preschool subsector. Damage to equipment has been reported only for the University of Zagreb, but is not included in the tables below as it is rather small compared to the damage suffered by buildings.

The total value of damage and losses to the education sector is estimated at 1,079.5 million EUR at pre-disaster prices (Table 15), with 97.9% affecting the City of Zagreb, 0.3% Krapina-Zagorje County and 1.8% Zagreb County. Of the total value, the damage to infrastructure and physical assets is estimated at 1,070.5 million EUR, while the losses amount to 9 million EUR. Losses refer to the short-term countermeasures needed to remove potential hazards and prevent further degradation of the buildings (such as the removal of collapsed chimneys, plaster, rubble and debris; and minor local repairs and the shoring of building elements).

25 Includes both central and satellite schools.

26 Includes all faculties and academies of the University of Zagreb.

TABLE 14
Number of damaged buildings and surface area affected in the education sector by subsector

Subsectors	Number of damaged buildings						Total damaged area in square meters
	Public			Private			
Schools and education centers	116	74	7	9	7	1	584,471
Preschool	71	15	0	16	4	0	98,020
Higher education	73	40	3	2	2	0	510,930
Institutes	16	13	0	0	0	0	36,883
Student dorms	30	2	0	0	0	0	67,325
Pupil dorms	6	3	1	2	0	0	25,252
TOTAL	**312**	**147**	**11**	**29**	**13**	**1**	**1,322,881**

FIGURE 10
Distribution of damaged buildings and of the total number of square meters damaged in the education sector

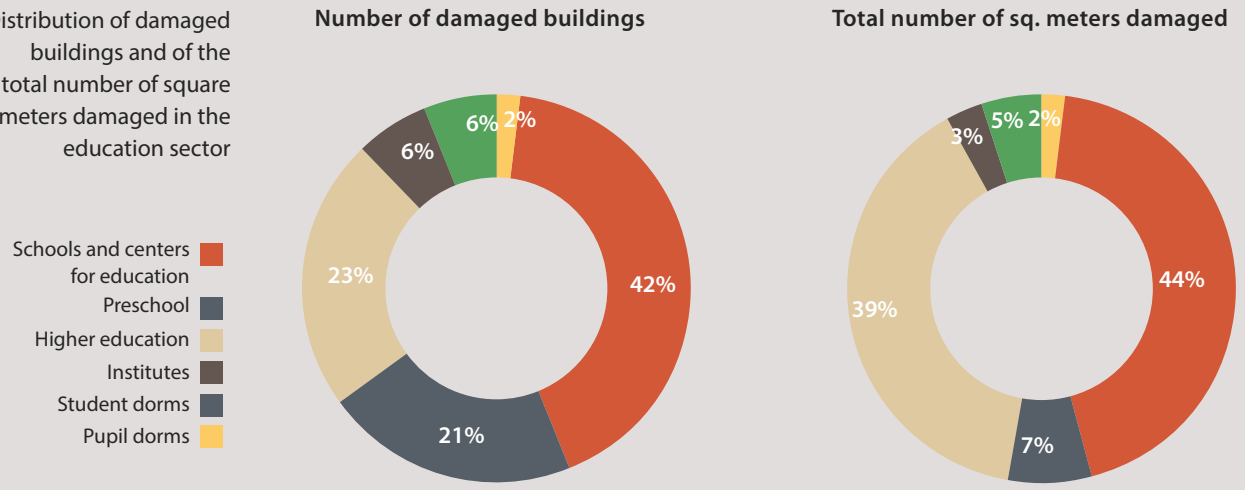


TABLE 15
Total damage and losses in the education sector by subsector (in million EUR)

Subsectors	Damage			Losses		
	Public	Private	Total	Public	Private	Total
Schools and education centers	437.88	39.49	477.37	3.77	0.28	4.05
Preschool	65.96	9.97	75.93	0.48	0.0	0.48
Higher education	404.10	13.81	417.92	3.52	0.11	3.63
Institutes	30.65	0	30.65	0.23	0	0.23
Student dorms	47.42	0	47.42	0.34	0	0.34
Pupil dorms	16.55	4.69	21.24	0.13	0.03	0.16
TOTAL	**1,002.56**	**67.97**	**1,070.53**	**8.47**	**0.51**	**8.98**

TABLE 16
Total damage and losses in the education sector in the affected counties (in million EUR)

Counties	Damage			Losses		
	Public	Private	Total	Public	Private	Total
City of Zagreb	981.06	67.42	1,048.49	8.17	0.50	8.67
Zagreb County	18.27	0.55	1882	0.24	0.006	0.25
Krapina-Zagorje County	3.20	0	3,20	0.06	0	0.06
TOTAL	**1,002.56**	**67.97**	**1,070.53**	**8.47**	**0.51**	**8.98**

Disaster Impact on the Affected Population

Zagreb is the largest city in Croatia, with a population of around 800,000, and the earthquake's impact on the population is correspondingly high. Nearly 30% of all primary- and secondary-school pupils and nearly 40% of all pre-schoolers in Croatia attend schools and kindergartens located in the three affected counties. The University of Zagreb alone accounts for almost 40% of Croatia's entire student population (65,098 students), while 20 of the nation's 25 scientific research institutes are located in the City of Zagreb. Additionally, nearly 60% of all researchers in Croatia are employed by higher education institutions or research institutes in the City of Zagreb. Initial estimates show that damage was sustained by 513 education and research facilities within the City of Zagreb, Zagreb County, and Krapina-Zagorje County. Twelve buildings were heavily damaged, and another 160 need significant repairs before they can be used again.

The earthquake occurred just four days after the declaration of a nationwide lockdown to tackle the COVID-19 pandemic. Damage to education facilities did not therefore cause major disruption in the provision of education, as teaching and learning had already been moved out of the classroom and was taking place online. However, the damage and disruption suffered by numerous households did prevent many pupils and students from following classes online. National lockdown measures were gradually reduced in May. Pre-school institutions and schools for grades 1 to 4 were reopened on May 11, 2020. Classes in earthquake-damaged schools were relocated to other schools nearby. The relevant local authorities initiated repairs to some of the damaged buildings, although it is estimated that 13 schools and 12 higher education institutions will be unable to organize in-person classes in their facilities or in part of their facilities when the new academic year starts.

It is estimated that approximately 6,200 children will need to be relocated from damaged schools to new school environments. This may have a negative effect on equity and lead to a decline in the quality of education. Children from disadvantaged socio-economic backgrounds could be particularly affected. Relocation may also require the organization of teaching in additional shifts in the host schools, thereby reducing already low instruction time and making it more difficult to implement the Whole Day School model.

The earthquake caused significant damage to 19 kindergartens (which were accorded yellow label status), which may further reduce already low participation rates in early childhood education and care. It is currently extremely difficult to assess the extent to which pupils, students and the education process will be affected by the traumatic experiences generated by both the earthquake and the pandemic.

Recovery and Reconstruction Needs

The recovery needs of the education sector have been estimated in two main fields: retrofit (the reconstruction of infrastructure and physical assets), and risk reduction and resilience education. The building back better principle is being applied to the retrofit of damaged buildings. In the new draft Law on Reconstruction of Damaged Buildings in Zagreb and the Surrounding Area four levels of retrofit have been suggested.

For the Education sector, the draft Law foresees the application of Level 3. Level 3 includes the strengthening of existing damaged structures, not to the full extent of structural resistance required by modern seismic regulations (which would be technically demanding and economically impractical for most of the buildings in question), but to the somewhat lesser extent of approximately 75%.

The estimated costs of a level-3 retrofit were arrived at by the expert group working on the draft Law. The estimates are based on the costs incurred in previous reconstructions of similar buildings. It should be noted that many of the affected buildings in the sector are located in the historic center of Zagreb, reconstruction of which will require specific attention and incur higher than usual costs.

The total needs for reconstruction and recovery have been estimated at 2,361.2 million EUR. Of this amount, 6.5% is intended for recovery needs. Recovery needs comprise the acquisition of a realistic earthquake simulator for the training of children; the establishment of a center for earthquake engineering[27] (HCPI – the Croatian Center for Earthquake Engineering) under the responsibility of a relevant academic institution; courses in disaster risk reduction and resilience education which will be aimed at teachers, pupils and parents; structural assessment of damaged facilities to update estimates of reconstruction and rehabilitation needs; the improvement of distance-learning practices in preparation for future disasters; contingency planning for multi-hazard disasters including earthquakes; and the psychological recovery of disaster-traumatized children, involving counselling, research and long-term recovery.

Photo: Igor Pavlović

27 On the basis of previous best practice examples of other countries from the region simalirily affected by earthquakes (e.g. Italy and North Macedonia).

TABLE 17
Reconstruction needs in the education sector by subsector (in million EUR)

Subsectors	Public	Private	Total
Schools and education centers	912.63	72.14	984.77
Preschool	142.00	21.74	163.75
Higher education	822.18	27.96	850.15
Institutes	62.14	0	62.14
Student dorms	104.39	0	104.39
Pupil dorms	33.14	10.37	43.51
TOTAL	**2,076.49**	**132.22**	**2,208.72**

The public sector accounts for a total of 94.4% of reconstruction and recovery needs, while the private sector accounts for 5.6%. Most of the reconstruction needs are estimated for the City of Zagreb (97.7%), while 2.0 % are estimated for Zagreb County, and 0.3% for Krapina-Zagorje County.

The recovery strategy and needs have been prioritized and sequenced over the short, medium, and long term (Table 18). The short-term interventions will focus on the more detailed structural assessments of damaged buildings (which will continue also in the medium term), followed by the retrofit of buildings - starting with all of the most damaged (red-label) buildings, and a third of the least damaged (green-label) buildings. The immediate short-term period will also see the preparation of educational programs for risk reduction, the acquisition of an earthquake simulator, the establishment of the center for earthquake engineering, the improvement of distance learning in preparation for future disasters, the initiation of a psychological recovery program for disaster-traumatized children, and the development of a contingency plan for multi-hazard disasters including earthquakes.

Medium-term and long-term needs will be focused on the reconstruction of infrastructure and physical assets. It is intended that another third of all buildings with green labels and half of those with yellow labels will be retrofitted in the medium term, while the rest will be retrofitted in the long term. Non-structural mitigation (such as the fixing of bookshelves and other equipment to the walls) needs to be carried out in order to minimize non-structural risks. Also, in the medium and long term, the center for earthquake engineering will become fully operational, distance-learning practices will be further improved, and the psychological recovery program for disaster-traumatized children will continue further.

TABLE 18
Recovery needs over time in the education sector (in million EUR)

Components	Short-term		Medium-term		Long-term		Total	
	Reconstruction	Recovery	Reconstruction	Recovery	Reconstruction	Recovery	Reconstruction	Recovery
Reconstruction of Infrastructure and Physical Assets	539.76	2.00	834.48	1.00	834.48		2,211.72	
Risks Reduction and Resilience Education		29.50		45.00		75.00		149.50
TOTAL	**539.76**	**31.50**	**834.48**	**46.00**	**834.48**	**75.00**	**2,361.22**	

Photo: Goran Mahkek / CROPIX

HEALTH

Background

Croatia's demographic and epidemiological profile is characterized by a declining, ageing population with a disease burden dominated by non-communicable diseases. Croatia is home to approximately 4.2 million[28] citizens, 20% of whom are aged over 65.[29] Life expectancy has increased from 74.6 years in 2000 to 78 in 2017, in line with the overall EU trend (from 77.3 to 80.9 in the same period). Croatia's life expectancy gender gap (6.1 years) exceeds the EU average. Both the rates of preventable and treatable mortalities, which serve to indicate the effectiveness of the healthcare system, are above the EU average.

From a health-financing perspective, the Croatian healthcare system offers significant protection from the financial risks of ill-health, but the overall sustainability of the system remains a challenge. Out-of-pocket payments, excluding voluntary health insurance, accounted for 10.5% of health expenditure in 2018, well below the EU average of 15.8%. Per capita health expenditure, at 1,272 EUR in 2017,[30] was among the lowest in the EU, where the average was 2,884 EUR. Croatia devotes 6.8% of its GDP to health compared to the EU average of 9.8%. Nevertheless, the share of public expenditure, at 83%, is above the EU average. The system is financed through mandatory health contributions for all employed citizens. Dependents obtain coverage through working members of their families. Self-employed workers are also obliged to pay healthcare contributions, while citizens who belong to vulnerable categories are exempted from payments.

28 Croatian Bureau of Statistic: Statistic Yearbook of the Republic of Croatia, Zagreb, 2018. https://www.dzs.hr/

29 https://data.worldbank.org/indicator/SP.POP.65UP.TO?locations=HR&display=graph--%3E

30 https://ec.europa.eu/health/sites/health/files/state/docs/2019_chp_hr_english.pdf

TABLE 19
An overview of healthcare service delivery nationwide

PRIMARY	SECONDARY	TERTIARY
• 49 health centers, with 61 branches across the country	• 22 general hospitals • 18 specialist hospitals • 6 psychiatric hospitals • 3 health resorts	• 5 Clinical Hospital Centers • 3 Clinical Hospitals • 5 Clinics

In terms of access to care, Croatians fare better than their European counterparts. For example, the share of self-reported, unmet medical needs in Croatia stood at 1.6%,[31] below the EU average of 2%. However, self-reported needs which are unmet due to geographical distance are higher in Croatia than in any other EU member state. The geographical distribution of healthcare infrastructure and human resources varies considerably, and there are a number of hospitals close to each other offering the same types of services (OECD, 2019). In addition, unmet medical needs affect 4.1% of people aged 65 and above, well above the EU average of 2.5%.[32] Table 19 outlines the organization of service delivery, which is further supported by state-level health institutes across the 20 counties and the City of Zagreb.

Effects of the Disaster (Damage and Losses)

Healthcare centers are critical to the delivery of primary care services. In the earthquake-affected area of the City of Zagreb, Zagreb County, and Krapina-Zagorje County there are six healthcare centers with 14 branches, comprising a total of 200 buildings (with a gross area of 145,955 square meters). Of these 200 buildings, 36 suffered non-structural damage and were accorded a green label, thereby requiring short-term countermeasures; eight buildings suffered moderate structural or heavy non-structural damage and were assessed as temporarily unusable (yellow-label); and two buildings suffered heavy structural damage and were assessed as unusable (red). Most of these damaged buildings (42 in total) are situated in the City of Zagreb, while four buildings with non-structural damage are situated in Zagreb County. In total 40% of healthcare centers were impacted by the earthquake and 5% were assessed as temporarily or permanently unsafe for use.

In the earthquake-affected area of the City of Zagreb, Zagreb County, and Krapina-Zagorje County there are two clinical hospital centers, four clinics, one general hospital, seven special hospitals and two psychiatric hospitals. These buildings, which provide secondary and tertiary care, are dispersed throughout the City of Zagreb. Most of the buildings are in the part of the city protected as cultural heritage, and three of them are in buildings specifically designated as protected cultural heritage. More than 80% of hospital buildings were directly impacted by the earthquake and 17% were assessed as temporarily or permanently unusable. From a total of 138 hospital buildings, 92 had non-structural damage and were recommended for short-term countermeasures (green), 21 had moderate structural or heavy non-structural damage and were assessed as temporarily unusable (yellow), and two buildings had heavy structural damage and were assessed as unusable (red). In addition to infrastructural damage, hospital equipment was also significantly damaged by the earthquake.

The administration and regulation of public health is organized through state health institutes. In the three earthquake-affected administrative units, there are 13 health institutes operating in 73 buildings. Almost 30% of these buildings were damaged by the earthquake to some extent, with seven

31 https://ec.europa.eu/health/sites/health/files/state/docs/2019_chp_hr_english.pdf

32 https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52020SC0510&from=EN

buildings evaluated as temporarily unusable, and two buildings evaluated as permanently unusable. The buildings that were assessed as permanently unusable are protected individually as cultural heritage, which makes their reconstruction more demanding. Of the 68 pharmacies located in the earthquake-affected area, 23 suffered damage, with five assessed as unusable. Although the majority of the damage occurred in the public sector, some damage was also recorded in the private sector.

The cost of the earthquake to the health system in the three affected areas was estimated at a total of 887.2 million EUR, of which 826 million EUR refers to damage and 61.2 million EUR to losses. In terms of ownership, almost 100% of the value of earthquake damage related to the public sector.

Unsurprisingly, given that Zagreb is the capital of Croatia, and has the largest overall number of health institutions, the City of Zagreb accounted for almost 96% of recorded damage, whereas Krapina-Zagorje County and Zagreb County accounted for three and one percent respectively.

TABLE 20
Damaged health facilities

Subsectors	Number of damaged buildings						Total damaged buildings	Total damaged area in square meters
	Public			Private				
Health centers	36	8	2	0	0	0	46	41,095
Clinical hospital centers	38	9	2	0	0	0	49	274,984
Clinical hospitals	22	0	0	0	0	0	22	123,072
Clinics	22	8	0	7	1	0	38	90,156
Polyclinics	5	2	0	0	0	0	7	34,086
Special hospitals	7	2	0	0	0	0	9	45,896
Health institutes	11	7	2	0	0	0	20	40,307
Pharmacies	18	3	2	0	0	0	23	4,561
TOTAL	**159**	**39**	**8**	**7**	**1**	**0**	**214**	**654,157**

TABLE 21
Total damage and losses in the health sector by subsector (in million EUR)

Subsectors	Damage			Losses		
	Public	Private	Total	Public	Private	Total
Hospitals[33]	722.43	1.83	724.26	56.95	0.01	56.96
Health centers	35.43	0	35.43	3.12	0	3.12
Health institutes	61.23	0	61.23	0.34	0	0.34
Pharmacies	5.05	0	5.05	0.80	0	0.80
TOTAL	**824.15**	**1.83**	**825.98**	**61.21**	**0.01**	**61.22**

TABLE 22
Total damage and losses in the health sector per county (in million EUR)

Counties	Damage			Losses		
	Public	Private	Total	Public	Private	Total
City of Zagreb	791.60	1.83	793.43	60.96	0.01	60.97
Zagreb County	7.78	0	7.78	0.05	0	0.05
Krapina-Zagorje County	24.77	0	24.77	0.20	0	0.20
TOTAL	**824.15**	**1.83**	**825.98**	**61.21**	**0.01**	**61.22**

33 Clinical hospital centers, clinical hospitals, clinics, polyclinics, special hospitals

Disaster Impact on the Affected Population

In the three administrative areas impacted by the earthquake, eight hospitals with 1,606 personnel provide healthcare to 453,817 children in 16 buildings. All eight hospitals with 877 personnel (85% women and 15% men) which provide annual healthcare services to 301,424 child patients were directly impacted by the earthquake, leaving five buildings temporarily or permanently unsafe for use (three buildings out of six in the Zagreb Children's Hospital in the Klaićeva Street, the main healthcare provider for children; one building at the Srebrnjak Children's Hospital, the main healthcare provider for children with respiratory diseases; and one building at the Special Hospital for the protection of children with neurodevelopmental and motor disorders). As well as buildings, equipment in these hospitals (such as incubators in the Srebrnjak Children's Hospital), were also damaged by the earthquake. Many of the buildings providing health services for children were built in the early 1900s, and are all either individually protected as cultural heritage or located in the part of the city which comes under cultural heritage protection. The earthquake served to highlight the seismic vulnerability of these buildings, and their limitations in providing sustainable healthcare services.

There are four public maternity hospitals in the City of Zagreb (the Clinic for Gynecology and Obstetrics at KBC Zagreb, known as Petrova; KBC Sestre Milosrdnice, known as Vinogradska; KB Sveti Duh and KB Merkur). All eight buildings of these four hospitals were assessed after the earthquake. They were mostly found to have suffered non-structural damage, and short-term countermeasures were prescribed. At the time of the first tremor at 6.24 a.m. on March 22, however, there were real fears that the building at Petrova hospital might collapse, and pregnant women and mothers with newly born babies were evacuated with the help of volunteers. Many of the patients were relocated to KB Dubrava.

Petrova hospital has 451 staff (90% women and 10% men) and 303 beds, and serves 92,615 patients annually. After the earthquake, this hospital remains severely impacted, and has suffered a decrease in its capabilities in providing healthcare to pregnant women and newborn children.

The earthquake will have lasting effects, especially on needs related to the evacuation of children, pregnant women, and patients with limited mobility from the damaged hospitals. All these factors serve to reemphasize the need to build new health infrastructure in the City of Zagreb which would also serve the entire country in healthcare provision.

Recovery and Reconstruction Needs

Healthcare services and functions are primarily provided in buildings that date from the late 19th and early 20th centuries. Around 80% of hospital buildings were built before the 1960s, when the minimization of seismic risk became part of the building design code. Only 5% of hospital buildings were built after 2000, and only 5% of old buildings benefited from structural intervention after 2000. Moreover, given the importance of health services to the general wellbeing of the population, the health sector is likely to experience more complex reconstruction needs, and a higher degree of expenditure than other sectors. According to the new draft Law on Reconstruction of Damaged Buildings in Zagreb and the Surrounding Area, hospital buildings have been designated infrastructure of the highest importance. Modern seismic regulations will be applied to ensure that the post-earthquake retrofit provides the highest possible standards of structural resistance. Upgrading historical buildings from no or limited earthquake resilience to the highest level of earthquake resilience, whilst also respecting BBB concepts, is expected to be both technically demanding and costly, as reflected in Table 23 and Table 24.

TABLE 23
Public and private health sector reconstruction needs (in million EUR)

Subsectors	Public	Private	Total
Hospitals[34]	2,228.62	3.46	2,232.08
Health centers	71.22	0	71.22
Health institutes	90.45	0	90.45
Pharmacies	8.80	0	8.80
TOTAL	**2,399.09**	**3.46**	**2,402.55**

TABLE 24
Reconstruction and recovery needs in the health sector (in million EUR)

	Short -term	Medium -term	Long -term	Total
Reconstruction	362.48	199.31	1,840.76	2,402,55
Recovery	11.40	10.80	9.80	32.00
TOTAL	**373.88**	**210.11**	**1,850.56**	**2,434.55**

Croatia's vulnerability to earthquakes increases the need to ensure that future health infrastructure is earthquake-resilient. The fact that the earthquake occurred during a pandemic, and had increased impact on vulnerable patients (such as pregnant women and patients with mobility restrictions), has further highlighted the importance of improving health sector infrastructure. This will be a substantial undertaking requiring national coordination and oversight. As a result, the draft Law on Reconstruction of Damaged Buildings in Zagreb and the Surrounding Area will provide guidelines for a comprehensive approach to strategic planning and the construction of health infrastructure. In line with other documents and plans currently in development, the overall approach to reconstruction will provide an opportunity for positive improvements in the strategic planning of health infrastructure and it should consider the relocation and closing of certain obsolete buildings and rationalization of the hospital network.

Looking at modernizing and rebuilding the sector's infrastructure, it is clear that the costs and technical demands involved in improving facilities in line with international standards for earthquake resilience, the functionality required by modern medical practice, and environmental considerations such as energy efficiency will be substantial. In order to better manage this going forward, it may be relevant for the government to invest in insurance. This might be a prudent mechanism to decrease the financial exposure of both central and local government, in the event of unfavorable circumstances in the future.

Finally, it will also be important to identify how healthcare workers and staff can be trained and supported to respond to emergencies such as earthquakes including a long-term emergency preparedness and response plan. Other recovery activities and measures will include a detailed assessment of health infrastructure, a strategic plan for earthquake response, an initial investment to improve the health EOC coordination model, earthquake preparedness and contingency plan, an annual disaster simulation and health facilities evacuation drills, training of health sector personnel in earthquake crisis management including coordination, disaster management, response and recovery, development of a safe hospital model focused on raising awareness among healthcare users about earthquake resilience, digitalization and setting up a database of health infrastructure, equipment, personnel and users of facilities, and the necessary feasibility studies for development of new health facilities (including the envisaged University Hospital Blato).

34 Clinical hospital centers, clinical hospitals, clinics, polyclinics, special hospitals

Photo: Ivan Marinković

CULTURE AND CULTURAL HERITAGE

Background

This chapter provides an account of damage, losses and recovery needs related to museums and galleries, libraries and cultural centers, theaters, movie-theaters and concert halls, culture associations, churches, chapels and religious facilities, and state government heritage buildings. It also includes movable assets such as works of art, art collections, and religious inventories. Of the total surface area of this sector, 60% is made up of protected monuments, 14% is located within the protected urban complex of Zagreb, and the remaining 26% has been included in this sector due to its culture-related purpose. Schools, hospitals, businesses or residential buildings which are housed in historic buildings or are protected cultural heritage, are dealt with in their respective chapters, and their recovery costs include the heritage aspects of the reconstruction.

The capital of Croatia prides itself on its rich historical and cultural heritage, much of which enjoys protected cultural status. As previously described, the historic urban complex of Zagreb consists of two protected heritage areas, concretely Zones A and B. Zone A covers the most valuable and the oldest parts of Zagreb – the Upper Town (Gornji grad), the Kaptol district and the Lower Town (Donji grad). The urban development of the Upper Town and Kaptol began in the Middle Ages and was completed by the beginning of the 19th century. Both parts are rich in religious buildings, town houses and palaces. The Lower Town largely dates from the second half of the 19th and the beginning of the 20th centuries, and is partly the product of reconstruction following the devastating earthquake of 1880. Zone B includes the remaining part of the historical urban area which was built until the mid-20th century. It is characterized by diverse urban patterns and numerous highly valuable buildings and complexes.

The most important historic buildings housing government institutions situated within Zagreb's historical center are those clustered around St. Mark's Square, where the Croatian Parliament, the Constitutional Court, the Zagreb City Assembly, and the Banski Dvori (the former governor's

palace, currently the seat of the Croatian government) are located.

Zagreb County and Krapina-Zagorje County are characterized by market towns with prominent parish churches, and aristocratic estates with castles and manors. Each county also boasts many important museums and libraries.

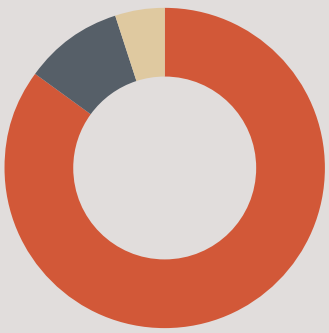
TABLE 25
Statistical data on the culture and cultural heritage sector

	Statistical data	Total	Annual number of visitors/users
City of Zagreb	Museums	33	1,258,631
	Libraries	47	2,400,000
	Archives	3	12,386
	Theaters	84	1,244,474
	Movie theaters	9	2,419,000
	Churches and chapels	113	N/A
Zagreb County	Museums	8	34,365
	Libraries	13	30,844
	Archives	0	0
	Churches and chapels	61	N/A
Krapina-Zagorje County	Museums	6	272,802
	Libraries	14	9,263
	Archives	1	155
	Churches and chapels	44	N/A

Effects of the Disaster (Damage and Losses)

The earthquake caused significant damage to the historic urban complex of the City of Zagreb. The Lower Town, the Upper Town and Kaptol have been hit the hardest, although individual immovable cultural property, mainly churches located in the wider city area and the neighboring counties, have also suffered considerable damage. In total, 85% of the damage to culture and cultural heritage sector occurred in the City of Zagreb, and 15% in the surrounding areas. This figure does not include damage to cultural heritage buildings in the housing, education, health and business sectors.

FIGURE 11
Share of total damage by county in the culture and cultural heritage sector



85%
of damage to culture and cultural heritage sector occurred in the City of Zagreb

A large part of the Croatian capital is made up of a protected historical urban complex comprising a total of 13,388 buildings,[35] of which 4,017 are located in the historical heart of Zagreb (Zone A). As much as 72% of the buildings in this protected zone were damaged, of which 27% suffered moderate, and 6% heavy structural damage. Within the wider urban area (Zone B), a total of 40% of buildings have been damaged, of which 9% suffered moderate to severe structural damage. These figures refer to all cultural heritage buildings including those in the sectors of housing, education, health and business. The fact that the earthquake has hit the historic urban area of the City of Zagreb, which is protected cultural heritage, substantially contributes to the high extent of damage.

TABLE 26
Number and percentage of damaged buildings in the protected historical urban complex of the City of Zagreb

City of Zagreb – Protected Historical Urban Complex – Zones A and B									
Urban Zone	No.							TOTAL DAMAGED	
A	4,017	1,561	39%	1,088	27%	240	6%	2,889	72%
B	9,371	2,927	31%	737	8%	98	1%	3,762	40%

The most severe damage was sustained by religious and public buildings. These are mainly masonry buildings with load-bearing walls, columns, arches and vaults of various shapes. The landmark Zagreb Cathedral suffered the partial collapse of its northern spire. The Basilica of the Sacred Heart of Jesus, the Church of St. Francis of Assisi, the Church of St. Catherine, and parts of the Museum of Arts and Crafts also suffered significant damage.

Among heritage buildings occupied by Government institutions, the earthquake damaged the Ministry of Finance, the government building known as Banski Dvori, the Ministry of Construction and Physical Planning, the Croatian Parliament and several others.

Certain characteristic features of Zagreb's urban ambience have been diminished by the earthquake. Damage has been done to unique stylistic and decorative elements of many of its historic buildings, and it has been necessary to remove many unstable features. Much of the damage involved the collapse of chimneys, gables and pediments, attics, prominent cornices and other elements. Such collapses have caused significant damage to roof coverings, trusses and floor structures. Buildings have also sustained a considerable amount of damage which is only visible on internal inspection. Damage to movable cultural heritage has included the collections of museums and galleries, religious inventories and other cultural goods owned by state institutions or private entities.

Total damage to the culture and cultural heritage sector is estimated at 1,378 billion EUR, of which 39% is in the public sector and 61% in the private sector. Most of the affected buildings in the private sector are churches and chapels, which account for 44% of the total sector damage. These figures do not include damage to cultural heritage buildings in other sectors.

Total losses amount to 20,576 million EUR. Calculated losses take into account (i) emergency measures such as demolition, rubble removal and the installation of supporting scaffolding; (ii) removal of damaged towers and domes, a measure that was particularly necessary for the spires of Zagreb Cathedral as well as several other buildings; (iii) installation of wood covers in churches; (iv) the relocation of museum exhibits and religious objects; (v) rental of temporary premises; and (vi) loss of revenues for a period of six months or longer as reported to the Ministry of Culture.

35 The number of houses refers to the number of addresses

TABLE 27

Number of damaged buildings and surface area affected by subsector in the culture and cultural heritage sector

Subsectors	Number of damaged buildings						Total damaged area in square meters
	Public			Private			
Museums and galleries	20	15	7	26	23	5	118,473
Libraries, archives and cultural centers	17	9	1	17	3	0	162,863
Theaters, movie theaters and concert halls	10	6	3	9	1	2	66,441
Cultural associations	3	4	0	8	2	1	13,286
State government heritage buildings	10	3	0				77,212
Churches and chapels				60	28	12	174,620
Other religious facilities				25	24	10	101,733
TOTAL	**60**	**37**	**11**	**145**	**81**	**30**	**714,629**

TABLE 28

Damage and losses by subsector in the culture and cultural heritage sector (in million EUR)

Subsectors	Damage			Losses		
	Public	Private	Total	Public	Private	Total
Museums and galleries	146.41	32.27	178,68	6,38	1,17	7,54
Libraries, archives and cultural centers	197.86	9.70	207.57	4.90	0.24	5.14
Theaters, movie theaters and concert halls	83.45	9.56	93.02	1.04	0.11	1.16
Cultural associations	6.38	13.02	19.40	0.09	0.69	0.78
State government heritage buildings	101.20		101.20	0.45		0.45
Churches and chapels		611.19	611.19		3.99	3.99
Other religious facilities		167.39	167.39		1.52	1.52
TOTAL	**535.31**	**843.14**	**1,378.45**	**12.86**	**7.72**	**20.58**

TABLE 29

Total damage and losses by county in the culture and cultural heritage sector (in million EUR)

Counties	Damage			Losses		
	Public	Private	Total	Public	Private	Total
City of Zagreb	523.98	657.08	1.181.06	12.36	6.96	19.32
Zagreb County	3.26	132.13	135.39	0.08	0.53	0.61
Krapina-Zagorje County	8.07	53.93	62.00	0.42	0.23	0.65
TOTAL	**535.31**	**843.14**	**1.378.45**	**12.86**	**7.72**	**20.58**

Disaster Impact on the Affected Population

Due to measures introduced by the National Civil Protection Headquarters to tackle COVID-19, all cultural institutions and religious buildings were closed at the time of the earthquake. Out of 30 churches with cultural heritage status in the City of Zagreb, a total of 15 are classified as temporarily unusable due to earthquake damage, and eight as totally unusable. Out of a total of 21 museums and galleries with cultural heritage status, seven are temporarily unusable and three totally unusable. Out of a total of three protected theaters, cinemas and concert venues, one is temporarily unusable. Out of a total of three protected archives and libraries, one is temporarily unusable. Of the 31 churches and chapels in Zagreb County that have cultural heritage status, one is temporarily unusable and two are totally unusable due to severe structural damage. Out of 15 individually protected churches and chapels in Krapina-Zagorje County, four are temporarily unusable.

Although the COVID-19 lockdown has been relaxed and many cultural institutions are starting to work again, some will remain closed due to severe structural damage and safety concerns for both artists and audience. Museums, galleries and cultural institutions have not ceased to function. Due to earthquake damage, however, some institutions have been forced to move to other locations, or use less damaged parts of their buildings. One of the consequences of earthquake damage on buildings in the culture and cultural heritage sector is that they are exposed to the risk of further damage, primarily due to the penetration of rainwater through roofs damaged by chimney collapse or excessive shaking due to tremors. Another possible risk is the collapse of unstable decorative elements on the facades of historic buildings, due to vibrations caused by heavy vehicles.

Photo: Ministry of Culture

Recovery and Reconstruction Needs

Short-term recovery strategy involves the urgent removal of damaged structural elements, such as parts of Zagreb Cathedral's spires; or non-structural elements, such as chimneys on the Museum of Arts and Crafts; as well as the temporary securing of all elements which pose a risk to pedestrians. Short-term measures also include repairs to prevent further damage and to enable immediate use of buildings which have suffered non-structural damage. These measures also include the protection or evacuation of movable cultural goods.

Medium-term recovery needs include the recovery of buildings and the conservation and restoration of damaged cultural heritage. Long-term needs focus on the systematic recovery of the historic urban center, improvement of resilience to earthquakes and other risks, and the application of energy efficiency measures on fixed cultural heritage. Particularly important is the retrofitting of heritage buildings to decrease their vulnerability to seismic hazards, while at the same time preserving their architectural and historical values.

The conservation approach to the recovery of a building will be based on a valorization of its construction techniques as well as its stylistic and architectural characteristics. It will entail the improvement of the building's seismic resilience, although the introduction of new structures and materials will have to be compatible with the building's historical construction features.

Throughout the recovery process special attention will be paid to the restitution of the facades of historic buildings, as they are central to the urban scenery of the city. Urban, architectural and environmental values that represent the cultural and spatial identity of Zagreb, and its significance as a Croatian and Central European metropolis, require an approach based on the safeguarding and recovery of all those values, in accordance with national and international standards in cultural heritage.

Some of the recovery activities and measures in this sector will include the recovery and instalment of seismic resistant exhibition areas in museums, a conservation recovery project for the historical center of the City of Zagreb with the earthquake reduction scheme, a diagnostic laboratory for pre and post-earthquake response for built heritage, advanced training in seismic design, conservation training, construction technologies, building materials, numerical computations for built heritage, development of a digital database of heritage at a seismic risk, and earthquake resistant museum storage facilities.

Reconstruction needs for the culture and cultural heritage sector are estimated at approximately 2.27 billion EUR. These needs are divided as follows: cultural institutions in the public sector (34.3%), cultural institutions in the private sector (5%), state government heritage buildings (8.4%), and religious buildings (52.3%). An additional 242 million EUR are planned for recovery projects in the sector. As far as the geographical distribution of construction costs is concerned, the largest proportion will be required by the City of Zagreb (85%), followed by Zagreb County (10%) and Krapina-Zagorje County (5%). This figure does not include recovery needs of cultural heritage buildings in the housing, education, health and business sectors.

TABLE 30
Total recovery and reconstruction needs in the culture and cultural heritage sector (in million EUR)

	Short-term	Medium-term	Long-term	Total
Reconstruction	454.92	1,478.49	341.19	2,274.60
Recovery	45.00	91.50	105.50	242.00
TOTAL	**499.92**	**1,569.99**	**446.69**	**2,516.60**

Photo: Anto Magzan

BUSINESS

Background

Small and medium-sized enterprises are critical to the Croatian economy, constituting a 99.7% share in the economy overall. In 2018 micro-, small- and medium-sized enterprises employed almost three quarters (72.2%) of all employees in business entities, generated 58% of the total revenue in Croatia and made up 53% of exports. Unfortunately, in 2019 there was a decline in the number of registered business entities compared to 2018. An even larger decline is expected in 2020, bearing in mind that the total number of newly registered business entities was less than 5000 for the first half of the year, compared to almost 15,000 for the whole year of 2019.

Most of the business activity in Croatia is concentrated in the City of Zagreb and its surroundings. Businesses registered in the City of Zagreb account for one third of all active firms (Table 31) in the country.[36] Another six percent of firms are registered in Zagreb County, and two percent in Krapina-Zagorje County. As with the structure of firms at the national level, the majority of firms in the City of Zagreb, Zagreb County and Krapina-Zagorje County are micro-, small- and medium-sized enterprises.

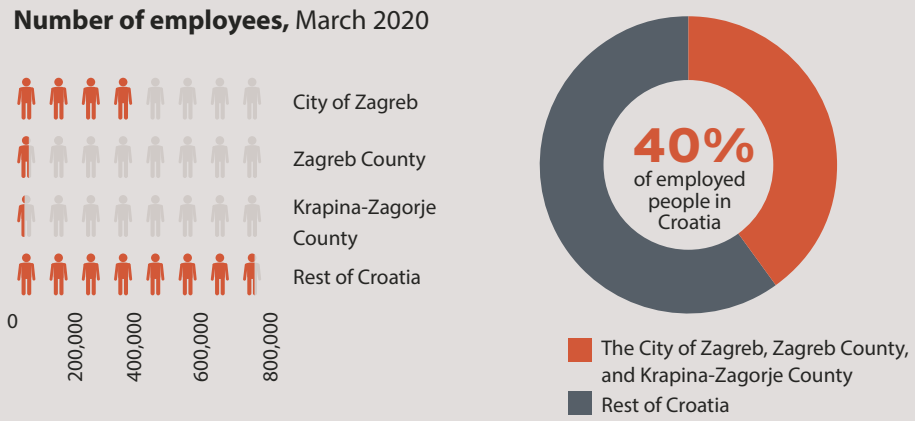
TABLE 31
Structure of the business sector by size

	Total firms	Percent		
	All sizes	Micro and small	Medium	Large
City of Zagreb	44,036	98.4	1.3	0.4
Zagreb County	8,600	98.3	1.4	0.3
Krapina-Zagorje County	2,270	97.7	2.1	0.2
Rest of Croatia	76,476	98.8	1.0	0.2
Total	**131,382**	**98.6**	**1.1**	**0.3**

Source: FINA 2018

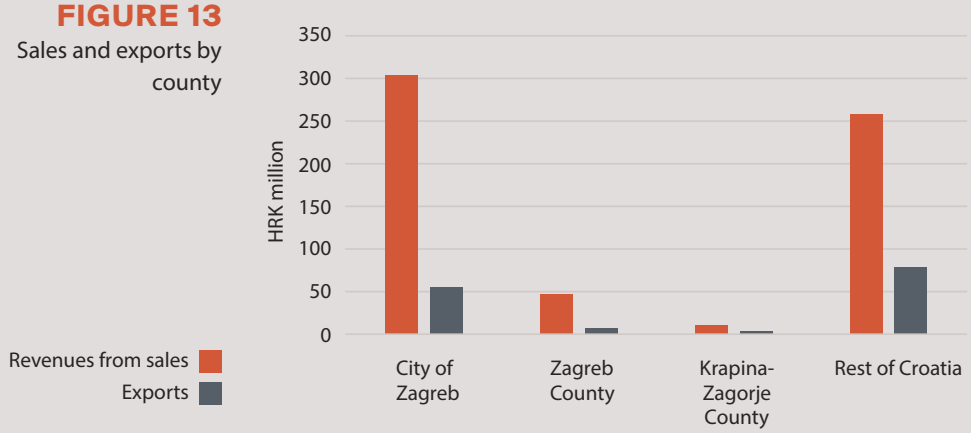
36 Firms that submitted financial statements to the Financial Information Agency (FINA)

FIGURE 12
Number of employees



Source: Croatian Bureau of Statistics

FIGURE 13
Sales and exports by county



Source: FINA 2018

Firms from Zagreb and its surroundings lead in terms of revenue and employment generation in Croatia. The City of Zagreb, Zagreb County, and Krapina-Zagorje County account for 40% of employed people in Croatia (Figure 12). Firms in the area generate more sales revenue than the rest of Croatia combined (Figure 13). To some extent this is to be expected, as half of Croatia's large firms are headquartered in the capital. At the same time, firms in the area account for 47% of all export revenues in Croatia.

The structure of the business sector in Zagreb and its surroundings is dominated by the wholesale and retail trade, and by manufacturing. Of around 55,000 firms, one quarter are registered in the wholesale and retail sector, one fifth in professional services, and one tenth in manufacturing (Figure 14). Using sales revenues as an alternative metric confirms that the wholesale and retail trade is indeed the largest sector, followed by manufacturing, transport, professional services, and construction (Figure 15). Firms registered in sectors related to tourism[37] also occupy a significant position – an estimated 7.4% of firms in Zagreb and its surroundings are registered in tourism-related activities, generating 5.7% of sales and accounting for 11% of jobs.

37 These include firms registered in accommodation, catering, transportation, tourism support services (e.g. travel agencies), rental, and entertainment activities.

FIGURE 14
Number of firms by sector

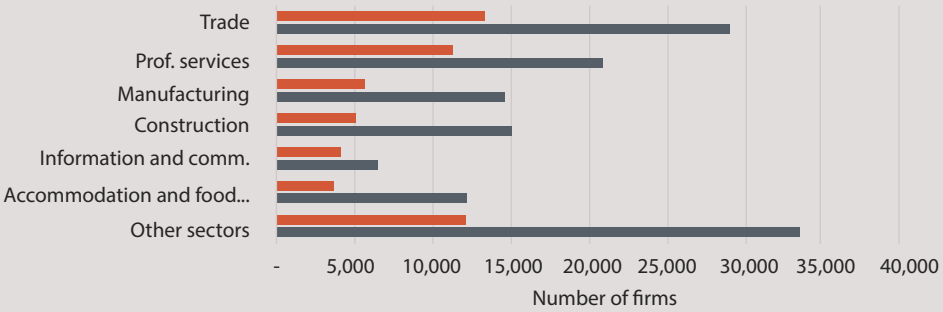
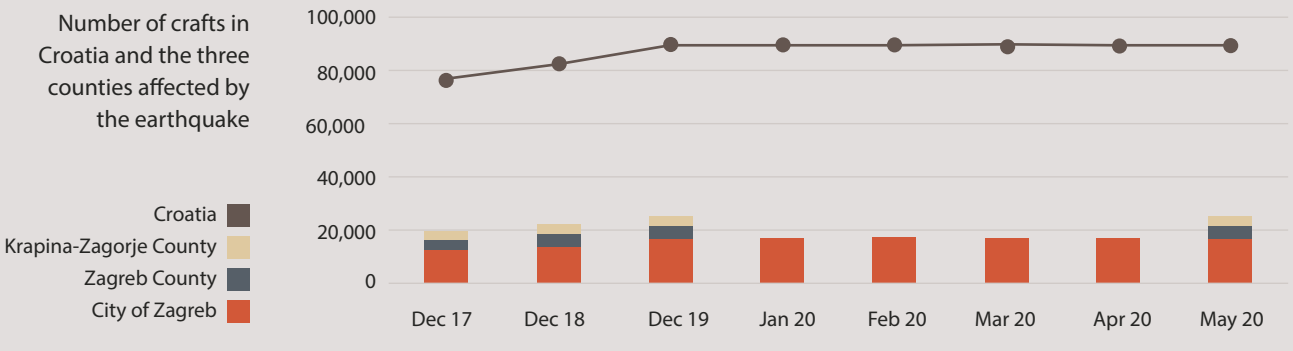


FIGURE 15
Sales revenues by sector

Source: FINA 2018

A large number of crafts (in Croatia, the "craft" category embraces many small businesses and self-employed people as well as craftspeople in the traditional sense) are also located in areas affected by the earthquake. The number of registered craft businesses has been on the rise in recent years, although this trend can be expected to reverse in 2020 (Figure 16). Compared to 2018, the number of crafts in 2019 increased by 17.2% in the City of Zagreb, 9.9% in Zagreb County and 8.2% in Krapina-Zagorje County. Crafts are important providers of employment and self-employment – by the end of February 2020, crafts employed over 182,000 people in Croatia, of which 94,000 were employees and the remainder were owners. Around 29,000 people were either employed or self-employed in crafts in the City of Zagreb alone. Due to the combined effect of the COVID-19 crisis and the earthquake, the number of employees in crafts in end-March in Zagreb decreased by 3% compared to end-February 2020 (Figure 17).

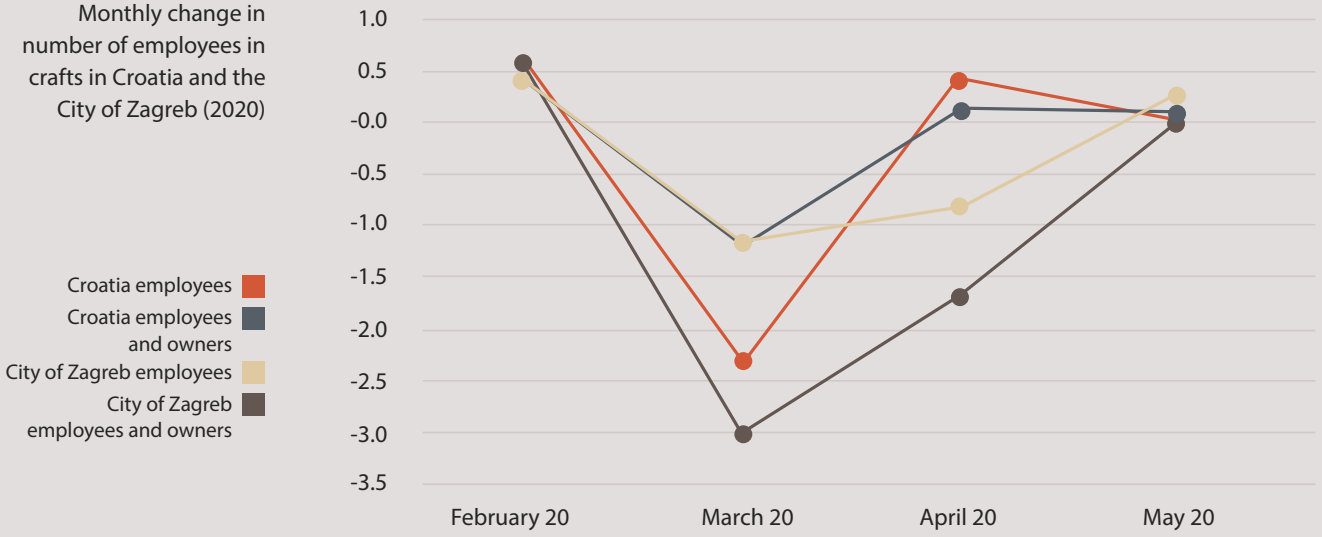
FIGURE 16
Number of crafts in Croatia and the three counties affected by the earthquake



Source: Croatian Craft Register, Printout: 15/05/2020.

FIGURE 17

Monthly change in number of employees in crafts in Croatia and the City of Zagreb (2020)



Source: Croatian Craft Register, Printout: 15/05/2020.

Effects of the Disaster (Damage and Losses)

A significant number of economic operators and their business premises were affected by the earthquake. Based on recently collected data, the total number of economic operators affected by the earthquake stands at 2,104. As shown in Table 32, most of these are located in the City of Zagreb. To put this in the context of infrastructure, the total surface area of all damaged commercial buildings affected by the earthquake is 1,382,173 square meters. Out of that, earthquake affected surface area amounting to 58,742 square meters has been declared unsafe and cannot be used whereas additional 322,155 square meters of business area has been assessed as temporarily unusable and will call for immediate reconstruction measures. A large number of businesses in the center of Zagreb are located in what are termed residential-commercial buildings, most of which are very old, and display visible earthquake damage.

TABLE 32

Economic operators and area affected by the earthquake in the area of the City of Zagreb, Krapina-Zagorje County and Zagreb County

Counties	Number of economic operators	Total damaged area in square meters
City of Zagreb	2,067	1,308,960
Zagreb County	29	66,665
Krapina-Zagorje County	8	6,846
TOTAL	**2,104**	**1,382,471**

TABLE 33
Total damage and losses by ownership and county in the business sector (in million EUR)

County	Damage			Losses			Total		
	Private	Public	Total	Private	Public	Total	Private	Public	Total
City of Zagreb	470.13	19.08	489.21	181.42	1.04	182.46	651.55	20.12	671.67
Zagreb County	13.28	0.46	13.74	1.61	0.06	1.67	14.90	0.51	15.41
Krapina-Zagorje County	1.11	0.74	1.85	0.22	0.14	0.36	1.33	0.89	2.22
TOTAL	**484.52**	**20.28**	**504.80**	**183.25**	**1.24**	**184.49**	**667.78**	**21.52**	**689.30**

The business sector damage in Zagreb and in private buildings are by far the largest. Table 33 shows the estimated damage by county and by ownership of buildings. Total damage amounts to almost 505 million EUR.

Other associated costs, such as the losses incurred in the removal of debris, are also high. For debris removal in the private sector, the total estimated cost stands at over 9 million EUR, of which 95% is for the City of Zagreb. In addition to this, interruption of service also counts as a significant loss (as elaborated in the next section - *Impact*). Altogether the total losses in public and private buildings in all three counties are estimated at 190 million EUR. If damage is added to this sum, the total value stands at 690 million EUR.

Disaster Impact on the Affected Population

The days of reconstruction which lie ahead will have a significant impact on businesses. Figure 18 and Figure 19 show total losses anticipated by businesses through the reduction of revenue resulting from each day of business inactivity. The estimates are made for enterprises whose real estate property was damaged by the earthquake. The total losses in the business sector are estimated at 908,502 EUR per day. Based on this, accounting for an average expected duration of the renovation process of 200 days, the total expected losses to the business sector in reduced revenue can be estimated at 181,700,400 EUR.

FIGURE 18
Interruption of service (private sector)

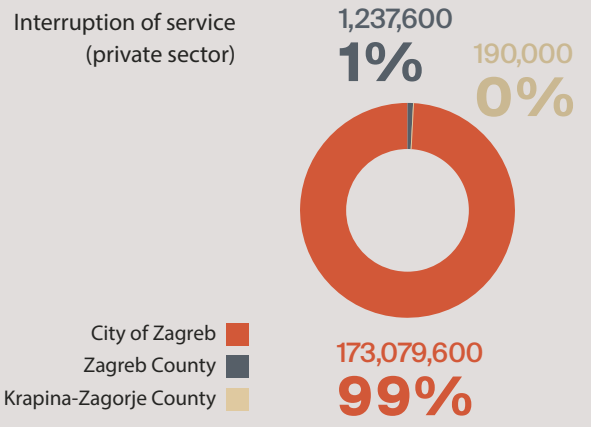
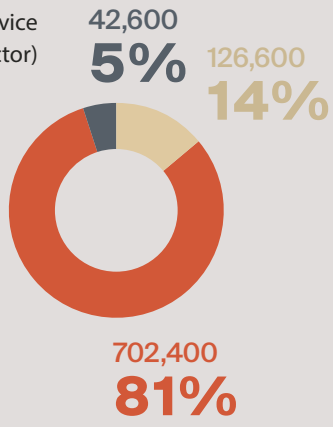


FIGURE 19
Interruption of service (public sector)



Unemployment is starting to rise. It is still too early to produce an exact picture of its impact in the private sector, but early results published by the Croatian Employment Service, comparing March and April 2020, show an increase in the unemployment rate. The rise in unemployment is clearly not only due to the earthquake, but to the COVID-19 pandemic as well; indeed the negative employment trend is visible in every single county in Croatia.

One of the sectors most affected by the disaster is tourism, and its ability to recover in the aftermath of the earthquake is a major unknown. As shown previously, tourism is a key contributor to economic growth in Croatia. In recent years, it has become increasingly significant in driving business growth in the City of Zagreb. The COVID-19 situation will also take its toll on tourism, but considering that many of the craft, accommodation and hospitality businesses associated with tourism are located in the areas of Zagreb most hit by the earthquake, the disaster will have a highly negative effect on this strategic sector of the local economy. On the other hand, demand in sectors such as construction and related activities is likely to increase.

Recovery and Reconstruction Needs

Reconstruction needs are almost double the estimated damage. Given that the estimated damage stands at 505 million EUR, the investments needed for reconstruction are almost double this amount. Loss in terms of interruption of services, as noted, is estimated at 182 million EUR whereas with the seismic retrofitting and energy efficiency elements built in to the reconstruction, the costs will go up and would therefore require an additional investment of close to 200 million EUR. Therefore, the cost of reconstruction needs in the business sector based on calculations for 1.3 million square meters of affected area categorized under three levels of damage amounts to around 937 million EUR.

Firms need well thought-out and immediate support to sustain their businesses and retain workers. As mentioned in previous sections, businesses in Croatia were already struggling with the effects of the COVID-19 pandemic. These problems were further compounded by the earthquake, and well-structured support is needed. In the immediate term, firms are struggling with liquidity, the potential loss of workers (layoffs), and the risk of closure. During the recovery phase, policies should be geared towards supporting growth-oriented enterprises, promoting reallocation of resources to more efficient companies, and avoiding measures that risk propping up zombie firms.[38] What is needed is a comprehensive approach that would include the reconstruction of resilient physical infrastructure, alongside measures to reduce the impact of future disaster risks and vulnerabilities.

The focus of the strategy to alleviate the negative impact on firms is twofold: it should (i) support reconstruction, and (ii) offer further assistance, including financing and soft support. Support for reconstruction should be immediate and focused on demolition, debris removal and the restoration of working capital to the affected businesses. While this will help to put businesses back in shape, targeted assistance will also be needed in accessing finance and markets, upgrading technical and business management skills in the SMEs, and other measures as required. Table 34

TABLE 34
Total recovery and reconstruction needs in the business sector (in million EUR)

	Short-term	Medium-term	Long-term	Total
Reconstruction	281.16	328.01	328.01	937.18
Recovery	57.00	22.50	11.00	90.50
TOTAL	**338.16**	**350.51**	**339.01**	**1,027.68**

38 COVID-19 Notes. Finance Series, 2020, the World Bank. (2020)

provides the estimates for the reconstruction and recovery of the business sector, which currently stand at 1.03 billion EUR.

The primary objective of the first phase of support is the reopening and restarting of businesses, particularly by assisting in the reconstruction of damaged infrastructure and restoring cash flow. In order to ensure sustainability and resilience, reconstruction should follow the build back better (BBB) concept, in line with the best practices and standards in the construction industry. There is also a need to focus on business revival, supporting firms in need with grants, micro-loans and wage subsidies. Increasing re-employment opportunities for those who lost their jobs is another strategy that needs to be taken into account. Earthquake-affected districts include mainly SMEs and crafts, many of which have a lower capacity to respond to these shocks than bigger, better performing firms. Limited availability of capital reserves and lack of insurance are only some of the issues adversely affecting the structures of businesses.

In the short to medium term, support should be concentrated on putting a system in place that will foster productivity-led growth. This will require well-targeted financial support for firms that can drive growth, create jobs and be competitive. Soft support for structural changes must also be considered. Improving managerial capabilities, vocational training and upgrading skills in general is a long process, but essential if firms are to grow. It will also be necessary to undertake reforms to the business environment key priorities being the digitalization of government services, and the adoption of digital technologies by firms. This would not only help to streamline business processes and reduce costs, but also encourage flexible and home-based work. Last but not least, more attention should be paid to undertaking preventive measures. Understanding and complying with business safety standards would mitigate the potential effects of similar disasters in the future.

The overall earthquake recovery strategy will further detail the recovery plan for the business sector. Indicatively, recovery activities and measures will focus on ensuring the reactivation of economy in the affected areas through adequate financial schemes, supporting the recovery of affected enterprises and providing support for establishing innovative disaster-resilient business models including the revision of business safety standards.

MACROECONOMIC AND HUMAN DEVELOPMENT IMPACTS

Photo: Goran Mahkek / CROPIX

ZAGREB EARTHQUAKE
M 5.5, 7 km north of Zagreb, Croatia
Origin Time: 22.03.2020 05:24:03 UTC (Sun 06:24:03 local)
Depth: 8 km

MACROECONOMIC AND HUMAN DEVELOPMENT IMPACTS

MACROECONOMIC IMPACT

Summary

The earthquake is estimated to have caused damage amounting to 20.4% of Croatia's 2019 GDP. Almost 80% of this damage is in the private sector, mostly due to the amount of harm done to the housing stock. Losses are estimated at 1.3% of Croatia's GDP. The hardest hit economic sectors were those linked to housing[39] and real estate, followed by health, culture, education, and services linked to tourism.

As the earthquake happened during a COVID-19 lockdown which had already significantly reduced economic activity, its adverse effects on GDP growth for 2020 are hard to estimate but are believed to be small. On the other hand, the large-scale reconstruction due to begin in the second half of 2020 could provide an additional boost to investment, and help accelerate economic recovery in subsequent years. It is therefore estimated that the Croatian economy could contract by 9.3% this year, which is only slightly worse than the pre-earthquake baseline projection of 9.2%. However, risks are tilted to the downside, and the most recent forecast for Europe suggests that the annual GDP drop could be more severe, and that the recovery could begin later than previously expected. The economic recovery could start in 2021 with a growth rate of 5.8% (compared to 4.8% in the pre-earthquake forecast).

The earthquake is expected to place only a small additional strain on public finances in the short term: the fiscal deficit is estimated to be higher by 0.1 percentage points of GDP in 2020 compared to the pre-earthquake baseline of 9.9% of GDP. The necessary increase in public investment due to post-earthquake reconstruction in 2021 should, to the extent possible, be financed by grants from the EU, hence only a minor worsening of public finances is anticipated. The trade deficit is expected to change only marginally in 2020, before slightly worsening in 2021 and 2022 due to the relatively high import content of capital investment. Grants from the EU could have a positive effect on the overall current account balance (CAB) in 2020. It is expected that the current account deficit will be lowered from the pre-earthquake baseline projection of 3.6% of GDP to 3.4% of GDP in 2020. On the other hand, as the large inflow of grants will more than offset the worsening of the trade balance due to a rise in imports related to reconstruction, the CAB is expected to improve by about 0.2 percentage points of GDP in 2021, from -0.7% of GDP to -0.5% of GDP. No grants are foreseen in 2022, so the CAB is likely to worsen due to continued reconstruction investment to a small surplus of 0.2% of GDP (from a pre-earthquake projection of 0.6% of GDP).

39 Housing activities are reflected in the Real estate activities in the GDP categories. They affect GDP primarily through a reduction of inputted rent on owner occupied dwellings and rent revenues lost from property owners. Likewise, tourism losses are classified into "Accommodation and food". In this chapter, sectoral losses are mapped into the GDP categories which may have a different labelling than the sectoral assessments.

Photo: CROPIX

The Pre-Disaster Economic Context

Even before the Croatian capital and surrounding municipalities were hit by the strongest earthquake in 140 years, the country was already facing a deep recession because of the COVID-19 crisis. Lockdown measures have eroded economic activity, creating depreciation pressures on the Croatian kuna, and leading to a rapid increase of unemployment. These events followed a very positive 2019, when GDP growth accelerated to 2.9%, the unemployment rate reached a historic low of 6.6%, and public debt continued its downward trend for the fifth consecutive year. Given widespread travel bans and slowing activity in major trading partners, tourism and exports of goods were expected to bear the brunt of the slowdown. Croatia's high reliance on tourism makes it especially vulnerable to such external shocks. The tourist season, which usually gets under way during the Easter holidays but did not make a stuttering start until June (or in some areas July), is likely to face major challenges in 2020, leading to an expected fall in the export of tourism services of over 50%. In addition, the fall in exports of goods was set to reach 10.2%. Repercussions in the labor market could be severe, pushing unemployment to over 12% in 2020 which, together with falling wages, was expected to cause an 8.4% decline in personal consumption. It has been assumed that the pandemic will gradually fade by the end of the year, leading to an economic rebound in 2021-2022, with average annual GDP growth of 4.5%.

Zagreb, as the capital of Croatia, accounts for a third of the national GDP,[40] but Zagreb's share of the market services sectors is much larger. For example, Zagreb accounts for more than 70% of

40 Subnational data on gross value added by sectors are published with a relatively large time gap of two years. Therefore, the latest information available refers to 2017

information and communication activities, 60% of financial and insurance activities and 55% of professional services (measured as the share of national gross value added). Over the 2015-2017 period, Zagreb's economy was growing at a rate slightly above the national average, with double-digit growth in information and communication activities and services related to tourism.

Disaster Impact on GDP

Since the earthquake occurred at a time when most business were closed due to the COVID-19 lockdown, its direct effects on economic activity were small. The losses linked to the earthquake will lower economic growth by only 0.1 percentage points in 2020. The growth impact estimates for the earthquake is principally based on a production-side national accounts growth model, whereby the detailed sectorial Damage and Loss Assessments are considered in terms of their overall impact on the economy. The Damage and Loss Assessment estimates show that real estate activities are the hardest hit by the earthquake, although health, culture, education and tourism also suffered significantly. On the other hand, reconstruction and recovery efforts are expected to start in earnest in the second half of 2020, offsetting to a large extent the initial negative effects on economic activity, and helping to accelerate recovery in subsequent years, primarily through faster growth of the construction sector.

On the expenditure side, the earthquake is expected to hit private consumption hardest in 2020. Disruption of rental activities and damage to residential property, coupled with a decline in the wealth of Croatian households, will adversely affect private consumption. However, if serious reconstruction efforts start up in the second half of 2020, it is expected that higher capital investment will, to a large extent, offset the decline in consumption. In 2021, positive effects of investment in reconstruction will dominate, but will also lead to a rise in imports of construction materials with a negative effect on the trade balance. In nominal terms, GDP in 2020 is estimated to be lower by about 65 million EUR (0.5 billion HRK). In 2021 and 2022, it is expected that capital investment related to reconstruction will reach 5 billion HRK, supporting recovery in subsequent years. The earthquake is not expected to have significant impact on consumer price inflation, as it did not cause significant disruption of retail supply chains. Also, while the earthquake could have resulted in the rise of rents in the city due to a reduction in the supply of habitable dwelling space, the COVID 19 crisis will more than offset such developments. This is partly because the major decrease in tourist arrivals to Zagreb has forced some landlords to move from daily tourist rentals to regular monthly rentals, increasing supply in this segment of the market.

Sectoral Impacts

The earthquake has caused economic losses in all key sectors, especially in housing, tourism, education and health. The share of the real estate business in Croatia's economy is more than 9% of GDP. Earthquake-related losses in the real estate business are due to disrupted rental activities, and damage to owner-occupied residential property. The total impact (damage and losses) is valued at 7.3 billion EUR (55.5 billion HRK), with the total damage amounting to 6.9 billion EUR (52.6 billion HRK) and the total losses estimated at 373.8 million EUR (2.9 billion HRK). The earthquake has also resulted in a decrease in the value of housing stock in the center of Zagreb, and has caused major shifts in the residential market. Available information suggests that real estate prices in the city center have dropped significantly. While this may have adverse effects in the short-run, cheaper property prices in the city center could attract new residents who will be willing to invest in upgrading current housing stock.

The tourist industry (embracing accommodation as well as cafés, restaurants and catering) accounts for close to 7% of Croatia's economy. The earthquake damaged a number of tourist-rental apartments. Due to the lockdown and its effect on tourism however there was no immediate impact on this sector. Indeed, it is expected that the number of tourists coming to Croatia and its capital will be significantly lower in 2020 and the subsequent two years due to the COVID-19 pandemic, and that the reduction in the supply of private accommodation will not represent a binding constraint. As a result, the pre-earthquake forecast for the sector, standing at a 50% drop in value added, has not changed.

The total damage in the health, education and cultural sectors is estimated at 3.3 billion EUR or 6.3% of 2019 GDP. Losses have also been significant, arising from the operational expenses of debris removal, emergency response, the costs of reallocating essential services in other areas, and so on. The total damage and losses have caused problems for service delivery in the affected communities, thus contributing to the decline in GDP.

On the other hand, earthquake emergency responses and reconstruction efforts are expected to support recovery in the subsequent period, offsetting the decline in economic activity in 2020, mainly through the construction sector and related services (including the transport trade). Under a reconstruction and recovery scenario, the construction sector, which accounts for slightly over 4% of GDP, is expected to grow by an additional 10% in 2021 compared to baseline assumptions.

Disaster Impact on Fiscal Position

Since joining the EU, Croatia has made solid progress in consolidating its public finances. The general government budget balance, calculated according to the methodology set out by ESA 2010 (European System of Accounts), has improved from a deficit of more than 5% of GDP in 2013 to an average surplus of 0.5% in 2017-19, with the structural deficit being above its medium-term budgetary objective. Budget surpluses, falling borrowing costs, and favorable economic developments also narrowed the public debt. After peaking in 2014 at 84.7% of GDP, general government debt at the end of 2019 was 73.2%.

However, plummeting economic activity, combined with the sizable fiscal package needed to contain the impact of COVID-19 and earthquake reconstruction costs, caused a large fiscal deficit and reversed the favorable trajectory of public debt. The annualized fiscal impact of the COVID support measures is estimated at around 5% of GDP and will be partly financed from EU funds (currently estimated at 1.7%). The earthquake presents an additional challenge to the fiscal position. The revised 2020 budget approved by parliament included the sum of 13 million EUR (100 million HRK) to help mitigate earthquake damage and losses. When combined with loss of revenues due to the drop in economic activity caused by the earthquake, the general government deficit is projected to increase by an additional 0.1% of GDP. Overall, the fiscal deficit is expected to reach 10% of GDP in 2020. While large public investments related to the recovery are expected to begin in 2021, it is expected that this will initially be largely financed by grants from the EU, so no significant worsening of public finances is expected. However, the public sector will in subsequent years have to also rely on borrowing from the markets, domestic finances, and international financial institutions to finance post-earthquake reconstruction. It is important to stress that the largest part of the reconstruction costs will be borne by the private sector, and it is therefore crucial to ensure that private sector actors have access to affordable financing schemes.

Disaster Impact on the Balance of Payments

In line with a relatively modest impact on GDP, the earthquake is also expected to have a negligible impact on the trade balance in 2020, and a small negative effect in 2021 and 2022. However, the current account deficit forecast stands now at -3.4% of GDP in 2020 from a pre-earthquake baseline of -3.6%, due to anticipated reconstruction grants from the EU estimated at 0.2% of GDP. The trade balance-to-GDP ratio is expected to widen in 2021 and 2022, when accelerated reconstruction will lead to an increase in imports of construction materials and equipment. However, significant EU grants might come in 2021, more than offsetting the widening trade deficit, so the CAB is expected to improve to -0.5% of GDP, down from -0.7% of GDP in the pre-earthquake baseline projection in 2021. Even with increased imports, the CAB is likely to remain in surplus in 2022. The earthquake is expected to have a negligible impact on exports. Damage in the historical center of Zagreb could result in a somewhat smaller demand for tourist services, but as tourist arrivals are already very low in the baseline projections due to the COVID-19 pandemic, any further effect will be marginal.

TABLE 35
Main macroeconomic and fiscal indicators

Macroeconomic Indicators	2019	2020		2021		2022	
Time period	Actual	Pre-earthquake estimate	Post-earthquake estimate	Pre-earthquake estimate	Post-earthquake estimate	Pre-earthquake estimate	Post-earthquake estimate
Output and prices							
GDP (current prices, EUR million)	53,968.6	47,411.5	47,345.6	50,360.3	50,777.2	53,208.2	53,709.7
GDP growth rate (percent) (constant prices)	2.9	-9.2	-9.3	4.8	5.8	4.2	4.3
CPI inflation (percent)	0.8	-0.2	-0.2	1.4	1.4	1.8	1.8
Deflator (percent)	1.5	-0.2	-0.2	1.4	1.4	1.5	1.5
Fiscal Position							
Total revenue (EUR million)	25,641.6	20,645.5	20,720.7	22,719.4	23,049.3	24,509.7	24,551.7
Total revenue (percent of GDP)	47.5	43.5	43.8	45.1	45.4	46.1	45.7
Tax revenue (EUR million)	20,949.8	15,667.2	15,646.9	18,220.6	18,259.6	19,752.9	19,795.1
Non-tax revenue (EUR million)	4,691.7	4,978.3	5,073.8	4,498.8	4,789.7	4,756.8	4,756.8
Expenditures (EUR million)	25,432.1	25,344.7	25,457.8	24,817.3	25,238.9	25,766.3	25,902.3
Expenditures (percent of GDP)	47.1	53.5	53.8	49.3	49.7	48.4	48.2
Fiscal balance (percent of GDP)	0.4	-9.9	-10.0	-4.2	-4.3	-2.4	-2.5
External sector							
Current account balance (EUR million)	1,570.8	-1,710.0	-1,609.7	-352.0	-277.0	293.0	83.0
Current account deficit (percent of GDP)	2.9	-3.6	-3.4	-0.7	-0.5	0.6	0.2
Exports (EUR million)	28,123.7	19,268.0	19,268.0	24,701.4	24,701.4	28,950.0	28,950.0
Growth rate (percent)	7.8	-31.5	-31.5	28.2	28.2	17.2	17.2
Imports (EUR million)	28,150.5	21,166.5	21,144.5	25,711.6	25,936.6	29,594.0	29,804.0
Growth rate (percent)	6.2	-24.8	-24.9	21.5	22.7	15.1	14.9

HUMAN DEVELOPMENT IMPACT

This chapter focuses on three key aspects related to the human development impact of the earthquake, namely poverty and inequality, gender, and disability.[41] In line with the methodology for the RDNA, while there was not a specific working group focusing on human development aspects as such, these aspects were considered as part of the respective sectoral assessments. Drawing on sectoral information as well as national and international research, this chapter provides background information, summarizes effects, and highlights key recommendations related to the issues of poverty and inequality, gender, and disability in support of a sustainable and resilient recovery and reconstruction process. Since the earthquake occurred in the midst of the COVID-19 outbreak, this chapter also highlights some of the combined implications/effects of this multi-layered disaster.

Background

Poverty and Inequality

Despite progress in poverty and inequality in Croatia in recent years, several challenges may hinder further improvements going forward. While mitigation options adopted by the government are expected to counteract a significant fraction of the expected increases in poverty, two key issues are important to note. First, poverty is still persistently high for some population groups and regions; and second, poverty reduction is expected to slow down given the growth slowdown, expected job losses and disruption of economic activity caused by the COVID-19 pandemic and the earthquake.

While national official poverty rates have been in decline, Croatia still faces an at-risk-of-poverty rate that is higher than the EU average, with the elderly population - particularly women - especially vulnerable. During 2017,[42] the most recent year of published figures, 19.4% of the population in Croatia lived in at-risk of poverty. The elderly (65+) in Croatia have an at-risk-of-poverty rate (28.2%) that is higher than the national average. Family composition matters: the most vulnerable group are single-elderly households, with at-risk of poverty rates reaching 48.3% in 2018. Poverty for elderly women (31.3%) is 7.8 percentage points higher than for elderly men (23.8%). In 2011,[43] the City of Zagreb was the least poor county in the Republic of Croatia, with an at-risk-of-poverty rate close to 10%. At the same time however it had the third highest concentration of the country's poor due to having a high population density. Income poverty in the districts of Zagreb ranged between 4.9 and 16.3% (see Figure 20).

Poor households in Croatia are expected to be disproportionately affected by the COVID-19 pandemic. During the period of the global financial crisis, large poverty increases were mostly driven by job losses and declining labor income. Insufficient safety nets were not enough to cover households from the welfare losses that resulted from the public health crisis, given the current coverage gaps of the bottom quintile. After the crisis, absolute poverty in Croatia increased from 4.7% in 2009 to 7.3% by 2014,[44] mainly due to losses in jobs and labor income, with part-time workers and the self-employed disproportionately affected.[45] Going forward, poverty is expected

41 This chapter also includes an account of impact on children which has been provided by the UNICEF Office in Croatia.

42 2017 income year correspond to 2018 survey year. Eurostat and the NSI reports survey year.

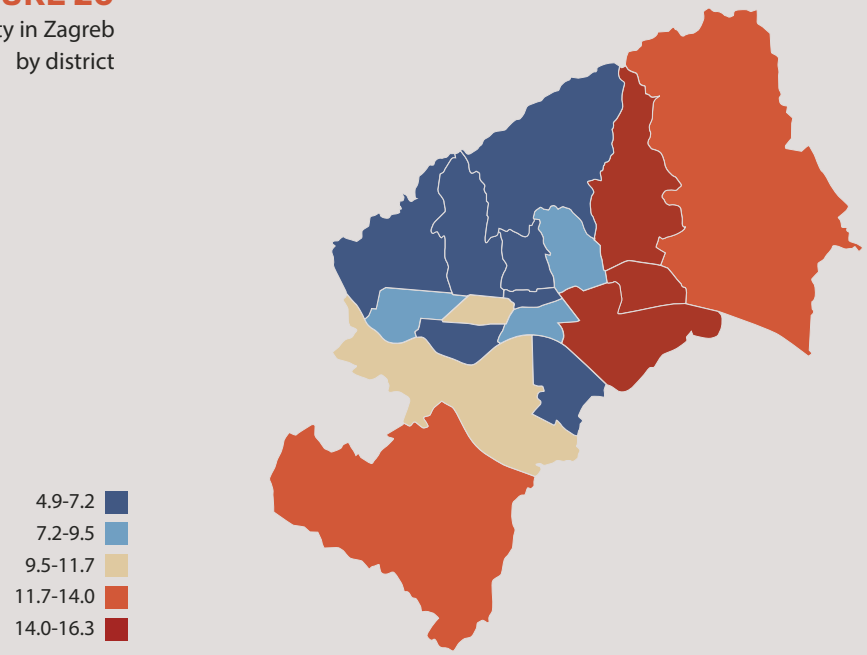
43 Latest year at which poverty maps are available in the country.

44 Poverty is measured as the share of population living on less than US$5.5 per day (2011 PPP).

45 World Bank. (2020). "Tackling Poverty and Inequality in Croatia: The Way Forward". Policy Note prepared for the Croatian National Development Strategy World Bank Reimbursable Advisory Services.

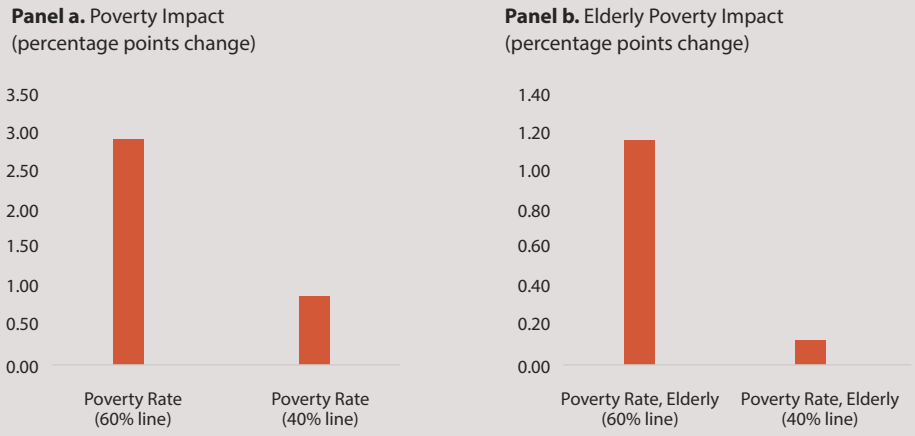
to increase (absent mitigation measures), given the expected negative labor market impacts of the current crisis. An upcoming World Bank study[46] shows that at-risk-of poverty rate is expected to increase by 2.9 percentage points (from 18.9 to 21.8%).[47] Elderly poverty is expected to increase by 1.2 percentage points.

FIGURE 20
Poverty in Zagreb by district



Source: World Bank (2018). Small area estimates of income poverty in Croatia: methodological report. https://documents.worldbank.org/en/publication/documents-reports/documentdetail/307961530044451676/small-area-estimates-of-income-poverty-in-croatia-methodological-report

FIGURE 21
Estimated poverty impact of COVID-19 crisis



Source: World Bank estimates based on microsimulation results. Poverty rate measure with official poverty line (60% median adult equivalent income). A lower poverty line set at 40% median adult equivalent income is also used.

46 Source: "Mitigating the Poverty Impact of the COVID-19 Crisis in Croatia", forthcoming

47 Estimated AROP in 2020 using 2018 SILC data and 2020 tax and benefit parameters

Gender

While the country has made significant progress in achieving gender equality across different spheres, gaps nevertheless persist, especially in access to economic opportunities.[48] Gender equality also has a strong ethnic dimension, with Roma girls and women severely excluded from all levels of education and work. Rural women also tend to suffer more in terms of poverty, employment, education, and access to services, childcare, and elderly care.[49] While Croatian women do well in education at all levels, school completion does not translate into higher levels of labor force participation. Roughly 61% of active women have paid jobs, compared to 71% of men. Key factors contributing to lower participation in the labor force among women include traditional gender norms related to the family, and barriers faced by women of childbearing age to find work or return to work after starting a family. There is also a wage gap between women and men which then leads to a pension gap, making women worse off than men throughout their lifecycle, and also poorer by 35% during retirement.

The poverty rate is disproportionally higher among households where the female is the primary breadwinner, and no working age males earn labor-market income; a contributing factor to this is the fact that women earn 17-19% less than the males. In general, the lack of affordable childcare appears to hinder women's participation in the labor force across the country, with women frequently leaving paid jobs in order to provide unpaid care for children and elderly members of the family. Furthermore, only about 3% of women aged 25-29 are entrepreneurs, only about 12% of firms have women in top management positions, and only one third of firms have women as owners.

Disaster Effects

Impact on Population and Access to Public Services

The earthquake had considerable impact on the population of Zagreb and the surrounding areas, further complicating access to public services such as health care and education. 26 people were injured, 18 severely. One 15-year old girl died. As of 5 June, 488 people were accommodated in student dormitories, a large number of residents went to live with families or friends (the exact number is unknown but is estimated to be around 30,000). The City of Zagreb, Zagreb County and Krapina-Zagorje County have a combined population of 1,239,333, of which 1,118,587 live in municipalities and towns where a state of natural disaster was declared. According to government data, it is estimated that a total of 1,904,729 people were directly exposed to the earthquake. Out of these, 791,038 were exposed to intensity level VII, 353,845 to intensity level VI, and 759,846 people to intensity level V of the Modified Mercalli Intensity Scale (Figure 22).[50] Out of these, 53% were women, 17% were over 65, and 15% had some form of inability to perform everyday tasks.

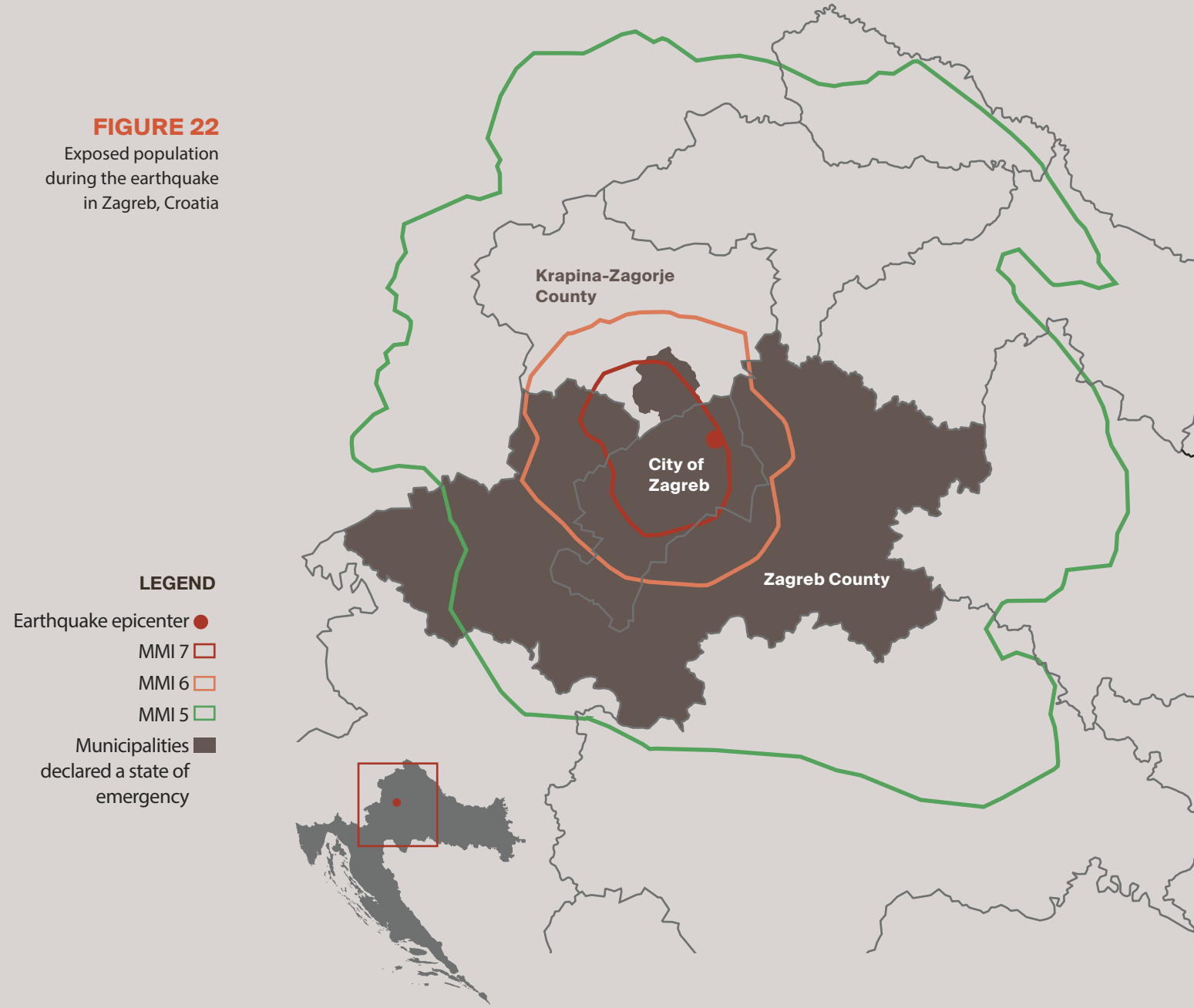
Healthcare: According to an assessment by the Faculty of Civil Engineering of the University of Zagreb, 137 health facilities were damaged by the earthquake. Several high-occupancy hospitals suffered substantial structural damage, forcing the evacuation of patients. In total, preliminary

48 Morrica, Valerie, Tara Sharafudheen, Paul Andres Corral Rodas, Ursula Casabonne, and Zuzana Boehmova. 2019. *Investing in Opportunities for All Croatia: Country Gender Assessment*. Washington, DC: World Bank Group.

49 Morrica, Valerie; Sharafudheen, Tara; Corral Rodas, Paul Andres; Casabonne, Ursula; Boehmova, Zuzana. 2019. *Investing in Opportunities for All Croatia Country Gender Assessment*. Washington, D.C.

50 Ministry of Interior, Civil Protection Directorate, Disaster Risk Reduction Sector, Risk Assessment Service, Database and GIS Support Department.

FIGURE 22
Exposed population during the earthquake in Zagreb, Croatia



MMI	Population				
	Overall	Age (0-14)	Age (65+)	Women	Disability*
VII	791,038	115,657	137,375	421,273	120,658
VI	353,845	58,258	53,866	183,179	36,416
V	759,846	118,315	131,517	390,738	178,550
Total	**1,904,729**	**292,230**	**322,758**	**995,190**	**335,624**

* population in a need of care in everyday life
Source: Census 2011, Croatian Bureau of Statistics

M 5.5, 7 km north of Zagreb, Croatia
Origin Time: 22.03.2020 05:24:03 UTC (Sun 06:24:03 local)
Depth: 8 km

Created: Civil Protection Directorate, Disaster risk reduction sector, Risk assesment department, Database and GIS support unit. Modified according to USGS.

estimates indicate that 214 buildings (health centers, clinical hospital centers, clinical hospitals, clinics, polyclinics, special hospitals, health institutes and pharmacies) were affected by the earthquake. For example, a whole inpatient ward with young mothers with newborn babies was evacuated from a damaged maternity hospital and moved with incubators to a new location with the help of the army.[51] According to Health Ministry data, overall damage affects the provision of services to at least 1,424,327 patients that are normally served annually, through the care of over 2,739 medical and non-medical personnel (with details in the Health sector chapter). The rehabilitation of damaged buildings is important to ensure that the capacity of the health system is restored, and that Croatia is equipped to meet its national healthcare needs, including preparations for future pandemics and natural disasters. For example, the Croatian Institute of Public Health, which provides critical public health capabilities—including the management of pandemic events such as the current COVID-19 outbreak or any future waves of the same—was damaged by the earthquake, causing temporary disruption to its services.

Education: Similarly, the earthquake has had a significant impact on the delivery of education services. According to an assessment by the University of Zagreb's Faculty of Civil Engineering, 513 education facilities were damaged. Fortunately, when the earthquake hit, all institutions were closed, and as a result, no pupils or students were injured. Nonetheless, the event rendered many buildings unsafe for future use. As the Ministry of Science and Education gradually reopens education facilities following their closure in March, the impact of the earthquake means that not all facilities can be reopened. Figures indicate that the total number of pupils and students affected by damage to their places of education stands at a minimum of 9,538. If staff and other employees are included, this figure rises to more than 10,000 people. It is estimated that some 6,200 children will need to be relocated from damaged schools to new school environments.[52] The University of Zagreb, which is among the most severely affected institutions, has over 60,000 students, many of which have been directly affected by the earthquake.

Children

There is scant robust research on children's coping with two concurrent disasters, but available information[53] indicates that children exhibit a rise in emotions of stress and fear, that they find it difficult to deal with uncertainty (particularly regarding their education), and that they miss the social contact with their peers. According to the available online questionnaires,[54] children not belonging to marginalized groups seem to be affected by the COVID-19 and the earthquake most in terms of their mental health, while children belonging to vulnerable groups seem to have experienced a barrier in the opportunity to attend distance education, most probably due to family circumstances and the resulting digital divide.

51 Peter Stubley. Croatia earthquake: Hospital evacuated as tremor hits during partial coronavirus lockdown, March 22, 2020, Independent.co.uk.

52 According to the Ministry of Science and Education.

53 First found by a pilot study, conducted by Zrinka Ristic Dedic of the Institute for Social Research in the days following the Earthquake, and confirmed in subsequent similar results of online questionnaires conducted by srednja.hr (https://www.srednja.hr/oznaka/anketa-maturanti/), by the Institute of Social Research and by Petar Bezinovic on Mental Health (who shared his preliminary research findings with UNICEF Croatia).

54 https://skolazazivot.hr/rezultati-upitnika-o-izvodenju-nastave-na-daljinu-od-16-3-2020-do-2-4-2020/; https://infogram.com/ukljucenost-ucenika-romske-nacionalne-manjine-u-nastavu-na-daljinu-1hmr6gvrl57z6nl?live&fbclid=IwAR0A2un5vpfc4Lqzdd0x1BM0uOuH6xDKBQnYGOLFKvh7vaDdqNBl7jF8EwQ.

Poverty and Inequality

Global experience shows that disasters and emergencies undermine development gains, diminish economic growth, and trap vulnerable groups in poverty. Research suggests that the poor are less able to cope with and recover from shocks than their better-off peers, and that these shocks may indeed have a lasting impact on their health and education.[55] Lower incomes and the underutilization of household assets contribute to the additional vulnerability of poor households to the negative shocks of natural disasters, unless risks are properly mitigated.

The compound effects of the COVID-19 crisis and the earthquake can therefore be significant. The earthquake – in addition to the COVID-19 pandemic crisis - is expected to increase poverty in several ways. Firstly, the sudden loss of assets (including housing) and capital. Secondly, the reduction in income that results from damaged infrastructure and employment losses. Thirdly, school closures and damage may affect these households disproportionately more, given the higher dependency ratios. Finally, the indirect effects associated with a slowdown In growth, rising food prices from food shortages, and so on. These factors affect the current poor, but also increase the risk of falling into poverty for those that are not poor but vulnerable. Preliminary findings from a forthcoming World Bank report on the poverty impacts of earthquake and floods in Croatia[56] confirm that the poorest 20% of the population are disproportionately affected by disasters. The consumption losses caused by this type of event have a 5% chance of occurring in the next 10 years, and are expected to push some 50,100 individuals into consumption poverty (1.2% of the local population), and displace some 110,000 people individuals under the middle-class consumption level (representing a 4.4% decrease compared to pre-disaster levels).

Gender

While there was no event-specific data collected with respect to gender during this assessment, global experience suggests that women are disproportionally affected by external shocks, including disasters and health emergencies, constrained by their traditional role of primary caregivers in their families. Disasters tend to discriminate along generational and gender lines, and indirect or secondary impacts of disasters make life worse for women. Several studies analyzing recovery from disasters have revealed that women and children are at greater risk due to low income levels and household composition (single female heads of household, older people, pregnant women). This vulnerability can be further aggravated by other elements of discrimination such as race (e.g. for Roma women), poverty, and disability.[57] Further, women are at risk of experiencing increased levels of gender-related violence, which is traditionally under-reported in Croatia.[58] The United Nations has projected that, globally, the outbreak of COVID-19 could see an increase in gender-related violence.[59]

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55 Hallegatte, Stephane, Adrien Vogt-Schilb, Mook Bangalore, and Julie Rozenberg. 2017. *Unbreakable: Building the Resilience of the Poor in the Face of Natural Disasters*. Climate Change and Development Series, Washington, DC: World Bank.

56 World Bank. Forthcoming (2020). *Overlooked. Reexamining the impact of disasters and climate shocks on poverty in the Europe and Central Asia region.* The study uses the World Bank poverty and middle-class thresholds for upper middle-income countries (respectively US$5.50 and US$15.00 per day per person) to calculate poverty impacts and recovery dynamics based on given disaster scenario (earthquake or floods).

57 Monica Vidili. *Why we must engage women and children in disaster risk management.* 2018. Washington, DC: World Bank Group.

58 Morrica, Valerie, Tara Sharafudheen, Paul Andres Corral Rodas, Ursula Casabonne, and Zuzana Boehmova. 2019. *Investing in Opportunities for All Croatia: Country Gender Assessment.* Washington, DC: World Bank Group.

59 https://www.unfpa.org/press/new-unfpa-projections-predict-calamitous-impact-womens-health-covid-19-pandemic-continues.

Photo: Damjan Tadić / CROPIX

Disability

While no event-specific data was collected with respect to disability during this assessment, global experience suggests that people with disabilities are disproportionately affected by the immediate and long-term effects of disasters and health emergencies. The reasons for this disparate impact include not only aspects of disability but also the interplay between disability and the other risk factors which point to enhanced vulnerability during emergencies, such as poverty. Disability-based discrimination marginalizes people with disabilities, and in many cases forces them into conditions of dependency. Disasters exacerbate such conditions, enhancing the disparities between people with disabilities and other members of society, and increasing the likelihood that those with disabilities will be disproportionately affected both during and after an earthquake. Evidence shows that, in the aftermaths of disasters, people with disabilities are often unable to access facilities associated with evacuation, response (including shelters, camps, and food distribution) and recovery/ reconstruction.[60]

60 Global Facility for Disaster Reduction and Recovery. 2017. *Disability Inclusion in Disaster Risk Management*, 2017. Washington, DC: World Bank Group.

Recovery and Reconstruction

Poverty and Inequality

Mitigation measures implemented by the government are expected to alleviate the impact of he earthquake on poverty. A forthcoming World Bank study found that wage subsidies can mitigate significantly the poverty increase caused by the epidemic, as they are generous and cover workers with temporary contracts as well as the self-employed, groups that are overrepresented among the employed poor. A new non-contributory cash benefit for the elderly is expected to have a small but positive poverty impact on those aged 65 and above. Overall, these measures, together with the supplemental health insurance scheme, are expected to decrease at-risk-of poverty by 2.1%, compared to a crisis scenario without any additional measures.[61]

Considering the potentially large compound effects of the epidemic and the earthquake, there is scope for combining emergency social protection policies with post-disaster and recovery reconstruction policies to stimulate progress in poverty and inequality reduction going forward. In order to increase the resilience of the poor and vulnerable in Croatia, it is critical to mitigate the risks of future disasters, while at the same time responding to the urgent problems posed by the current crisis. In order to mitigate the impact on access to public services among the affected population, it is important to restore the functioning of critical public services, including health, education, and social welfare. Also, when restoring such services, special attention should be given to aligning investments with strategic governmental priorities, like the deinstitutionalization of children and the development of community-based social services.

Gender

Sustainable and resilient recovery and reconstruction processes should promote equal access and feedback from diverse population groups and improve data collection of, and awareness to, gender-specific needs. In a society subject to COVID-19-related social distancing and isolation policies, traditional engagement methods and feedback mechanisms can benefit from digital solutions. For example, participatory methods and consultations, including the use of online tools to support two-way information flows, or regular consultations and online focus group discussions with existing women's networks and associations through virtual or mobile/online platforms, can help ensure that women's specific needs are addressed. Communication and information campaigns should be designed to reach the vulnerable, including women, children and the elderly. Local women, who are the most effective at mobilizing their communities, should be supported to monitor local government action. This includes any gaps emerging at the point of recovery service delivery, including feedback on aspects of social assistance and support for peoples' livelihoods. Also, the design of reconstructed buildings may benefit from functional upgrades that take personal safety, accessibility, and hygiene needs into consideration.

Children

To reduce the impact on children's' mental health and bridge the digital divide in education, it will be important to concentrate efforts on providing the conditions for the most vulnerable children and families to be involved, by finding practical solutions for bridging the digital divide and preventing dropout, helping students with coping strategies for uncertainty and stress to increase

61 No assesment has been made regarding poverty impacts by districts or municipalities.

Photo: Ronald Goršić / CROPIX

the chances for their future educational success, building capacity of teachers for distance education. Focus would be needed to support the learning of Roma children and children with disabilities, as well as their capacity development that addresses support to learning strategies that address mental health. Bearing in mind the consequences of the earthquake on children, when renovating any infrastructure, it would be important to respect the principle of the best interest of the children and the principles of Universal Design. Specifically, this means to improve the accessibility of inclusive education of children with disabilities/developmental delays, to provide space and equipment for the provision of family and community-based services as well as timely intervention and accessibility of social welfare services to children with disabilities.

Disability

The rehabilitation and reconstruction of damaged infrastructure should comply with national and EU regulations on universal access. The design of the rehabilitated or reconstructed infrastructure can benefit from consultations with existing networks and associations and building accessibility audits. The key is to anticipate problems by including disability concerns in future emergency and recovery plans, partnering with people with disabilities and disability advocacy groups, and pushing emergency management institutions to provide clear direction on what they are doing for the disabled community. Including the needs of people with disabilities at all stages of the earthquake recovery process can help significantly to reduce the vulnerability of these people and increase the effectiveness of the government response and recovery effort. In addition, inclusive recovery and reconstruction efforts should ensure "building back better" (both physically, and with respect to the provision of services and community support for people with disabilities)[62] and routinely adapt the "Design for All" concept (physical spaces are designed and built to be accessible to and safe for all, especially people with disabilities).[63]

62 Global Facility for Disaster Reduction and Recovery. 2017. *Disability Inclusion in Disaster Risk Management*, 2017. Washington, DC: World Bank Group.

63 World Health Organization. *Disasters, disability and rehabilitation*.

RECOVERY AND RECONSTRUCTION

Photo: Igor Pavlović

ZAGREB EARTHQUAKE
M 5.5, 7 km north of Zagreb, Croatia
Origin Time: 22.03.2020 05:24:03 UTC (Sun 06:24:03 local)
Depth: 8 km

RECOVERY AND RECONSTRUCTION

DISASTER RISK REDUCTION

National Risk Assessment Efforts and the 2020 Zagreb Earthquake

In 2009 the Republic of Croatia established the Croatian National Platform for Disaster Risk Reduction. The main aim of the Platform is to connect the relevant political and operational institutions with the scientific community in order to improve the sharing of knowledge, prepare strategic documents, and enable science-based decision-making that could improve the prevention and reduce the impact of disasters. In 2014, the Main Working Group of the Croatian National Platform for Disaster Risk Reduction identified 28 threats divided into 11 groups facing Croatia. The risk assessment revealed that the threat of earthquake was one of the top three disaster risks in Croatia. The preliminary assessment showed that earthquakes could have significant consequences at the national level, and the working group proceeded with a detailed earthquake risk assessment. The national risk assessment, in accordance with the Civil Protection System Act is updated every three years. This was done most recently in 2019.[64]

The earthquake risk assessment was coordinated by the Ministry of Construction and Physical Planning. It was drawn up by experts from Zagreb University's Faculty of Civil Engineering together with representatives of the Croatian Seismological Survey, and also received the input of specialists from universities throughout Croatia. The risk assessment foresaw several potentially complex risk scenarios, including the possibility of Zagreb suffering an earthquake and a flood at the same time.

The March 22 earthquake, the strongest in 140 years, demonstrated how robust the methodology used in developing earthquake risk assessments actually was. The risk assessment had accurately predicted that an earthquake with an epicenter just northeast of Zagreb would cause severe damage to the historical city center. The assessment also foresaw that significant damage would also be sustained by those modern buildings not built in accordance with current regulations and sound professional practice.

Croatia has a systematic approach to disaster risk reduction. It started drafting the National Disaster Risk Management Strategy after having completed the preparation of the Disaster Risk Assessment and the Capacity Assessment of Disaster Risk Management. Although the work was affected by restrictions introduced to deal with the COVID-19 pandemic, the preparation of the Strategy should be completed by the end of 2020. The Strategy aims to prioritize investments in disaster risk management (DRM) over the next ten years and earthquake risk management will form an

64 Government of Croatia. Procjena rizika od katastrofa za Republiku Hrvatsku. https://civilna-zastita.gov.hr/UserDocsImages/CIVILNA%20ZA%C5%A0TITA/PDF_ZA%20WEB/Procjena_rizika%20od%20katastrofa_2019.pdf

Photo: Tomislav Kristo / CROPIX

important part of the Strategy, especially because it is a risk with possibly the most fragmented jurisdiction in the country. Completion of the National Disaster Risk Management Strategy will be a prerequisite for determining allocations from European Structural and Investment Funds within the next financial perspective (2021-2027).

The Disaster Risk Management Strategy is therefore a document of utmost importance for the Disaster Risk Management System, bringing much-needed order to the field of disaster risk reduction. Mainstreaming DRM into all national and sectoral policies is the main goal of the Platform. Much more remains to be done in this regard, especially in the area of earthquake risk management, but the measures implemented by the Platform are a step in the right direction.

The March 22 earthquake also revealed the need to improve cooperation within the Croatian National Platform for Disaster Risk Reduction, as well as between the Platform and the experts from the Faculty of Civil Engineering, not just in order to develop risk assessment documents and analyses, but also to recommend measures for disaster risk reduction and prevention based on the assessments. There is a clear need for improved inter-sectoral cooperation in the field of disaster risk reduction, alongside more detailed monitoring of construction practices and spatial planning.

According to the DRM Capability Assessment, earthquake risk management is based on risk assessment, insufficiently developed legislation (concerning anti-earthquake construction and physical planning), and a very sparse seismograph network.

Photo: Goran Mahkek / CROPIX

A thorough seismic assessment of existing buildings is needed to help engineers identify earthquake-prone structures. An assessment of the vulnerability of buildings, together with an estimation of the seismic hazard, will allow more informed decisions to be made. Improved knowledge of local soil conditions will help determine the anti-seismic parameters of each building. Further investment in the Croatian Seismological Survey will improve seismic monitoring and lead to a more detailed approach to seismic risk reduction planning.

Despite earthquakes being recognized as a major danger, there is no single body fully competent to coordinate the management of that danger. Because catastrophic earthquakes occur relatively rarely, the system of earthquake management has, up until very recently, been subject to neglect.

With no single body responsible for earthquake risk; and no systematic management of investments in earthquake risk reduction, responses are dispersed across multiple sectors. This situation can only be resolved by raising awareness of the level of risk, and by appointing risk reduction coordinators from within existing sectors that already have an obligation to manage that risk. The National Disaster Risk Reduction Platform is the body to implement these measures, providing it is given enough political and financial support.

RECOVERY NEEDS AND GUIDING PRINCIPLES

Reconstruction and Recovery Needs

Led by the Croatian government, the RDNA process accessed a broad range of expertise, including contributions from the relevant ministries, representatives of universities, the regional and local authorities, as well as experts from the World Bank, which facilitated the whole process. The process has been captured in this report, which will help the Croatian government to move forward with the formulation of an overall earthquake recovery strategy.

The total cost of reconstruction and recovery is estimated at 17.469 billion EUR. Of this amount, 4.522 billion EUR relates to short-term needs (26%), followed by 7.113 billion EUR (41%) for medium-term needs, and 5.833 billion EUR (33%) for long-term needs.

Throughout the recovery process, the Croatian government will bear responsibility for the strategical allocation of resources and for establishing the necessary legal framework covering all aspects of material and social recovery. The implementation of measures to strengthen existing buildings and to mitigate earthquake risks is a key factor in improving the resilience of the community in the future.

Defining the reconstruction and recovery needs is the final step in the assessment process. The total recovery needs, which include both reconstruction costs and soft recovery measures, are considerably higher than the estimated damage and losses for all sectors. Several factors have contributed to this; notably the fact that the earthquake severely damaged Zagreb's historical city center, which as a whole is classified as cultural heritage; the need to apply build back better principles and improve functional characteristics of buildings; and the fact that many of the affected hospitals and schools will need to be retrofitted to meet the highest seismic resistance standards.

The collected data shows that considerable damage has been inflicted on the following sectors: housing (the most affected sector), culture and cultural heritage, health, education, and business. The most important short-term goal has been recognized as restoring the capacities of the health sector as quickly as possible, in order to prepare for future earthquakes or other potential disasters. This will have to be done at a time when the COVID-19 pandemic still poses a considerable threat. Developing a strategy for health-sector recovery also entails a strategy for the long-term development of the Croatian health system as a whole, in particular its ability to respond to all sorts of disasters and pandemic risks. In the case of the City of Zagreb, for example, a strategic decision needs to be made on the cost-effectiveness of reconstructing existing hospital capacity in the buildings where they are currently located, or moving them to other premises, bearing in mind that partially prepared spaces for this purpose already exist.

The main short-term goal in the education sector is to ensure the full functioning of the existing system at all levels, from preschool education through to university faculties and research institutes. This will be achieved wherever possible through the urgent recovery of existing capacity, so that the next school year can commence without major hindrance. In the long run, it will be necessary to move some of the educational institutions of the University of Zagreb into newly repurposed areas, such as the former military barracks in Borongaj.

The sector affected most by the earthquake is housing. It is urgently necessary to prevent further damage to housing stock, especially the further weakening of buildings that have suffered structural damage. Such buildings continue to pose a threat to residents who have made a partial return to their damaged homes, as well as endangering passers-by due to the possible collapse of facades, chimneys or other elements. In the longer term it will be necessary to create housing

Photo: Ranko Šuvar / CROPIX

conditions in accordance with recent scientific findings regarding the resistance of structures to seismic stress. Reconstruction of damaged housing will also need to take into account the social, cultural, sanitary and other conditions appropriate for a modern society.

The geographical area which suffered most earthquake damage was the historical center of Zagreb. Developing a feasible recovery strategy for this immovable cultural heritage will be one of the Government's key priorities. The reconstruction of the historical center will necessitate a comprehensive and interdisciplinary approach involving up-to-date conservationist practices. Before any major interventions, the inputs of conservationists will be needed to ensure that the historical characteristics of old buildings are retained. As such measures are often complex, they require considerable time, and special techniques, and since reconstruction work will need to be carried out in a densely populated urban environment, it is expected the reconstruction to be especially costly.

In the business sector, which, in addition to the consequences of the earthquake is also suffering from the COVID-19 pandemic, it is necessary to develop a unified recovery strategy for the entire economy at the national level, with assistance from all partners and especially the European Union. It is crucial to ensure a realistic financial framework for the recovery of the entire economy.

In order to develop the best possible reconstruction strategy it will be necessary to carry out detailed inspections of the buildings affected by the earthquake, as the inspections conducted so far are insufficient for any final assessment of their bearing capacity and seismic resistance. This is particularly important as aftershocks have still not subsided, with minor tremors occurring almost daily in the Zagreb area. It will also be necessary to carry out a multidimensional analysis of the cost-effectiveness of repairs to a large number of public buildings which, due to their historical and architectural significance, are recognized as cultural heritage (and whose removal or destruction would not be acceptable), but have suffered too much damage to be returned to their original function. This primarily concerns a larger number of institutions in the health, education and administrative sectors. The disruption caused by the earthquake has also affected the accessibility of hospitals within the city center. Difficulty of access to health institutions in any future disasters could seriously hamper the efforts of the emergency services.

The Croatian government has provided some of the financial resources for emergency assistance to the population hit by the earthquake, and the relevant ministries have prepared a legal framework for the use of these funds. The City of Zagreb has also organized assistance by donating construction materials to citizens for emergency repairs, while the relevant ministries have started making cash payments to citizens to reimburse the costs of emergency repairs and the removal of damaged chimneys and gable walls. The legal framework for reconstruction of damaged buildings, including precise guidelines for construction work, will be set out in the draft Law on Reconstruction of Damaged Buildings in Zagreb and the Surrounding Area which was, at the time of writing the report, undergoing public consultation. The consultations started on May 15, 2020 and the draft Law is due to be approved by the new Parliament as a priority action.

The government has already embarked upon the recovery process by preparing the legal framework for a thorough and long-term program of restoration. Building on action already taken, and using the RDNA process as a basis, a comprehensive Recovery Strategy will be drafted. The time span for recovery has been divided into short-, medium- and long-term periods, although the exact duration of these periods has not yet been determined. These will be decided during the preparation of the Recovery Strategy.

BOX 3

Proposed Law on Reconstruction of Damaged Buildings in Zagreb and the Surrounding Area

Almost immediately after the earthquake struck on March 22, the Ministry of Construction and Physical Planning began drafting a new law to address the specific needs of rehabilitation and reconstruction. The aim of this *lex specialis* is to prescribe the manner and procedures for the removal of debris, and the rehabilitation and reconstruction of damaged buildings on the territory of the City of Zagreb, Krapina-Zagorje County and Zagreb County. The main purpose of this Law is to establish a post-earthquake management system with mid-term and long-term response measures, and designated standards for the carrying out of repairs. The draft Law covers the rehabilitation and upgrading of both public and private buildings. It includes four levels of rehabilitation and reconstruction: (i) repair of non-structural elements of buildings required for legal use and occupancy of a building; (ii) repair of structural elements; (iii) upgrade of structural elements; and (iv) full rehabilitation and reconstruction. The proposed Law aims to streamline administrative procedures by prescribing roles and responsibilities among existing central and local agencies, and establishing a coordinating body and Expert Council for the rehabilitation and reconstruction of damaged infrastructure. The Law also stresses that the technical and analytical basis for rehabilitation of the urban historic city center will follow the latest EU and international seismic standards. Replacement housing will be provided to those residents whose dwellings have suffered severely and cannot remain there. The Law also intends to provide indication for the reimbursement of expenses for reconstruction, rehabilitation, dislocation or other actions eligible under this Law, including actions undertaken before adoption of the said legislation.

ANNEX

Photo: Anto Magzan

ZAGREB EARTHQUAKE
M 5.5, 7 km north of Zagreb, Croatia
Origin Time: 22.03.2020 05:24:03 UTC (Sun 06:24:03 local)
Depth: 8 km

ANNEX

ADDITIONAL INFORMATION ON THE RDNA METHODOLOGY

Summary: Following the earthquake, the Croatian government convened its development partners and called for an RDNA to be carried out under the leadership of the Inter-ministerial Committee for Civil Emergencies led by the Ministry of Construction and Physical Planning. The assessment focused on the affected counties of the City of Zagreb, Krapina-Zagorje County and Zagreb County; and select sectors, including (i) housing, health, and education; (ii) business (manufacturing and trade) and culture and cultural heritage; and (iii) intersecting areas of civil protection and disaster risk reduction (DRR).

RDNA training and arrangements: Following the training on the methodology and scope of the RDNA, officials and experts from the government, the University of Zagreb's Faculty of Civil Engineering and the World Bank technical teams formed working groups or teams for each sector. The teams included two members who completed post-disaster needs assessment training in February 2020. Each team had a dedicated focal point assigned by the relevant line ministry, one person from the RDNA secretariat, and experts from the lead development agency. These joint teams undertook an intensive exercise of data collection and verification in just over three weeks.

Summary of the methodology: The RDNA adopted the principles of Damage and Loss Assessment (DaLA) methodology, which includes the estimation and assessment of the effects (damage and losses) of a given event. DaLA was adapted to the requirements of the local context, taking into consideration the drafting of the draft Law on Reconstruction of Damaged Buildings in Zagreb and the Surrounding Area, as well as the Croatian government's assessment of damage and losses as part of their application to the EU Solidarity Fund (EUSF). Communication related to the EUSF application process was led by the Ministry of Regional Development and EU Funds, in cooperation with other RDNA participants.

The RDNA assessment summarizes the damage and loss across key sectors affected by the earthquake, as well as recovery and reconstruction needs. Sectoral teams collected pre-disaster (baseline data) to compare with post-disaster conditions, evaluated the effects and impacts of the disaster in each sector, and identified prioritized recovery needs. The methodology underpins a consistent application of the basic concepts of damage, losses and post-disaster recovery needs across all the respective sectors. Baseline data provided by the Croatian Bureau of Statistics and other sources were used as a benchmark to guide the assessment of changes in flows across major economic sectors. The assessment built on the collection and analysis of available information from the database of rapid post-earthquake assessments of damage and building usability, as well as information from various government and private sources. The damage and losses differ substantially between the sectors, due to the specificity of their corresponding calculations. The financial requirements needed to undertake reconstruction and recovery were also estimated, in relation to the short, medium and long-term periods. Alongside DRR measures, it is proposed that building back better (BBB) practices (considering improved quality reconstructions and energy efficiency) should be integrated in all reconstruction and recovery needs in order to improve the overall future disaster resilience. Likewise, social vulnerability, gender, and disability aspects were included as much as was possible throughout the sectoral analyses. The assessment also

considered the impact of the earthquake on the quality of human life in the medium and long term. The impact of the assessed sectoral damage and losses on the macro-economic level was also analyzed. The assessment also included the collection of relevant data and documentation (such as photographs) demonstrating the impact of the earthquake, as this is highly relevant for the submission of the application for EUSF support.

Assessment of damage: Damage is the quantification of the monetary value of public and private sector infrastructure and physical assets, which suffered high, moderate or low levels of damage during the disaster. This comprises (i) social infrastructure, including the number of residential buildings, education facilities, healthcare facilities and government buildings; (ii) sectors pertaining to business and to culture and cultural heritage ; (iii) the physical assets damaged or destroyed in those buildings and infrastructures, such as furnishings and equipment and movable cultural heritage.

Damage considers the number of damaged buildings and the total area in m^2 to have suffered different levels of damage. The levels of damage are based on the post-earthquake field surveys, which focused on damage and building usability assessments (Table 36). The levels of damage assigned by the field-study experts were color-coded as follows: (i) **green**, subdivided into the categories U1 and U2; in which U1 are buildings safe for use with slight non-structural damage, and U2 are buildings safe for use, but with suggested short term countermeasures (such removal of collapsed chimneys, moderate non-structural damage and slight structural damage); (ii) **yellow**, subdivided into PN1 and PN2, which are temporarily unusable buildings with heavy non-structural damage and moderate structural damage; and (iii) **red**, subdivided into N1 and N2, which are unusable due to external risk or heavy structural and non-structural damage. A 3D view of the Lower and Upper Towns of the City of Zagreb based on the usability classifications is presented in Figure 23.

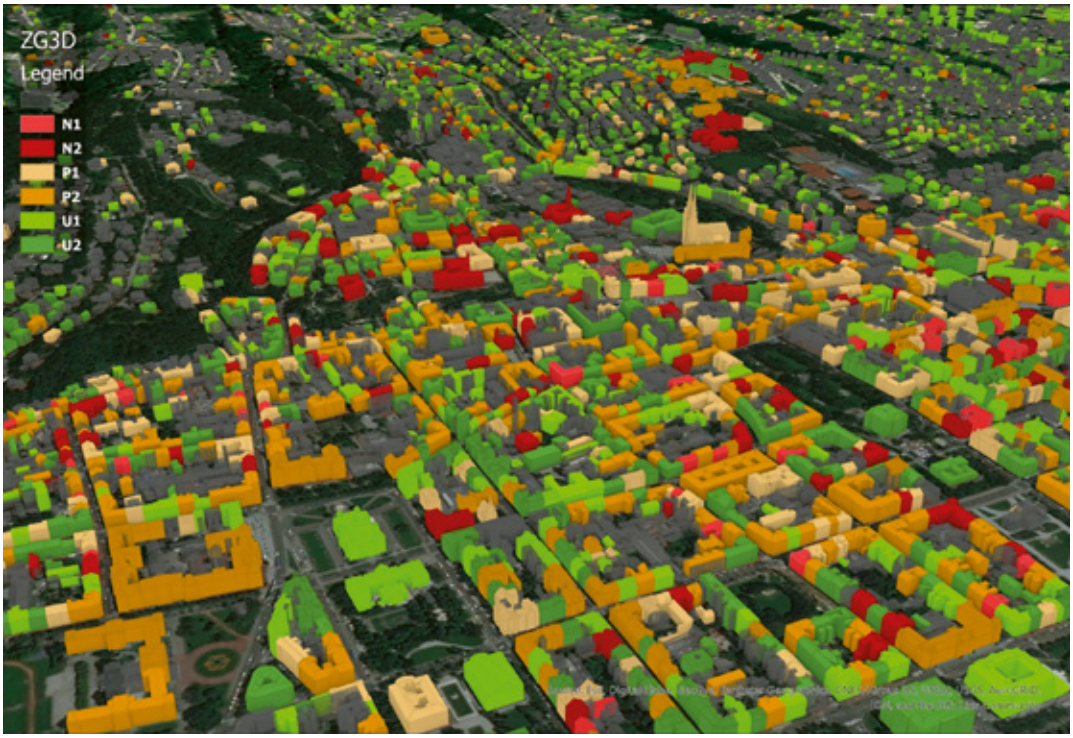
TABLE 36
Damage and building usability assessment levels

Damage states determined based on the conducted post-earthquake field surveys and the usability assessment	Level
Slight structural damage	
Moderate structural damage	
Heavy structural damage	

The economic value of damage is calculated using the average value of repair costs corresponding to different usability grades (green, yellow and red). Initial retrofit unit costs for each sector were defined using detailed analyses of real examples of recently reconstructed buildings.

Analyses were carried out for the Croatian government by external experts, just after the earthquake, in line with the proposed draft Law on Reconstruction of Damaged Buildings in Zagreb and the Surrounding Area. However, these initial estimates of costs were subsequently increased due to the inclusion of specialized work by craftspeople (not included in initial costs), energy efficiency upgrading, design fees, the potential increase of construction costs due to a lack of available labor, additional costs for the reconstruction of cultural heritage buildings, and VAT. Existing prices, bank calculations and existing data from other counties were also used in arriving at the estimates. Indirect costs comprise the short-term countermeasures needed to remove potential hazards and prevent further degradation of the buildings (such as the removal of collapsed chimneys, plaster, rubble and other debris; local minor repairs; and the propping and shoring of building elements). They were evaluated as flat rate values depending on the extent of damage and the specifics of individual buildings.

FIGURE 23
3D view of the Lower and Upper Towns of the City of Zagreb based on the usability classifications



Source: University of Zagreb Faculty of Civil Engineering.
Notes: 3D model of buildings represented by the color-coded usability classifications (green, yellow, and red).

Recovery and reconstruction needs: Based on the estimation of damage and losses, as well as qualitative impacts, each sector has been given specified recovery needs and suggested implementation arrangements. The needs identified form the basis for determining short-, medium-, and long-term recovery and reconstruction interventions. The costs consider the reconstruction of destroyed assets, provision of services, improved specifications, and risk reduction measures. It is assumed that the BBB principle will be used in the rehabilitation and reconstruction of damaged buildings, as well as improvements in energy efficiency. Rehabilitation consists of strengthening the existing damaged structures to the specific level of structural resistance prescribed by currently valid seismic regulations (Eurocode 8). The safety level of reconstructed buildings will be established in line with the relevant regulations. For example, buildings which are vital in emergency situations (such as critical hospitals, fire stations etc.) are expected to be rehabilitated according to seismic regulations. All other public buildings (such as those in the education, culture and cultural heritage sectors) will be rehabilitated to a slightly lower safety level (around 75% of that designated by current regulations). The objective for reconstruction in the housing sector is rehabilitation at a safety level which corresponds to at least 50% of that designated by current regulations. The total cost of recovery, which includes the cost of reconstruction of destroyed assets, was estimated through the aggregation of the cost of recovery needs across the assessed sectors.

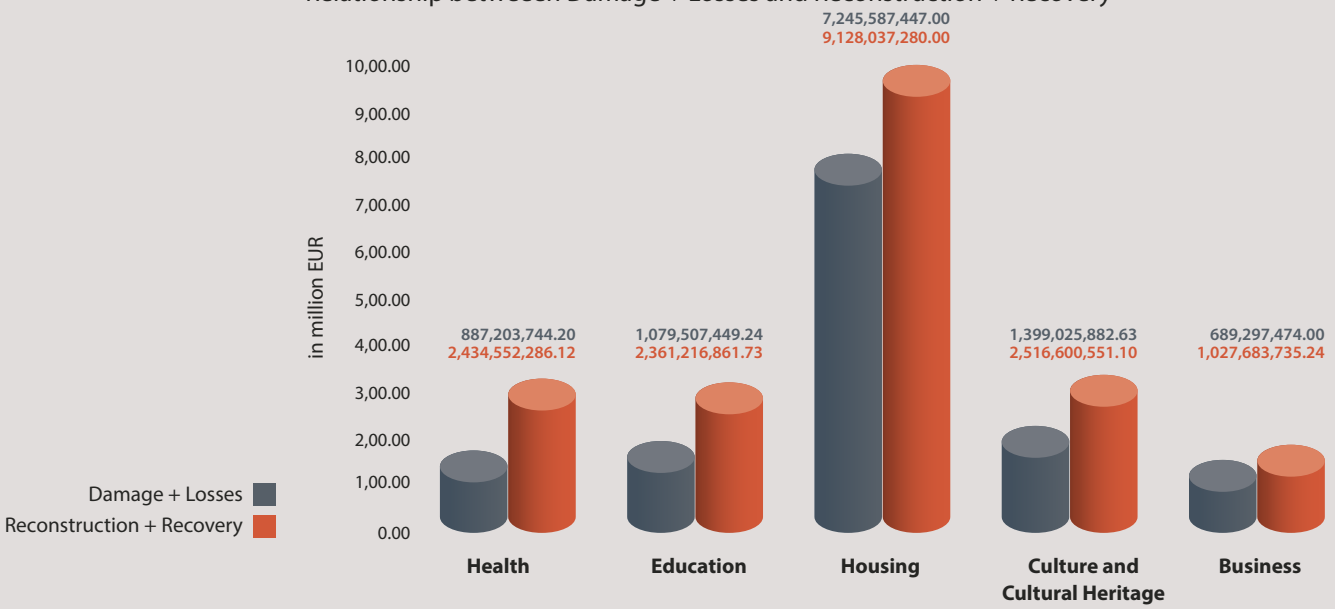
RDNA Findings

Methodology & Approach

- All sector teams used standardized damage and loss data collected and analyzed by FoCE engineers
- Where applicable costs related to furniture, equipment & goods damages were also accounted for
- Losses were calculated considering the debris removal costs
- Any other data was also taken into account and where possible triangulated providing most realistic and credible estimates
- **All sector teams identified respective recovery needs and provided recommendations for increased resilience as a combination of hard reconstruction and soft recovery measures**

Findings

Relationship betweeen Damage + Losses and Reconstruction + Recovery



Recommendations

- Detailed Reconstruction and Recovery Strategy/Framework should be developed
- BBB concept (including EE) and DRR measures should be integrated in all reconstruction and recovery needs in order to improve future disaster resilience
- Human impact in relation to social vulnerability to disaster (gender, disability, age etc.) should be mainstreamed in all reconstruction and recovery measures

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